No.	Date	Item
1.	12/20/88	Operators of Pirate Shipboard Radio Station Permanently Enjoined From Operation
2.	11/18/88	Applicants for Washington AM Station Ordered to Supplement Record (BC Dockets 82-436-7)
3.	11/10/88	FCC Declines to Amend Rules to Authorize the Use of Multiple Transmitters by AM Broadcast Stations (MM Docket 87-6)
4.	11/10/88	NPRM (MM Docket 88-510) Improved Methods for Calculating Groundwave Field Strength in the AM Broadcast Band
5.	11/5/88	Appendix, Calculation of Skywave Field Strength
6.	11/4/88	NPRM (MM Docket 88-511) Review of the Methods for Calculating Nighttime Protection for Stations in the AM Broadcast Service
7.	10/27/88	FCC Modifies Radio Duopoly Rule (MM Docket 87-7)
8.	10/21/88	Summary and Conclusions of the Proceedings of the Technical Sub-Group of the FCC's Radio Advisory Committee with Respect to MM Docket 87-267 in the Matter of Review of Technical Assignment Criteria for AM Broadcast Service
9.	10/18/88	NAB Memo re NRSC Rule Making (FCC Docket 88-376)

10.	10/13/88	FCC Proposes Rule Changes to Enhance Nighttime Operations by AM Stations, Improve Skywave and Groundwave Field Strength Calculations, and Revise Methods for Calculating Nighttime Protection for AM Stations (MM Dockets 88-508, 88-509, 88-510, and 88-511)
11.	9/29/88	Location of Field Installations
12.	9/21/88	AM Directional Antennas to Use Metric System Beginning January 4, 1982
13.	9/13/88	Delta Electronics, Stereo Noise Generator
14.	9/13/88	Delta Electronics, Preemphasis Monitor
15.	7/20/88	FCC Proposes Improving Quality of AM Service by Reducing Adjacent Channel Interference and Eliminate Protected Daytime Contour Restrictions (MM Docket 88-376)
16.	6/22/88	Expanded Band (1605-1705 KHz)
17.	6/17/88	NAB Comments on Section I and IV of the Notice of Inquiry (MM Docket 87-267)
18.	6/1988	NAB AM Radio Interference Study, Final Report
19.	5/17/88	NAB, AM Technical Assignment Criteria, An Examination of Issues Raised in MM Docket 87-267
20.	5/12/88	John Reiser phone no.

21.	4/16/88	Radiotechniques Letter re WFIL
22.	4/7/88	FCC Reaffirms and Orders Resumption of Processing of AM Applications for 14 Foreign Clear Channels (MM Docket 84-281)
23.	4/6/88	FCC, Suppression Performance of Directional Antenna Systems in the Standard Broadcast Band
24.	3/8/88	Radiotechniques letter re WFIL
25.	3/1988	Engineering Considerations
26.	1/28/88	Memo re Facilities Authorized Under Part 22 of FCC Rules - AM Facilities
27.	1/15/88	Unlimited-Time Operation by Existing AM Daytime-Only Radio Broadcast Stations; Discontinuance of Authorization of Additional Daytime-Only Stations; and Minimum Power of Class III Stations
28.	1/4/88	Radio Regulation, Report 41-1
29.	1988	WMP Notes

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982

December 20, 1988

OPERATORS OF PIRATE SHIPBOARD RADIO STATION PERMANENTLY ENJOINED FROM OPERATION

Ruling that the right of free speech does not include the right to broadcast without a license, United States District Court Judge John J. McNaught, Boston, Massachusetts, granted summary judgment to the government in a case seeking an injunction against the operators of an unlicensed "pirate rock and roll" shipboard radio station. On December 13, 1988, Judge McNaught held that Allan H. Weiner, Joseph Paul Ferraro, Randall Ripley and others had violated both federal and international law with past and planned broadcasts and permanently enjoined them from operating the unauthorized station.

The defendants had broadcast under the name "Radio New York International" or "RNI" on the AM radio band between 1605 and 1705 kHz from on board a ship known as the Sarah located off Long Island, NY. The defendants first broadcast without a license in July 1987 over AM, FM and shortwave radio from on board the Sarah until the broadcasts were halted by the government. RNI announced plans to resume the broadcasts and in August 1988 the government filed suit to enjoin them from doing so.

The United States argued that the defendants were in violation of both international and federal law and intended to further violate those laws in the future; and that numerous AM, FM, and shortwave radio stations would be subjected to interference from future RNI broadcasts. The government further contended that members of the listening public who rely on certain licensed programming for information and entertainment could have such programming disrupted by the unlicensed broadcasts.

In support of its position, the United States relied upon the International Telecommunication Convention, the basic instrument of the International Telecommunication Union of the United Nations, as well as the Communications Act. The Convention and its international administrative regulations govern radio broadcasting between nations and on the high seas. Article 30, Section 1(1) of the international Radio Regulations prohibits the establishment and use of broadcasting stations on board ships outside national territories.

Judge McNaught further concluded that the First Amendment does not grant anyone the right to broadcast by radio and that government regulation of broadcasting is constitutional.

(over)

The Judge also held that Section 2 [47 U.S.C. 152] of the Communications Act of 1934 expressly extends coverage of the Act to all transmissions by radio which originate and/or are received within the United States. Jurisdiction under the Act is therefore extended beyond places over which the United States has sovereignty. The Judge noted that there was no question that the broadcasts of the Sarah could be received within the borders of the United States.

The judge also stated that the FCC must allocate the limited available broadcast frequencies by way of the licensing process, and that this type of regulation best serves the public interest. Such regulation of the radio band does not infringe upon the constitutional rights of the defendants, but instead serves to foster international relations.

-FCC-

News Media contacts: Patricia A. Chew and Audrey Spivack at (202) 632-5050.

Field Operations Bureau contact: Lawrence R. Clance at (202) 632-7591.

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PARAN Any

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Report No. DC-1289 ACTION IN DOCKET CASE November 18, 1988

APPLICANTS FOR WASHINGTON AM STATION ORDERED TO SUPPLEMENT RECORD
(BC DOCKETS 82-436-7)

The Commission has ordered Valley Broadcasters, Inc. and Northwest Indian Women Broadcasters, Inc., to supplement their showings as to the performance capabilities of Valley's perimeter current antenna (PARAN).

Valley and Northwest seek authority to construct an AM broadcast station on 660 KHz at Mount Vernon, WA, and Portland, OR, respectively.

An FCC administrative law judge granted a summary decision in favor of Valley on an engineering qualification issue concerning its proposed use of a PARAN. In the initial decision, the judge resolved site intervention and lack of candor issues favorably to Valley and awarded a dispositive transmission service preference to Valley for providing Mount Vernon with its first competitive nighttime local transmission service while Portland had 19 commercial radio stations already.

The Review Board affirmed the judge's conclusion and Northwest appealed the ruling.

In reviewing the Board's decision, the Commission concluded that the Board may have erred in affirming the ALJ's grant of a summary decision to Valley on the PARAN antenna issue. The issue had been designated because the PARAN antenna system, consisting of four towers arranged in a square and radiating a non-directional AM signal comparable to that of a much taller monopole tower, had never been licensed before. The ALJ, however, granted a summary decision to Valley basically because the Mass Media Bureau supported Valley's theoretical projections and because a condition was placed on the grant that Valley must demonstrate by means of a full proof of performance that it complied with the applicable FCC efficiency standards before grant of program test authority.

The Commission said it was an error for the Board to rely on the license condition and on Valley's promise to move to another site and erect a conforming tower if the PARAN antenna did not operate as proposed. Thus, the Commission is seeking additional comments to determine whether sufficient information exists as to the ability of the PARAN to operate in compliance with the Commission's rules and regulations to support disposition of this case by summary decision.

(over)

The Commission noted that on November 24, 1986, it authorized Big Island Broadcasting Co., to use a PARAN antenna in the experimental synchronous operation of radio station KIPA in Hilo, HI. Program test authority was granted April 5, 1988. Thus, it noted, there was at least one PARAN system presently operating. The Commission ordered both parties to comment on the relevance to this proceeding of the KIPA operation, including what evidence it offers to prove or refute Valley's assertions.

It also ordered the Mass Media Bureau to submit its computer analysis of Valley's proposal and other pertinent information supporting its conclusion that Valley's theoretical projections are likely to materialize as proposed.

Action by the Commission November 8, 1988, by Order (FCC 88-366). Commissioners Patrick (Chairman), Quello and Dennis.

- FCC -

AM 3

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Report No. DC-1283 ACTION IN DOCKET CASE November 10, 1988

FCC DECLINES TO AMEND RULES TO AUTHORIZE THE USE OF MULTIPLE TRANSMITTERS BY AM BROADCAST STATIONS (MM DOCKET 87-6)

The Commission has concluded that current transmitter synchronization technology does not warrant amending its rules to authorize the use of multiple synchronous transmitters by AM broadcast stations at this time.

In reaching this conclusion, the Commission stated it was of the opinion that needed technological advances could take three-to-five years to develop and test, and would likely render obsolete much of the information it had currently received. The Commission expressed, however, its willingness to entertain further applications for experimental synchronous operation and said it would revisit this matter when circumstances appeared appropriate.

Synchronous broadcasting involves the use of two or more transmitters that broadcast identical program material on the same frequency. Such transmitters are generally located in geographic proximity to each other and are used to enhance or extend the coverage of an AM station. Since the service areas of the individual transmitters may overlap to some extent, mutual interference must be minimized by precisely synchronizing the carrier frequency or phase between stations.

On January 15, 1987, the Commission issued a Notice of Inquiry to solicit information relevant to the development of appropriate technical standards for the operation of synchronous AM transmitters. In response to the Inquiry, many commenters expressed optimism over the potential benefits of synchronous transmitters, while others enumerated a variety of technical and operational difficulties. In sum, the Inquiry was useful in soliciting direction on eligibility and authorization issues associated with the use of synchronous transmitters, but less successful in resolving some of the technical issues.

Consequently, the Commission found that while this proceeding had produced beneficial information concerning synchronous AM transmission, remaining technical uncertainties appeared to preclude further meaningful rulemaking activity at this time. Instead, any information received by the FCC, particularly information which could serve as the impetus for a new proceeding, will be included in a new docket file so that the public can be fully informed of interim developments and relevant technical advances.

(over)

Action by the Commission November 8, 1988, by Memorandum Opinion and Order (FCC 88-368). Commissioners Patrick (Chairman), Quello and Dennis.

-FCC-

News Media contact: Patricia A. Chew at (202) 632-5050.
Mass Media Bureau contact: Jim McNally at (202) 632-9660.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-510

In the Matter of

Improved Methods for Calculating Groundwave Field Strength in the AM Broadcast Band

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 10, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this *Notice of Proposed Rule Making* to examine its Rules relating to groundwave propagation in the AM broadcast service. In particular, the Commission is considering replacing the existing groundwave propagation curves contained in the FCC Rules with groundwave propagation curves recently developed. The Commission believes that these new curves are more accurate and their use would provide a better depiction of groundwave service and interference in the AM broadcast band.

2. This proceeding is an outgrowth of the *Notice of Inquiry*, MM Docket No. 87-267, 52 FR 31795, August 24, 1987, (*Inquiry*) which provided a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.[1] The goal of the *Inquiry* was to identify any changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.

3. The Commission discussed a number of issues specifically related to the calculation of groundwave field strength in its *Inquiry*. In particular, one alternative discussed is to replace all of the current groundwave propagation curves in the FCC Rules with improved groundwave propagation curves recently developed by the Commission's staff. Several related matters were also discussed in the *Inquiry*, notably, the need to revise the current FCC ground conductivity map (Figure M3) and revision of the current FCC method used to calculate groundwave field strength over paths containing more than one conductivity value.

4. We recognize that changes to the Commission's Rules to reflect new procedures for calculating groundwave field strength may well have, among other things, an effect on the portrayal of existing service and interference as well as an effect upon future calculations related to new and modified AM facilities. However, we believe that consideration at this time of procedures providing improved accuracy would facilitate future consideration of other possible changes to the Commission's technical assignment criteria. This would provide accurate groundwave field strength calculations for use in assessing the interrelationships of such proposed changes. Ultimately, improved accuracy in groundwave calculations would ensure that proposed new or modified AM stations would provide intended protection to other stations, or, conversely, that such proposed changes would not be unnecessarily restricted.

5. A substantial number of public comments which addressed groundwave propagation issues were received in response to the *Inquiry*.[2] These comments provide a general consensus supporting consideration of new methods for calculating groundwave field strength as suggested by the Commission in its *Inquiry*. For all of the reasons discussed, we believe that the time is now ripe for considering changes to the procedures for calculating groundwave field strength as proposed in the following sections.[3] Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

6. In contrast to the other frequency bands where broadcast services are authorized, the propagation characteristics of the AM broadcast band vary with the time of day. During daytime hours, signal propagation of an AM station is predominantly by groundwave signals. Groundwave signals travel along the surface of the earth and are thus affected by the characteristics of ground conductivity along the propagation path.

7. During nighttime hours, however, skywave signals from an AM station reach distances many times greater than its groundwave signals. Skywave signals are reflected from the ionosphere and can be propagated many hundreds of miles from the transmitter location. Nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave can be employed to provide skywave service many hundreds of miles from the transmitter, whereas, on the other hand, such enhanced conditions also increase the interference possibilities of co-channel stations over distances of hundreds of miles. As a consequence, co-channel stations that could be located reasonably close to one another without experiencing interference during daytime hours could cause significant mutual interference during nighttime hours.

8. A fundamental characteristic of groundwave propagation is that the signal radiated from an AM station is at a maximum at or near the transmitter site and diminishes in strength as the distance from the station increases. Groundwave field strength calculations are performed in accordance with Section 73.183 of the FCC Rules. These procedures make use of the groundwave propagation curves contained in Section 73.184 of the FCC Rules[4] as well as FCC Figure M3 which portrays estimated effective ground conductivities throughout the United States.[5] Procedures are also included for determining ground conductivity from field strength measurements which may be used in lieu of ground conductivity values obtained from Figure M3.

9. Significant advances were made in groundwave propagation theory in the late 1930s, and the FCC developed a full set of groundwave propagation graphs based upon that theory in 1939. These curves, which were prescribed by the FCC Rules until 1985, were drawn on the basis of exact mathematical computations for the field strength out to approximately 80 kilometers and also at much greater distances, typically beginning at approximately 320 km. It was necessary, however, to use freehand drawing to com-

plete the curves at the intermediate distances because the required computations for this region were too laborious to perform and the underlying mathematics was not fully established at that time. An additional very low conductivity curve was added to each of the original graphs in 1954. When these low conductivity curves were added, freehand drawing was still necessary to depict the field strength values at the intermediate distances.

10. In preparation for the Regional Administrative Radio Conference for AM broadcasting convened in 1980,[6] a computer program was developed by the Commission for recalculating a new set of groundwave curves for consideration by the Conference. These new groundwave propagation curves were drawn in metric format and extended to 10,000 km.[7] The field strength values derived from the new curves agreed to within one or two decibels with values from the curves in the FCC Rules. However, the computer program developed to produce the new curves did not overcome the difficulties previously encountered in calculating field strength values for intermediate distances since the mathematics involved still did not provide an adequate solution. Thus, it was necessary to force a match between the two portions of the curves where calculations were possible.

11. In implementing the Final Acts of the Region 2 Conference (1981), the Commission conducted a rule making proceeding for the purpose of aligning the domestic technical standards with those in international agreements.[8] At the conclusion of the rule making, the Commission adopted the groundwave propagation curves for domestic use.[9] Although in a different format, these curves were consistent with those adopted at the Conference.

12. The Commission staff continued its efforts to improve further the accuracy of the FCC groundwave curves. In February 1986, the Commission released a report, FCC/OET R86-1,[10] which described a new computer program incorporating solutions to the previous mathematical deficiencies. Use of that computer program permited precise field strength calculations to be performed at all distances, including the previously troublesome intermediate distances. The computer program was used to compute the groundwave curves for the band 1605-1705 kHz that were proposed by the United States to the First Session of the Conference[11] convened in 1986 to expand the AM broadcast band from 1605 to 1705 kHz.[12] This computer program is capable of calculating new groundwave curves for the band 535-1605 kHz.

DISCUSSION

13. The Commission has identified shortcomings in the current FCC groundwave field strength calculation procedures, the importance of which is magnified by the continuing demand for spectrum and growing concerns regarding interference as the AM broadcast band becomes more congested. Shortcomings in these procedures discussed in the *Inquiry* included: (1) the groundwave propagation curves, Graphs 1 to 19 of Section 73.184 of the FCC Rules, are not fully consistent with formulas in engineering texts; (2) the method described in the FCC Rules to adjust for a dielectric constant different from the standard value used in drawing the curves is not easily applied;[13] (3) the ground conductivity map, Figure M3, does not accurately depict ground conductivity values throughout the United States; and (4) the FCC method used to calculate groundwave field strength over paths containing more than one conductivity value is limited in its application.

14. Based upon the public comments received in the *Inquiry* and our own assessment of the issues raised in these matters, we are proposing new groundwave propagation curves derived from the 1986 computer program to replace the current curves in Section 73.184 of the FCC Rules. However, as discussed in detail *infra*, we are deferring consideration of the other issues related to groundwave calculation procedures.

15. *New Groundwave Propagation Curves.* The present FCC groundwave propagation curves appear to be sufficiently accurate over the ranges where precise calculations for their development were possible. However, there is a significant range of distances for these curves over which precise field strength calculations were not performed during their development. As a consequence, their use in certain instances results in an inaccurate portrayal of service and interference for AM broadcast stations.

16. For these reasons, in the *Inquiry* we discussed the desirability of developing new groundwave propagation curves to replace the curves currently in the FCC Rules. Comments filed in response to the *Inquiry* were overwhelmingly in favor of using the most advanced methods available for performing groundwave field strength calculations and recommended development of the revised curves. In their comments, the National Association of Broadcasters (NAB) and other parties urge the Commission to establish technical standards and calculation methods that would more accurately depict the service and interference in the AM broadcast band. CBS, Inc. (CBS) notes that where accurate determinations of interfering signals and protected contours are not available, interference may be caused where none was calculated, or the parameters of a station may be unnecessarily constrained. In addition, the Association for Broadcast Engineering Standards, Inc. (ABES) believes that it would be desirable to revise Graphs 1 to 19 to agree more closely with engineering formulas in order to simplify calculator or computer aided analyzing processes.[14]

17. Another matter discussed in the *Inquiry* concerns the conversion of Graph 20 of Section 73.184 of the FCC Rules from English to metric units. All commenters agreed that conversion to metric is desirable except for Schober who stated that the graph is unnecessary since the curves may be calculated directly by use of a computer.[15]

18. In view of the recommendations we received in the comments and the improved accuracy[16] that would be derived from adoption of improved groundwave propagation curves, we propose amending the Rules to incorporate the use of new groundwave propagation curves which are based upon the report, FCC/OET86-1.[17] Sample draft curves, reduced in size, are included in Appendix B of this *Notice*. A complete set of draft curves drawn to full scale is being placed in the record of this proceeding. In addition, we propose to convert Graph 20 to metric units in order to facilitate its use.[18] Comments are invited on these proposed changes, and, in addition, the Commission will consider alternative proposals which may provide potential improvements related to calculating groundwave field strength in the AM broadcast service.

19. *Improvements to FCC Figure M3.* Since the development of FCC Figure M3 in 1954, substantial ground conductivity measurement data has been collected by the FCC as a result of field strength measurements related to con-

struction and testing of AM broadcast antenna systems. These measurements have demonstrated the inaccuracies of Figure M3.[19] Section 73.183(c) of the Rules recognizes the limitations of Figure M3 and prescribes its use only when accurate and acceptable measurements have not been made.[20]

20. An alternative discussed in the *Inquiry* was the possibility of using the groundwave field strength measurements on file with the FCC to revise Figure M3. The Commission also noted in the *Inquiry* that other government agencies have been performing tasks related to collection of groundwave conductivity data and questioned whether such data would be appropriate to use if Figure M3 were revised.[21]

21. There was unanimous support in the comments received in response to the *Inquiry* to undertake steps to improve the accuracy of the ground conductivity map, FCC Figure M3. The comments of CBS are typical. CBS agrees with the *Notice*'s assessment of deficiencies in Figure M3 and believes the Commission should conduct a rule making to consider the issues surrounding revision and updating of Figure M3. According to CBS, it has long been known that Figure M3 is an imprecise guide and that inadequacies in the ground conductivity estimates taken from it limit the accuracy of calculations of AM groundwave propagation. In addition, CBS notes that the imprecision inherent in the present map unduly complicates and adds to the cost of AM engineering practice, as actual field strength measurements must be made in many instances where the Figure M3 conductivity value is unsuitable. On the matter of considering the use of ground conductivity data from other agencies, such as the FAA, the majority of the comments provided little support. Moreover, one commenter specifically opposed their use citing the fact that the FAA continues to employ FCC Figure M3 as the basis for its current frequency allocation studies.[22]

22. One dominant and recurring theme appears in the comments on this matter. That is, commenters note the complexity of the task to compile a data base of groundwave field strength measurements and to revise FCC Figure M3. ABES, for example, urges the Commission to take the lead in a project which, because of its complexity and great cost, can only be effectively undertaken at the governmental level.[23] This view was shared by many other commenters as well.

23. We agree that improvement of Figure M3 is both a desirable and substantial undertaking. This issue was raised in the *Inquiry* to provide the opportunity to identify possible approaches for updating Figure M3 that would not exceed available resources both within the industry and the FCC. In view of the comments received on this matter, it appears that the only viable alternative for updating Figure M3 is for the FCC to undertake the task, possibly through a contract. The Commission agrees with the comments regarding the anticipated substantial costs of such a project. Currently, there are no funds available for such a project and, in view of budget restrictions, it is not anticipated that such funding would be available anytime in the near future. In view of this, we are deferring further consideration of this matter until funding becomes feasible.

24. *Calculations over mixed paths.* Section 73.183(e) of the FCC rules prescribes the procedure to be used when calculating groundwave field strength over paths containing more than one conductivity value (mixed paths). This is referred to as the equivalent distance method or "Kirke method" after H. L. Kirke who described several calculation methodologies and compared results of calculations with actual measurements in 1949. Predictions by the Kirke method are known to be imperfect and we explored alternative procedures in the *Inquiry*.[24]

25. The comments on this subject were mixed. Most commenters suggested the continued use of the "Kirke" method while some recommended consideration of other methods. None, however, identified any other method which would be a worthwhile improvement. AFCCE finds the "Kirke Method" acceptable and it does not foresee that a change in methodology would result in a substantial increase in accuracy in the prediction of groundwave field strength contours whether for service or for interference situations. Robert A. Jones notes that the present method has served the AM broadcast service well over the years and suggests no change. After considering the comments, we have concluded that it would not be useful to attempt to improve on the Kirke method at this time. Commenters in this proceeding who have specific proposals to offer or definitive studies on this subject are invited to submit such material for our further consideration.

OTHER MATTERS

26. A general matter was raised by several commenters concerning implementation of new groundwave propagation curves and the relationship of this issue with other technical assignment criteria. WGN Continental Broadcasting Company (WGN), for example, believes that the issues surrounding groundwave propagation are so closely related to the allocations issues to be addressed later by the Commission that consideration of them at this point is premature. WGN, thus, requests the Commission to defer changes in the groundwave propagation rules until a review of the related allocations issues has been concluded. The Clear Channel Broadcasting Service (CCBS) urges the Commission to proceed with caution in developing new standards because of concerns about the possible disruptions of service that could result with such changes.

27. As we discussed *supra*, we are cognizant of the relationship between the groundwave propagation curves which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We noted in the *Inquiry* that use of new technical standards could result in changes to the location of service contours and calculated levels of interference. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a record on this issue. Such a record will guide the Commission on appropriate actions which ultimately should be taken.

28. We also believe, however, that there may be practical reasons for considering a delay in implementing new groundwave propagation curves, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, we believe that there is merit in considering implementing simultaneously all the interrelated changes that may ultimately be adopted. We believe that this approach would minimize administrative burdens for the Commission as well as uncertainties within the industry. We seek comment on the advisability of such an approach.

29. It would not be our intent to require any modifications of existing AM broadcast facilities as a result of the changes proposed in this *Notice*; nor would we intend to require parties whose applications are pending at the time any proposed rule changes are implemented to amend their application.

ADMINISTRATIVE MATTERS

30. Authority for the rule changes on which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

31. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **January 3, 1989**and reply comments on or before **January 18, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

32. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

33. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously-filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

34. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96-354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

35. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection and/or record keeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed on the public.

36. For further information on this proceeding, contact Larry W. Olson, Mass Media Bureau, (202) 632-6955.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment on the desirability of replacing the existing AM broadcast groundwave propagation curves with a new propagation model recently developed. The new model results from recent scientific analysis of groundwave measurement data and theory that provides a better understanding of groundwave propagation phenomena. Use of the new method for calculating groundwave field strength in the AM service would provide a more accurate depiction of the service and interference relationships between AM stations.

II. Objective:

The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis:

Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected:

There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to the standards (curves and formulas) used to calculate groundwave field strength. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. We will, however, consider in future rule making proceedings the related questions regarding assignment principles which, together with the propagation model, may result in new definitions of service and interference for AM broadcast stations. Such definitions are not now known but are intended to be beneficial to the AM service as a whole.

V. Reporting Record Keeping, and other Compliance requirements:

There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules:

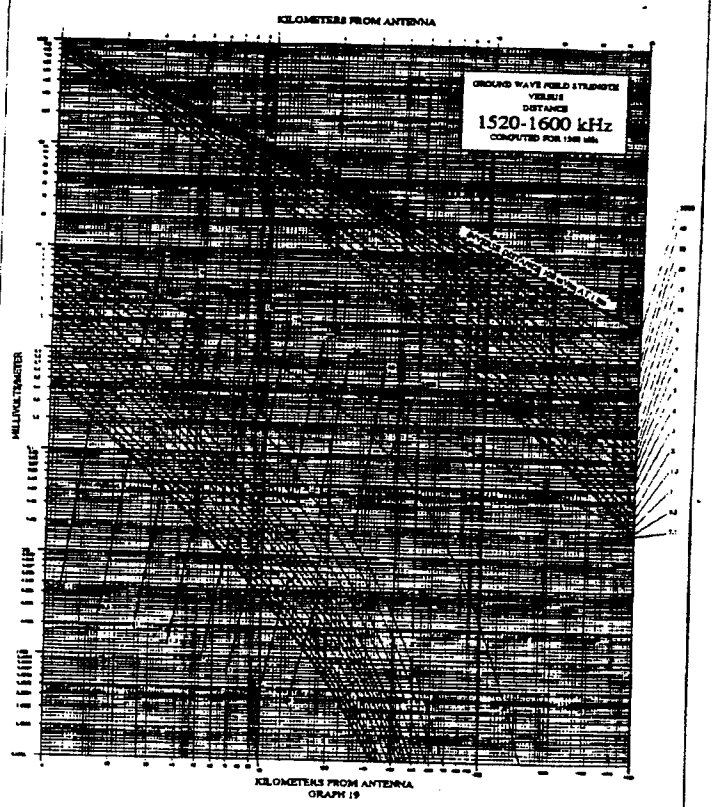
There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives:

There are no significant alternatives available.

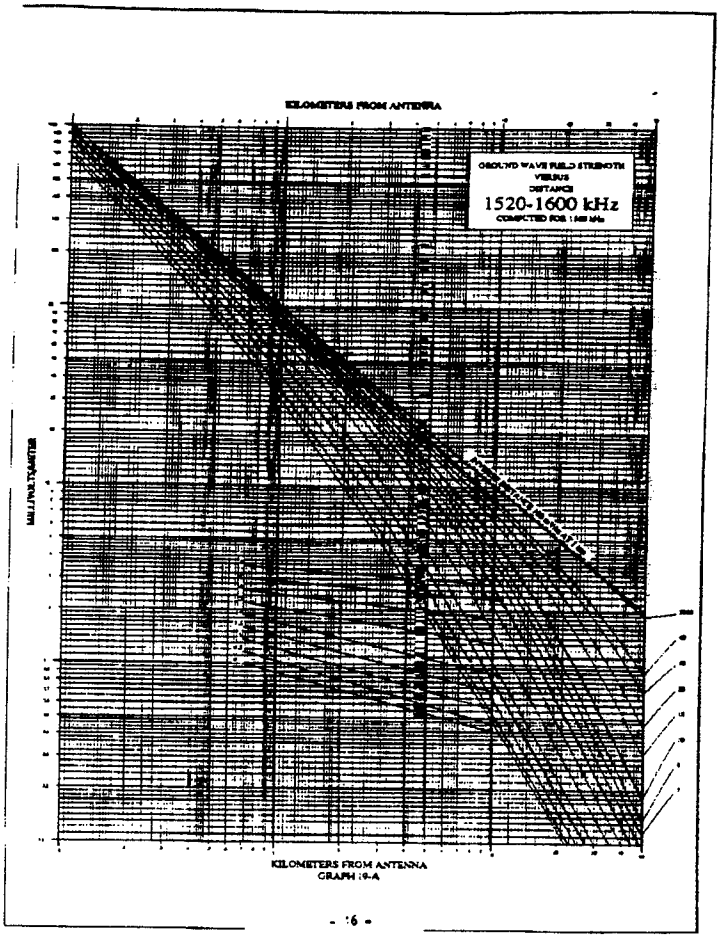
APPENDIX B

SAMPLE GROUNDWAVE PROPAGATION CURVES



GRAPH 19

- 15 -


KILOMETERS FROM ANTENNA
1520-1600 kHz
KILOMETERS FROM ANTENNA

GRAPH 9-A

- 16 -

FOOTNOTES

[1] The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, (*Report*) released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

[2] By *Order*, DA 87-1823, released December 15, 1987, the Commission granted a "Motion for Extension of Time for Filing Comments and Reply Comments" submitted by the National Association of Broadcasters (NAB). In that *Order*, the Commission bifurcated the proceeding and established separate filing periods. Phase 1 involved Sections II and III of the *Inquiry* while Phase 2 involved Sections I and IV. For the specific issues raised in Section III (Related Technical Issues) of the *Inquiry* under which groundwave propagation falls, the time for filing comments and replies was extended to February 1, 1988 and March 1, 1988, respectively.

[3] This proceeding will examine only those issues pertaining to groundwave propagation. Where appropriate, the Commission will institute future rule making proceedings to deal with the remaining issues addressed in the *Inquiry* and public comments. For example, in a similar action today, the Commission instituted a proceeding concerning skywave propagation. *See, Notice of Proposed Rule Making*, MM Docket No. 88-508, FCC 88-324.

[4] Graphs 1 to 19 are plotted for various AM broadcast frequencies and describe groundwave field strength as a function of the distance from the transmitter. Generally, for a given station the groundwave field strength at a specified distance is a function of the frequency and the earth's conductivity along the propagation path (*i.e.*, it varies inversely with frequency and directly with ground conductivity).

[5] FCC Figure M3 was developed more than thirty years ago by correlating field strength measurement data with identified soil types. This process resulted in a very generalized depiction of ground conductivity in the United States with broad areas on the map delineated by individual conductivity values.

[6] Regional Adminstrative MF Broadcasting Conference (Region 2). First Session, Buenos Aires, 1980; Second Session, Rio de Janeiro, 1981.

[7] These curves were later adopted by the Conference.

[8] At that time, negotiations on new bilateral agreements with Canada and Mexico either had been completed or were nearing completion. In both cases, negotiations were conducted with the view to incorporating the groundwave propagation curves adopted at the Rio Conference (1981).

[9] FCC MM Docket No. 84-752, Report and Order "In the Matter of Changes in AM Technical Rules to Reflect New International Agreements," published in the *Federal Register* May 2, 1985 (50 FR 18818). The computer program used for calculating these curves was subsequently released to the public for use in lieu of curves for calculating groundwave field strength.

[10] R. P. Eckert, "Modern Methods for Calculating Ground-wave Field Strength over a Smooth Spherical Earth", Report FCC/OET R86-1, February 1986.

[11] Regional Administrative Radio Conference to Establish a Plan for the Broadcasting Service in the Band 1605-1705 kHz in Region 2. First Session, Geneva, 1986; Second Session, Rio de Janeiro, 1988.

[12] These groundwave propagation curves were adopted by the Conference.

[13] Graph 20 of Section 73.184, of the Rules, "Ground Wave Field Intensity versus Numerical Distance of a Plane Earth," is provided for this purpose. However, it is in English units (miles) and therefore unwieldy since the related curves are in metric units (kilometers). The computer programs released in MM Docket No. 84-752 may be used in lieu of Graph 20.

[14] Two commenters addressed the international implications. Edward A. Schober (Schober) stated that these graphs should have been included in the international negotiations with Mexico and Canada; and, unless the agreements can be modified to include the revised graphs, the current graphs should be retained. Karl D. Lahm (Lahm) believes that the Commission should encourage other Region 2 administrations, particularly Canada and Mexico, to do the same in order to maintain consistent technical methods for all allocation purposes. Our intent at this time would be to use the new graphs, if adopted, for domestic purposes. If the new groundwave curves are adopted, we would explore with Canada and Mexico the possibility of incorporating their use in our bilateral agreements.

[15] Although not addressed in the *Inquiry*, Lahm suggested a change in the horizontal scale of the printed graphs and the density of the grid in order to facilitate curve reading and measurement analysis. A number of reply comments supported Lahm's suggestion.

[16] As an example of the differences between the current FCC groundwave curves and those we are proposing, Commission studies show that for a frequency of 1000 kHz and a conductivity of 10 mmhos/m the groundwave field strengths derived from the proposed curves at distance ranges of 0-80, 80-320, and 320-4220 km are at most 0.5, 1.5, and 6.6 dB lower, respectively, than those derived from the current curves.

[17] For reference, we are placing a copy of this report in the record of this proceeding. The computer program reproduced in the report could also be used for calculating groundwave field strength in lieu of the printed curves. Comments are solicited on the format of the draft curves.

[18] The computer program described in Report FCC/OET86-1 can be employed in lieu of Graph 20.

[19] On December 15, 1980, the FCC released a *Notice of Inquiry* in BC Docket No. 80-757, In the Matter of Amendment of the Rules concerning Automation of the use of Measurement Data for AM Broadcast Stations. This proceeding solicited comments concerning development of a data base comprising all outstanding measurement data submitted to the FCC for AM assignment studies. A consideration included was development of a digitized conductivity map based on the measurement data.

[20] Also, Figure M3 does not include conductivity information for Alaska, Hawaii, or United States territories.

[21] The Federal Aviation Administration (FAA) also has collected ground conductivity data relevant to aeronautical beacons in the band 200-415 kHz and maps have been produced with more detail in some areas of the United States than FCC Figure M3. *See,* S. A. Arcone and A. J. Delaney, "Electrical Ground Impedance Measurements in the U.S. between 200 and 415 kHz", Report No. FAA-RD-78-103, 1978.

[22] *See,* September 8, 1987, edition of the FAA's "Spectrum Management Regulations and Procedures Manual" (6050.32), Figure 11-2 (page 103).

[23] In noting that all commenters favored the updating of the ground conductivity map, ABES states that the problem with the revision of the ground conductivity map is finding someone who, in these days of austerity, can absorb the costs of such an enormous undertaking. As stated in its comments, ABES believes that the federal government is the only entity with the capacity of completing that task and urges the Commission to approach the Office of Management and Budget, the Congress and the National Telecommunications and Information Administration for the funds and facilities required.

[24] One of the alternative methods discussed was the "Millington" method. *See,* G. Millington, "Ground Wave Propagation over an Inhomogeneous Smooth Earth", *Proc. of the Institution of Electrical Engineers (London),* Part III, Vol. 96, pp. 53-64, January 1949; H. L. Kirke, "Calculation of Ground-wave Field Strength over a Composite Land and Sea path", *Proceedings of the IRE,* Vol. 37, May 1949, pp. 489-496; J. R. Wait, "Recent Analytical Investigations of Electromagnetic Ground Wave Propagation over Inhomogeneous Earth Models", *Proceedings of the IEEE,* Vol. 62, pp. 1061-1072, August 1974.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-510

In the Matter of

Improved Methods for Calculating
Groundwave Field Strength in the
AM Broadcast Band

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 10, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this *Notice of Proposed Rule Making* to examine its Rules relating to groundwave propagation in the AM broadcast service. In particular, the Commission is considering replacing the existing groundwave propagation curves contained in the FCC Rules with groundwave propagation curves recently developed. The Commission believes that these new curves are more accurate and their use would provide a better depiction of groundwave service and interference in the AM broadcast band.

2. This proceeding is an outgrowth of the *Notice of Inquiry*, MM Docket No. 87-267, 52 FR 31795, August 24, 1987, (*Inquiry*) which provided a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.[1] The goal of the *Inquiry* was to identify any changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.

3. The Commission discussed a number of issues specifically related to the calculation of groundwave field strength in its *Inquiry*. In particular, one alternative discussed is to replace all of the current groundwave propagation curves in the FCC Rules with improved groundwave propagation curves recently developed by the Commission's staff. Several related matters were also discussed in the *Inquiry*, notably, the need to revise the current FCC ground conductivity map (Figure M3) and revision of the current FCC method used to calculate groundwave field strength over paths containing more than one conductivity value.

4. We recognize that changes to the Commission's Rules to reflect new procedures for calculating groundwave field strength may well have, among other things, an effect on the portrayal of existing service and interference as well as an effect upon future calculations related to new and modified AM facilities. However, we believe that consideration at this time of procedures providing improved accuracy would facilitate future consideration of other possible changes to the Commission's technical assignment criteria. This would provide accurate groundwave field strength calculations for use in assessing the interrelationships of such proposed changes. Ultimately, improved accuracy in groundwave calculations would ensure that proposed new or modified AM stations would provide intended protection to other stations, or, conversely, that such proposed changes would not be unnecessarily restricted.

5. A substantial number of public comments which addressed groundwave propagation issues were received in response to the *Inquiry*.[2] These comments provide a general consensus supporting consideration of new methods for calculating groundwave field strength as suggested by the Commission in its *Inquiry*. For all of the reasons discussed, we believe that the time is now ripe for considering changes to the procedures for calculating groundwave field strength as proposed in the following sections.[3] Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

6. In contrast to the other frequency bands where broadcast services are authorized, the propagation characteristics of the AM broadcast band vary with the time of day. During daytime hours, signal propagation of an AM station is predominantly by groundwave signals. Groundwave signals travel along the surface of the earth and are thus affected by the characteristics of ground conductivity along the propagation path.

7. During nighttime hours, however, skywave signals from an AM station reach distances many times greater than its groundwave signals. Skywave signals are reflected from the ionosphere and can be propagated many hundreds of miles from the transmitter location. Nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave can be employed to provide skywave service many hundreds of miles from the transmitter, whereas, on the other hand, such enhanced conditions also increase the interference possibilities of co-channel stations over distances of hundreds of miles. As a consequence, co-channel stations that could be located reasonably close to one another without experiencing interference during daytime hours could cause significant mutual interference during nighttime hours.

8. A fundamental characteristic of groundwave propagation is that the signal radiated from an AM station is at a maximum at or near the transmitter site and diminishes in strength as the distance from the station increases. Groundwave field strength calculations are performed in accordance with Section 73.183 of the FCC Rules. These procedures make use of the groundwave propagation curves contained in Section 73.184 of the FCC Rules[4] as well as FCC Figure M3 which portrays estimated effective ground conductivities throughout the United States.[5] Procedures are also included for determining ground conductivity from field strength measurements which may be used in lieu of ground conductivity values obtained from Figure M3.

9. Significant advances were made in groundwave propagation theory in the late 1930s, and the FCC developed a full set of groundwave propagation graphs based upon that theory in 1939. These curves, which were prescribed by the FCC Rules until 1985, were drawn on the basis of exact mathematical computations for the field strength out to approximately 80 kilometers and also at much greater distances, typically beginning at approximately 320 km. It was necessary, however, to use freehand drawing to com-

plete the curves at the intermediate distances because the required computations for this region were too laborious to perform and the underlying mathematics was not fully established at that time. An additional very low conductivity curve was added to each of the original graphs in 1954. When these low conductivity curves were added, freehand drawing was still necessary to depict the field strength values at the intermediate distances.

10. In preparation for the Regional Administrative Radio Conference for AM broadcasting convened in 1980,[6] a computer program was developed by the Commission for recalculating a new set of groundwave curves for consideration by the Conference. These new groundwave propagation curves were drawn in metric format and extended to 10,000 km.[7] The field strength values derived from the new curves agreed to within one or two decibels with values from the curves in the FCC Rules. However, the computer program developed to produce the new curves did not overcome the difficulties previously encountered in calculating field strength values for intermediate distances since the mathematics involved still did not provide an adequate solution. Thus, it was necessary to force a match between the two portions of the curves where calculations were possible.

11. In implementing the Final Acts of the Region 2 Conference (1981), the Commission conducted a rule making proceeding for the purpose of aligning the domestic technical standards with those in international agreements.[8] At the conclusion of the rule making, the Commission adopted the groundwave propagation curves for domestic use.[9] Although in a different format, these curves were consistent with those adopted at the Conference.

12. The Commission staff continued its efforts to improve further the accuracy of the FCC groundwave curves. In February 1986, the Commission released a report, FCC/OET R86-1,[10] which described a new computer program incorporating solutions to the previous mathematical deficiencies. Use of that computer program permited precise field strength calculations to be performed at all distances, including the previously troublesome intermediate distances. The computer program was used to compute the groundwave curves for the band 1605-1705 kHz that were proposed by the United States to the First Session of the Conference[11] convened in 1986 to expand the AM broadcast band from 1605 to 1705 kHz.[12] This computer program is capable of calculating new groundwave curves for the band 535-1605 kHz.

DISCUSSION

13. The Commission has identified shortcomings in the current FCC groundwave field strength calculation procedures, the importance of which is magnified by the continuing demand for spectrum and growing concerns regarding interference as the AM broadcast band becomes more congested. Shortcomings in these procedures discussed in the *Inquiry* included: (1) the groundwave propagation curves, Graphs 1 to 19 of Section 73.184 of the FCC Rules, are not fully consistent with formulas in engineering texts; (2) the method described in the FCC Rules to adjust for a dielectric constant different from the standard value used in drawing the curves is not easily applied;[13] (3) the ground conductivity map, Figure M3, does not accurately depict ground conductivity values throughout the United States; and (4) the FCC method used to calculate groundwave field strength over paths containing more than one conductivity value is limited in its application.

14. Based upon the public comments received in the *Inquiry* and our own assessment of the issues raised in these matters, we are proposing new groundwave propagation curves derived from the 1986 computer program to replace the current curves in Section 73.184 of the FCC Rules. However, as discussed in detail *infra*, we are deferring consideration of the other issues related to groundwave calculation procedures.

15. *New Groundwave Propagation Curves.* The present FCC groundwave propagation curves appear to be sufficiently accurate over the ranges where precise calculations for their development were possible. However, there is a significant range of distances for these curves over which precise field strength calculations were not performed during their development. As a consequence, their use in certain instances results in an inaccurate portrayal of service and interference for AM broadcast stations.

16. For these reasons, in the *Inquiry* we discussed the desirability of developing new groundwave propagation curves to replace the curves currently in the FCC Rules. Comments filed in response to the *Inquiry* were overwhelmingly in favor of using the most advanced methods available for performing groundwave field strength calculations and recommended development of the revised curves. In their comments, the National Association of Broadcasters (NAB) and other parties urge the Commission to establish technical standards and calculation methods that would more accurately depict the service and interference in the AM broadcast band. CBS, Inc. (CBS) notes that where accurate determinations of interfering signals and protected contours are not available, interference may be caused where none was calculated, or the parameters of a station may be unnecessarily constrained. In addition, the Association for Broadcast Engineering Standards, Inc. (ABES) believes that it would be desirable to revise Graphs 1 to 19 to agree more closely with engineering formulas in order to simplify calculator or computer aided analyzing processes.[14]

17. Another matter discussed in the *Inquiry* concerns the conversion of Graph 20 of Section 73.184 of the FCC Rules from English to metric units. All commenters agreed that conversion to metric is desirable except for Schober who stated that the graph is unnecessary since the curves may be calculated directly by use of a computer.[15]

18. In view of the recommendations we received in the comments and the improved accuracy[16] that would be derived from adoption of improved groundwave propagation curves, we propose amending the Rules to incorporate the use of new groundwave propagation curves which are based upon the report, FCC/OET86-1.[17] Sample draft curves, reduced in size, are included in Appendix B of this *Notice*. A complete set of draft curves drawn to full scale is being placed in the record of this proceeding. In addition, we propose to convert Graph 20 to metric units in order to facilitate its use.[18] Comments are invited on these proposed changes, and, in addition, the Commission will consider alternative proposals which may provide potential improvements related to calculating groundwave field strength in the AM broadcast service.

19. *Improvements to FCC Figure M3.* Since the development of FCC Figure M3 in 1954, substantial ground conductivity measurement data has been collected by the FCC as a result of field strength measurements related to con-

struction and testing of AM broadcast antenna systems. These measurements have demonstrated the inaccuracies of Figure M3.[19] Section 73.183(c) of the Rules recognizes the limitations of Figure M3 and prescribes its use only when accurate and acceptable measurements have not been made.[20]

20. An alternative discussed in the *Inquiry* was the possibility of using the groundwave field strength measurements on file with the FCC to revise Figure M3. The Commission also noted in the *Inquiry* that other government agencies have been performing tasks related to collection of groundwave conductivity data and questioned whether such data would be appropriate to use if Figure M3 were revised.[21]

21. There was unanimous support in the comments received in response to the *Inquiry* to undertake steps to improve the accuracy of the ground conductivity map, FCC Figure M3. The comments of CBS are typical. CBS agrees with the *Notice*'s assessment of deficiencies in Figure M3 and believes the Commission should conduct a rule making to consider the issues surrounding revision and updating of Figure M3. According to CBS, it has long been known that Figure M3 is an imprecise guide and that inadequacies in the ground conductivity estimates taken from it limit the accuracy of calculations of AM groundwave propagation. In addition, CBS notes that the imprecision inherent in the present map unduly complicates and adds to the cost of AM engineering practice, as actual field strength measurements must be made in many instances where the Figure M3 conductivity value is unsuitable. On the matter of considering the use of ground conductivity data from other agencies, such as the FAA, the majority of the comments provided little support. Moreover, one commenter specifically opposed their use citing the fact that the FAA continues to employ FCC Figure M3 as the basis for its current frequency allocation studies.[22]

22. One dominant and recurring theme appears in the comments on this matter. That is, commenters note the complexity of the task to compile a data base of groundwave field strength measurements and to revise FCC Figure M3. ABES, for example, urges the Commission to take the lead in a project which, because of its complexity and great cost, can only be effectively undertaken at the governmental level.[23] This view was shared by many other commenters as well.

23. We agree that improvement of Figure M3 is both a desirable and substantial undertaking. This issue was raised in the *Inquiry* to provide the opportunity to identify possible approaches for updating Figure M3 that would not exceed available resources both within the industry and the FCC. In view of the comments received on this matter, it appears that the only viable alternative for updating Figure M3 is for the FCC to undertake the task, possibly through a contract. The Commission agrees with the comments regarding the anticipated substantial costs of such a project. Currently, there are no funds available for such a project and, in view of budget restrictions, it is not anticipated that such funding would be available anytime in the near future. In view of this, we are deferring further consideration of this matter until funding becomes feasible.

24. *Calculations over mixed paths.* Section 73.183(e) of the FCC rules prescribes the procedure to be used when calculating groundwave field strength over paths containing more than one conductivity value (mixed paths). This is referred to as the equivalent distance method or "Kirke method" after H. L. Kirke who described several calculation methodologies and compared results of calculations with actual measurements in 1949. Predictions by the Kirke method are known to be imperfect and we explored alternative procedures in the *Inquiry*.[24]

25. The comments on this subject were mixed. Most commenters suggested the continued use of the "Kirke" method while some recommended consideration of other methods. None, however, identified any other method which would be a worthwhile improvement. AFCCE finds the "Kirke Method" acceptable and it does not foresee that a change in methodology would result in a substantial increase in accuracy in the prediction of groundwave field strength contours whether for service or for interference situations. Robert A. Jones notes that the present method has served the AM broadcast service well over the years and suggests no change. After considering the comments, we have concluded that it would not be useful to attempt to improve on the Kirke method at this time. Commenters in this proceeding who have specific proposals to offer or definitive studies on this subject are invited to submit such material for our further consideration.

OTHER MATTERS

26. A general matter was raised by several commenters concerning implementation of new groundwave propagation curves and the relationship of this issue with other technical assignment criteria. WGN Continental Broadcasting Company (WGN), for example, believes that the issues surrounding groundwave propagation are so closely related to the allocations issues to be addressed later by the Commission that consideration of them at this point is premature. WGN, thus, requests the Commission to defer changes in the groundwave propagation rules until a review of the related allocations issues has been concluded. The Clear Channel Broadcasting Service (CCBS) urges the Commission to proceed with caution in developing new standards because of concerns about the possible disruptions of service that could result with such changes.

27. As we discussed *supra*, we are cognizant of the relationship between the groundwave propagation curves which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We noted in the *Inquiry* that use of new technical standards could result in changes to the location of service contours and calculated levels of interference. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a record on this issue. Such a record will guide the Commission on appropriate actions which ultimately should be taken.

28. We also believe, however, that there may be practical reasons for considering a delay in implementing new groundwave propagation curves, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, we believe that there is merit in considering implementing simultaneously all the interrelated changes that may ultimately be adopted. We believe that this approach would minimize administrative burdens for the Commission as well as uncertainties within the industry. We seek comment on the advisability of such an approach.

29. It would not be our intent to require any modifications of existing AM broadcast facilities as a result of the changes proposed in this *Notice*; nor would we intend to require parties whose applications are pending at the time any proposed rule changes are implemented to amend their application.

ADMINISTRATIVE MATTERS

30. Authority for the rule changes on which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

31. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **January 3, 1989**and reply comments on or before **January 18, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

32. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

33. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously-filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

34. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96-354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

35. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection and/or record keeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed on the public.

36. For further information on this proceeding, contact Larry W. Olson, Mass Media Bureau, (202) 632-6955.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment on the desirability of replacing the existing AM broadcast groundwave propagation curves with a new propagation model recently developed. The new model results from recent scientific analysis of groundwave measurement data and theory that provides a better understanding of groundwave propagation phenomena. Use of the new method for calculating groundwave field strength in the AM service would provide a more accurate depiction of the service and interference relationships between AM stations.

II. Objective:

The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis:

Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected:

There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to the standards (curves and formulas) used to calculate groundwave field strength. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. We will, however, consider in future rule making proceedings the related questions regarding assignment principles which, together with the propagation model, may result in new definitions of service and interference for AM broadcast stations. Such definitions are not now known but are intended to be beneficial to the AM service as a whole.

V. Reporting Record Keeping, and other Compliance requirements:

There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules:

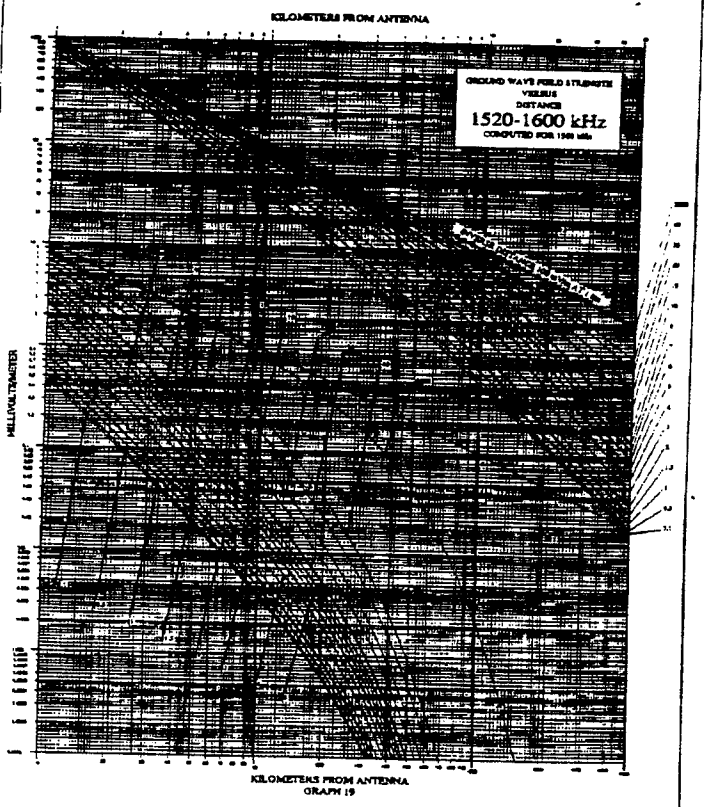
There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives:

There are no significant alternatives available.

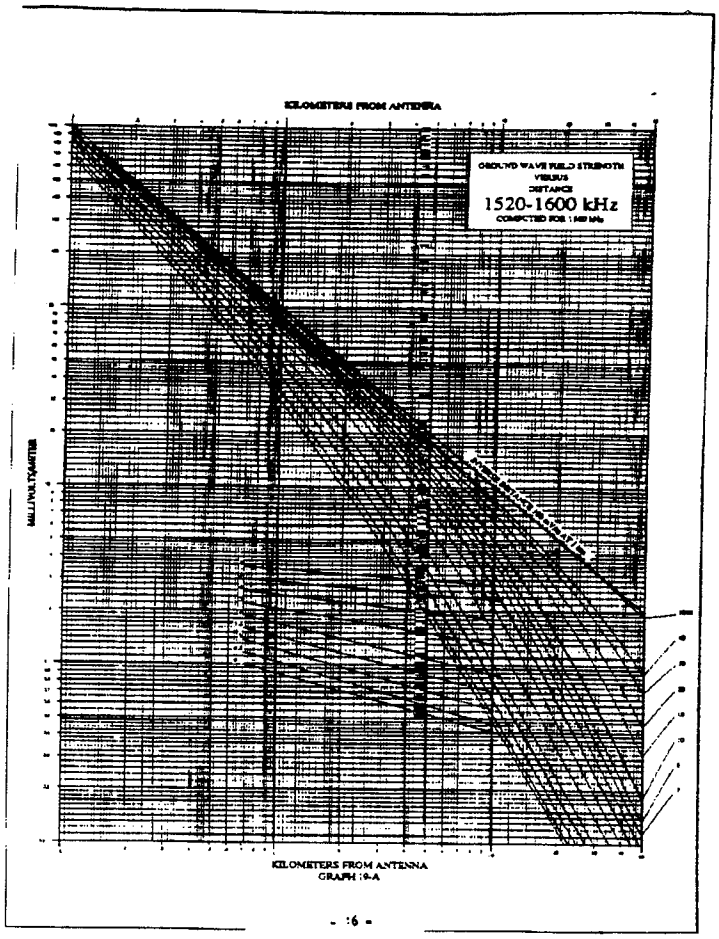
APPENDIX B

SAMPLE GROUNDWAVE PROPAGATION CURVES



GRAPH 19

- 15 -


KILOMETERS FROM ANTENNA
1520-1600 kHz
KILOMETERS FROM ANTENNA

GRAPH 19-A

- 16 -

FOOTNOTES

[1] The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, (*Report*) released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

[2] By *Order*, DA 87-1823, released December 15, 1987, the Commission granted a "Motion for Extension of Time for Filing Comments and Reply Comments" submitted by the National Association of Broadcasters (NAB). In that *Order*, the Commission bifurcated the proceeding and established separate filing periods. Phase 1 involved Sections II and III of the *Inquiry* while Phase 2 involved Sections I and IV. For the specific issues raised in Section III (Related Technical Issues) of the *Inquiry* under which groundwave propagation falls, the time for filing comments and replies was extended to February 1, 1988 and March 1, 1988, respectively.

[3] This proceeding will examine only those issues pertaining to groundwave propagation. Where appropriate, the Commission will institute future rule making proceedings to deal with the remaining issues addressed in the *Inquiry* and public comments. For example, in a similar action today, the Commission instituted a proceeding concerning skywave propagation. *See, Notice of Proposed Rule Making*, MM Docket No. 88-508, FCC 88-324.

[4] Graphs 1 to 19 are plotted for various AM broadcast frequencies and describe groundwave field strength as a function of the distance from the transmitter. Generally, for a given station the groundwave field strength at a specified distance is a function of the frequency and the earth's conductivity along the propagation path (*i.e.*, it varies inversely with frequency and directly with ground conductivity).

[5] FCC Figure M3 was developed more than thirty years ago by correlating field strength measurement data with identified soil types. This process resulted in a very generalized depiction of ground conductivity in the United States with broad areas on the map delineated by individual conductivity values.

[6] Regional Adminstrative MF Broadcasting Conference (Region 2). First Session, Buenos Aires, 1980; Second Session, Rio de Janeiro, 1981.

[7] These curves were later adopted by the Conference.

[8] At that time, negotiations on new bilateral agreements with Canada and Mexico either had been completed or were nearing completion. In both cases, negotiations were conducted with the view to incorporating the groundwave propagation curves adopted at the Rio Conference (1981).

[9] FCC MM Docket No. 84-752, Report and Order "In the Matter of Changes in AM Technical Rules to Reflect New International Agreements," published in the *Federal Register* May 2, 1985 (50 FR 18818). The computer program used for calculating these curves was subsequently released to the public for use in lieu of curves for calculating groundwave field strength.

[10] R. P. Eckert, "Modern Methods for Calculating Ground-wave Field Strength over a Smooth Spherical Earth", Report FCC/OET R86-1, February 1986.

[11] Regional Administrative Radio Conference to Establish a Plan for the Broadcasting Service in the Band 1605-1705 kHz in Region 2. First Session, Geneva, 1986; Second Session, Rio de Janeiro, 1988.

[12] These groundwave propagation curves were adopted by the Conference.

[13] Graph 20 of Section 73.184, of the Rules, "Ground Wave Field Intensity versus Numerical Distance of a Plane Earth," is provided for this purpose. However, it is in English units (miles) and therefore unwieldy since the related curves are in metric units (kilometers). The computer programs released in MM Docket No. 84-752 may be used in lieu of Graph 20.

[14] Two commenters addressed the international implications. Edward A. Schober (Schober) stated that these graphs should have been included in the international negotiations with Mexico and Canada; and, unless the agreements can be modified to include the revised graphs, the current graphs should be retained. Karl D. Lahm (Lahm) believes that the Commission should encourage other Region 2 administrations, particularly Canada and Mexico, to do the same in order to maintain consistent technical methods for all allocation purposes. Our intent at this time would be to use the new graphs, if adopted, for domestic purposes. If the new groundwave curves are adopted, we would explore with Canada and Mexico the possibility of incorporating their use in our bilateral agreements.

[15] Although not addressed in the *Inquiry*, Lahm suggested a change in the horizontal scale of the printed graphs and the density of the grid in order to facilitate curve reading and measurement analysis. A number of reply comments supported Lahm's suggestion.

[16] As an example of the differences between the current FCC groundwave curves and those we are proposing, Commission studies show that for a frequency of 1000 kHz and a conductivity of 10 mmhos/m the groundwave field strengths derived from the proposed curves at distance ranges of 0-80, 80-320, and 320-4220 km are at most 0.5, 1.5, and 6.6 dB lower, respectively, than those derived from the current curves.

[17] For reference, we are placing a copy of this report in the record of this proceeding. The computer program reproduced in the report could also be used for calculating groundwave field strength in lieu of the printed curves. Comments are solicited on the format of the draft curves.

[18] The computer program described in Report FCC/OET86-1 can be employed in lieu of Graph 20.

[19] On December 15, 1980, the FCC released a *Notice of Inquiry* in BC Docket No. 80-757, In the Matter of Amendment of the Rules concerning Automation of the use of Measurement Data for AM Broadcast Stations. This proceeding solicited comments concerning development of a data base comprising all outstanding measurement data submitted to the FCC for AM assignment studies. A consideration included was development of a digitized conductivity map based on the measurement data.

[20] Also, Figure M3 does not include conductivity information for Alaska, Hawaii, or United States territories.

[21] The Federal Aviation Administration (FAA) also has collected ground conductivity data relevant to aeronautical beacons in the band 200-415 kHz and maps have been produced with more detail in some areas of the United States than FCC Figure M3. *See,* S. A. Arcone and A. J. Delaney, "Electrical Ground Impedance Measurements in the U.S. between 200 and 415 kHz", Report No. FAA-RD-78-103, 1978.

[22] *See,* September 8, 1987, edition of the FAA's "Spectrum Management Regulations and Procedures Manual" (6050.32), Figure 11-2 (page 103).

[23] In noting that all commenters favored the updating of the ground conductivity map, ABES states that the problem with the revision of the ground conductivity map is finding someone who, in these days of austerity, can absorb the costs of such an enormous undertaking. As stated in its comments, ABES believes that the federal government is the only entity with the capacity of completing that task and urges the Commission to approach the Office of Management and Budget, the Congress and the National Telecommunications and Information Administration for the funds and facilities required.

[24] One of the alternative methods discussed was the "Millington" method. *See*, G. Millington, "Ground Wave Propagation over an Inhomogeneous Smooth Earth", *Proc. of the Institution of Electrical Engineers (London)*, Part III, Vol. 96, pp. 53-64, January 1949; H. L. Kirke, "Calculation of Ground-wave Field Strength over a Composite Land and Sea path", *Proceedings of the IRE*, Vol. 37, May 1949, pp. 489-496; J. R. Wait, "Recent Analytical Investigations of Electromagnetic Ground Wave Propagation over Inhomogeneous Earth Models", *Proceedings of the IEEE*, Vol. 62, pp. 1061-1072, August 1974.

APPENDIX B – CALCULATION OF SKYWAVE FIELD STRENGTH

The following formulas are proposed to be used in place of the curves in Section 73.190 of the FCC Rules. The methods used to determine other factors such as radiation value, elevation angle, and f(θ) are unchanged and can be determined by referring to the appropriate section of the FCC Rules.

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

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

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

The slant distance, D, is given by:

$$D = \sqrt{40.000 + d^2} \text{ km} \quad (2)$$

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

$$\phi_M = \arcsin[\sin a_M \sin 78.5° + \cos a_M \cos 78.5° \cos(69 + b_M)] \text{ degrees} \quad (3)$$

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

$$d = 111.18 d° \text{ km} \quad (4)$$

Where:

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

Where:
a_T is the geographic latitude of the transmitting terminal (degrees)
a_R is the geographic latitude of the receiving terminal (degrees)
b_T is the geographic longitude of the transmitting terminal (degrees)
b_R is the geographic longitude of the receiving terminal (degrees)
a_M is the geographic latitude of the midpoint of the great-circle path and is given by:

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

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

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

Note(1): If $|\theta_M|$ is greater than 60 degrees, equation (1) is evaluated for $|\theta_M| = 60$ degrees.
Note(2): North and east are considered positive; south and west negative.
Note(3): In equation (7), $k = -1$ if $b_R > b_T$, otherwise $k = 1$.

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

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

$$F_c(10) = F_c(50) + \Delta \text{ dB}(\mu\text{V/m}) \quad (8)$$

Where:
$\Delta = 6$ when $|\phi_M| < 40$
$\Delta = 0.2|\phi_M| - 2$ when $40 \leq |\phi_M| \leq 60$
$\Delta = 10$ when $|\phi_M| > 60$

DATE: November 15, 1988

SUBJECT: MM Docket No. 88-508

The Notice of Proposed Rule Making in this proceeding refers to Appendix B which includes formulas to be used to calculate skywave field strength. Unfortunately, the agency which publishes the Commission's documents did not produce a legible copy of the appendix. Attached is a copy of the appendix which should be easier to read.

Larry W. Olson
Policy and Rules Division
Mass Media Bureau
Federal Communications Commission

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-511

In the Matter of

Review of the Methods for Calculating
Nighttime Protection for Stations
in the AM Broadcast Service

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 4, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this proceeding to propose revision of its Rules relating to procedures for calculating nighttime protection level to be afforded stations in the AM broadcast service. In particular, the Commission is considering modifying its Rules that relate to the calculation of nighttime RSS (root-sum-square) skywave interference levels to the protected groundwave contours of Class II and Class III AM broadcast stations and the skywave service contours of Class I clear channel stations. Consideration also is given to including adjacent channel skywave signals in such calculations.

2. This proceeding is an outgrowth of the *Notice of Inquiry (Inquiry)* in MM Docket No. 87-267, which initiated a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.[1] Its goal was to identify any needed changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.

3. Among the issues discussed in the *Inquiry* was the most appropriate method of calculating the RSS skywave interference to the nighttime groundwave service of Class II and Class III AM stations.[2] Alternative methods for modifying the current calculation procedure prescribed in the FCC Rules were discussed, along with the possible need for including the effects of adjacent channel skywave signals in the calculations. Subsequent consideration of this matter has led us to tentatively conclude that a similar calculation procedure may be useful in determining interference to the skywave service of Class I stations. Accordingly, this possibility will be examined herein.

4. A substantial number of comments addressing nighttime interference issues and procedures were received in response to the *Inquiry*. These comments support further consideration of the improved methods for calculating nighttime interference discussed in the *Inquiry*. Accordingly, we believe that the time is now ripe for considering changes to the procedures for calculating nighttime interference as proposed below.[3] Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

5. The AM service is the most technically complex broadcast service to administer. This is due largely to the propagation conditions that exist in the AM broadcasting band. In contrast to other frequency bands where broadcast services are authorized, the propagation characteristics of the AM band vary with the time of day. During daytime hours, service is provided predominantly by groundwave signals that travel along the surface of the earth, and which are affected by the soil conductivity along the propagation path.

6. During nighttime hours, however, skywave signals from an AM station may be reflected from the ionosphere[4] and can be propagated many hundreds of miles from the transmitter location. This nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave signals can be employed to provide service many hundreds of miles from the transmitter. On the other hand, such enhanced signal propagation increases the probability of interference among stations hundreds of miles apart. Consequently, co-channel stations that could be located reasonably close to one another without interference during daytime hours could cause significant mutual interference during nighttime hours.

7. Interference during nighttime hours is further exacerbated by the fact that skywave interference can be caused by several co-channel and adjacent channel AM stations simultaneously. For this reason, the Commission adopted rules several decades ago to deal with the effect of cumulative interference to the service of Class II and Class III stations. However, as will be discussed below, there is reason to believe that the current Rules do not adequately deal with the effect of cumulative interference received from multiple interfering AM signals.

8. Class I and Class II stations operate on clear channels. Class I stations provide extensive primary (groundwave) service during the day and night, as well as secondary skywave service during nighttime hours generally extending out to 750 miles or more. Class II stations normally render primary service only, the area of which depends on the station location, power, and frequency. Class III stations operate on regional channels and provide primary service to larger cities and the surrounding rural areas.

9. Requisite protection to existing nighttime service of Class II and Class III stations is calculated in accordance with §73.182(l) of the Commission's Rules, which provides that the basis of protection to an existing station is the RSS (root-sum-square) value of interference caused to that station. In order to limit the number of interfering signals that must be taken into account, a "50% exclusion method" is used in making the calculations. This method provides a procedure for determining at what point interfering signals can be disregarded. Thus, the RSS for a station is determined by considering interfering signals in order of decreasing magnitude, excluding those that are less than 50% of that obtained using the stronger signals.

10. In the case of U.S. Class I stations, protection is afforded to the nighttime 0.5 mV/m 50% skywave signal.[5] However, currently protection is calculated only on a

"single signal" basis (i.e., each interfering signal is to be treated individually without considering the effect of other interfering signals). Thus, unlike the RSS procedure applied to Class II and Class III stations, no provision is currently made for considering the effect of multiple interfering signals. Absence of such a provision is mitigated by the fact that, unlike the regional channels where many nighttime stations operate, the clear channels are used by far fewer nighttime stations.

DISCUSSION

Limitations associated with the current method of RSS interference calculation.

11. Calculating a station's RSS interference level using the 50% exclusion method cannot yield the true RSS value since the contributions of the weaker stations are excluded. Thus, its use can result in the gradual erosion of nighttime service as new nighttime operations are placed into service, or as existing stations modify their facilities to increase the signal strength in various directions. In fact, this method may allow each new nighttime operation to cause about 12% (approximately 1 dB) of additional interference to an existing nighttime station.

12. Additionally (as we pointed out in the *Inquiry),* there is a basic inconsistency in the application of the 50% exclusion method. For example, a new station can be placed on the air as long as its interference contribution to other stations is sufficiently low as to be ignored by the 50% exclusion method. However, an existing station whose interfering contribution to the same protected station is sufficiently strong to already require its inclusion in the protected station's calculated RSS value would not be permitted to increase interference by any amount, even though the resulting interference may be equal or less than that caused by a proposed new station.

13. The *Inquiry* discussed two alternative procedures that might be used instead of the current RSS method in order to alleviate its shortcomings. One was to eliminate the 50% exclusion method altogether and to apply an acceptable factor (some decibel or percentage increase) by which the RSS interference level at the protected contour of any station could be increased by another station. This procedure would have the advantage of consistent application to all stations whether they are already included in the RSS of an existing station or not. However, those filing comments generally did not favor this approach, because it would permit each station to cause some additional interference, and because of its potential for abuse (nothing was proposed that would prevent a particular station for filing for successive upgrades, each of which would comply with the new standard, the aggregate of which could substantially exceed it).

14. The other alternative proposed a reduction (such as 25%) in the exclusion reference, above which new interference contibutions would not be permitted. This procedure would not resolve the inconsistency discussed in the paragraph 12, above. Nevertheless, this proposal received the greatest amount of support, since it was seen as capable of providing a modest reduction in overall interference levels without eliminating all flexibility in facility design or modification.

15. The primary objectives in considering a change in the procedures for RSS calculations are to determine service and interference more accurately, and to limit the incremental increase of interference that may be caused to existing stations by new stations or changes in the facilities of existing stations. In doing so, we must take care that the imposition of rigid interference constraints does not restrict substantially the introduction of new AM service in areas lacking it or changes to existing existing facilities.[6] Some mechanism is needed to balance restrictions on the incremental increase of interference to existing stations while, at the same time, maintaining sufficient flexibility for new stations or modifications to existing stations to be effectuated in order to meet the service needs of the public and AM stations alike. In the past we believed that authorizing facilities that contributed interference levels less than half of that existing previously was a reasonable way to balance these conflicting concerns.

16. We are sensitive to the concerns of those who feared that replacing the 50% exclusion method with a method that would allow a station to increase interference to any other station by a given amount (e.g., 1 dB or 0.5 dB) could be subject to abuse. Such a method would need to include a procedure to preclude the filing of successive applications by a station, where each application raised the level of interference to other stations by the maximum amount permitted. Such a procedure may be difficult to enforce in actual practice, however, because of the administrative complexity of examining subsequently filed applications for consistency with the requirement.

17. We have, therefore, tentatively concluded that a modification of the current RSS calculation procedure prescribed in §73.182(l) of the Rules to change the 50% exclusion to a 25% exclusion would provide the best balance between limitations on new interference and flexibility in facility design. The 25% exclusion method that we are proposing would be applied in a manner similar to the current 50% exclusion method; that is, each contributing interfering signal would be ranked in descending order of magnitude and all interfering signals that are less than 25% of the RSS of preceding contributors would be disregarded in the calculation of the RSS.[7] Although we are proposing an exclusion level of 25%, we solicit comments on whether some other value would be more appropriate. We also solicit comment on whether the need for consistency and improved accuracy in the determination of interference levels warrants elimination of the approximate method of determining the nighttime service of Class IV stations given in the Note in Section 73.182(a)(4) of the Commission's Rules. Considering the refinement in the calculation methodolgy we are proposing herein, retention of such an approximate approach to interference computation may no longer be appropriate.

18. The 25% exclusion method would permit the RSS of an existing station to be increased by up to 3% (.26 dB) by a new co-channel station. We would note, however, that the RSS limits of existing Class II and Class III stations would increase when they are recalculated in the future because a greater number of existing interfering contributors would be included in the RSS calculation using the 25% exclusion method, as compared to the 50% exclusion method.

19. On a related matter, Section 73.182(m) of the Rules states, in effect, that objectionable interference from a station on the same channel shall be considered to exist to a station if the interfering field strength at the normally protected contour for the protected station (or the contour corresponding to the RSS for the protected station) from another station exceeds the value prescribed in Section

OTHER MATTERS

28. We believe we should treat the signals of stations in Canada and in Mexico as we would domestic stations in terms of their contribution to the calculation of co-channel and adjacent channel interference as proposed herein, to the extent such action would not conflict with current international agreements. Thus, until any change in the international agreements are effected, foreign facility proposals will continue to be evaluated as to their impact on U.S. stations pursuant to the 50% exclusion method and they will not be questioned on the basis of their adjacent channel skywave interference potential. Moreover, protection to foreign assignments will continue to be afforded in accordance with applicable international agreements. However, we propose to treat such foreign stations as we would domestic stations in terms of protection to domestic facilities.

29. Several parties commenting in response to the *Inquiry* were concerned about the impact that use of new calculation procedures may have on current AM broadcast service. For instance, although endorsing the use of more accurate procedures, several commenters urged the Commission not to implement their use until other AM assignment criteria were fully considered in appropriate rule makings. ABES and CBS, for example, are supportive of the more accurate procedures, adding that a rule making proceeding on this subject should be instituted. Such a proceeding, according to ABES, would permit a more detailed evaluation of its technical aspects as well as the potential impact on existing AM broadcast service such as changes in interference levels to existing stations, issues related to the processing of applications, and the potential for added administrative burdens.

30. We are cognizant of the relationship between the calculation procedures which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a better record on this issue. Such a record will guide the Commission on appropriate actions which ultimately should be taken. We believe, however, that there may be practical reasons for considering a delay in implementing new calculation procedures, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, there may be merit in considering implementing simultaneously all the interrelated changes that may ultimately be adopted. This approach could minimize administrative burdens for the Commission, as well as uncertainties within the broadcast industry. Accordingly, we seek comment on the advisability of such an approach.

31. It would not be our intent to require any modifications of existing facilities as a result of the changes proposed in this Notice. Nor would we require modifications to applications pending at the time any changes proposed herein are implemented.

ADMINISTRATIVE MATTERS

32. Authority for the rule changes on which comments are invited is contained in Sections 4(i) and 303(f) of the Communications Act of 1934, as amended.

33. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **December 27, 1988** and reply comments on or before **January 11, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

34. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

35. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously- filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates Section 1.1206.

36. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public com-

73.182(s), or the RSS divided by 20, whichever is greater. We also solicit comments as to whether it is still appropriate to maintain the provision of Section 73.182(m) in the Rules.

Adjacent channel skywave interference

20. Another issue concerning calculation methodologies relates to adjacent channel skywave interference. Section 73.182(n) of the FCC Rules limits the amount of interference that is permitted at the normally protected contour of a station resulting from the groundwave signal of an adjacent channel interfering station. However, no provision currently is made for also considering the effect of adjacent channel skywave interference. Comments filed in response to the *Inquiry* indicate that adjacent channel skywave signals can cause significant interference.

21. The *Inquiry* discussed two possible alternative procedures for dealing with the effects of adjacent channel skywave interference. One alternative discussed would be to amend the Rules to include co-channel and adjacent channel skywave signals in a single RSS calculation with appropriate weighting to account for the adjacent channel protection ratio. The other alternative discussed would be to require inclusion of adjacent channel skywave signals in the calculation of the adjacent channel groundwave RSS in the traditional manner prescribed in §73.182(n) of the Commission's Rules, in which the adjacent channel RSS level is computed normally, then checked to determine that it does not exceed the specified adjacent channel protection.

22. While the subject of adjacent channel interference is not well developed in the comments, the majority of commenters nevertheless expressed strong convictions that the current levels of interference in the AM broadcasting service border are nearly intolerable. They assert that over the years, there has been a continuing increase in interference levels, along with corresponding erosion of service areas. It is argued that this has perpetuated a steady decline in the AM audience because of public dissatisfaction with the level of interference to received programs. The comments are unanimous in expressing the opinion that not only should no further increase in interference be permitted under any circumstances, but steps should be taken to reduce current levels. Accordingly, the Commission is being strongly urged to direct its immediate attention to the amendment of §73.182, so that it more completely and accurately addresses actual signal and interference levels.

23. Encouraged by this general mandate to amend §73.182 to be more responsive to the foregoing concerns, we are proposing to amend paragraph (n) to include skywave signals on first adjacent channels along with co-channel skywave signals in the calculation of a station's RSS interference level.[8] Adjacent channel skywave signals would be weighted with an appropriate first adjacent channel protection ratio in the calculation procedure.[9] We further propose that the 25% exclusion method, proposed above, be applied to the weighted first adjacent channel skywave signals in the same manner as for co- channel interfering signals. Thus, a proposed new station, or modification to the facilities of an existing station, would not be permitted to increase the RSS level of any station within 10 kHz of the frequency of the proposed facility. We do not believe that it is necessary to consider the effect of skywave signals on second or third adjacent channels[10] because of the skywave field strength that would be required, after weighting with the applicable protection ratio, before such interference would become significant.[11]

Protection of nighttime service of Class I stations

24. We believe we should also consider at this time what changes, if any, may be appropriate in the protection afforded the skywave service of Class I stations. As we pointed out in paragraph 10, protection to the 0.5 mV/m 50% skywave signal of Class I stations currently is calculated by treating each interfering signal individually without considering the effect of other interfering signals. The effect of multiple interfering signals was believed to be mitigated by the relatively limited number and geographic distribution of co-channel Class II stations on any given clear channel frequency.[12] However, inasmuch as an important objective of this proceeding is the consistent application of improved interference prediction criteria to current and future broadcast facilities, we believe the proposed RSS computational method should be extended to cases where multiple interfering signals may affect the skywave service of Class I stations.[13]

25. In order to limit the effect of such cumulative interference, we are proposing to require that protection to a Class I station be determined by calculating the RSS at the 0.5 mV/m skywave or groundwave contour, whichever extends farther along each pertinent radial. Proposed new nighttime operations or modifications to existing facilities would be required to protect either the calculated RSS at any point on the protected contour or 0.5 mV/m, whichever is greater.[14]

26. There is presently no provision in the Commission's Rules to limit interference to the skywave service areas of Class I stations from adjacent channel skywave interference. Here also, the Commission is concerned that an increase in the number of nighttime operations on channels adjacent to clear channels could result in additional interference to Class I stations. We are, therefore, proposing to include skywave signals on first adjacent channel frequencies in the RSS calculations performed at the protected contour.

27. A final issue that must be resolved regarding the calculation of the RSS at the nighttime protected contour of Class I stations is the point at which interfering skywave signals are not included in the RSS calculation. Because we are proposing use of the 25% exclusion method for Class II and Class III protection, we believe that for purposes of consistency, Class I stations should be treated similarly. Nevertheless, there may be circumstances which warrant consideration of some other value. For example, the RSS calculation for Class II and Class III stations is related to protection of primary (groundwave) service, whereas the RSS calculation for Class I stations would be primarily related to secondary (skywave) service. The secondary skywave service of Class I stations may not need be protected to the same degree as primary service because skywave service does not have the same degree of reliability as groundwave service, due to the widely varying characteristics of skywave propagation. Therefore, while we are proposing use of the 25% exclusion method when calculating the RSS for Class I stations, we recognize that some tradeoff between the quality and quantity of service may suggest some other value as being more appropriate. Accordingly, we encourage interested parties to give careful consideration to this issue.

AM Broadcast Rules, RM-5532, *(Report)* released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

[2] *See Inquiry*, para. 74-80.

[3] This proceeding will examine only those issues pertaining to procedures for calculating nighttime interference for Class I, Class II, and Class III stations. Where appropriate, the Commission will institute rule making proceedings to deal with the remaining issues addressed in the *Inquiry* and in public comments.

[4] The ionosphere is a region of the earth's atmosphere consisting of several layers subject to ionization. These layers are alphabetically designated and have varying effects on radio waves. Pertinent to the propagation of AM broadcast signals are three ionization layers (D, E, and F). The distance of these layers above the earth varies from approximately 50 km for the D-layer (nearest the earth) to approximately 300 km for the F-layer (farthest from the earth).

[5] *See* Section 73.182(a)(1)(i)(B).

[6] Commission experience has been that a substantial number of existing stations make changes to their facilities each year for a number of reasons. In some cases such changes are required because the station has lost its transmitter site and must move to a new location. More commonly, construction in the vicinity of the current antenna site causes the directional antenna pattern to experience adjustment difficulties, thereby requiring a new directional antenna pattern or a new antenna site. In other cases changes result due to refurbishing the antenna system or because the station needs to adjust its service area due to demographic changes that have occurred in its community of license.

[7] For purposes of protection, the RSS would not be considered to be increased when a new interfering signal is added which is less than 25% of the RSS value of interference from existing stations, and which at the same time is not greater than the smallest signal included in the RSS value of interference from existing stations. Moreover, it should be noted that the anomalies discussed in Section 73.182(1)(3),(4) and (5) would still need to be assessed.

[8] The formula that we are proposing for use in calculating the RSS of Class II and Class III stations is contained in Appendix B of this *Notice*. It is similar to the "power sum method" described in Report 945-1 in Volume X - Part 1, Recommendations and Reports of the CCIR (International Radio Consultative Committee).

[9] The current first adjacent channel ratio prescribed in §73.182(t) is 1:5 (desired to undesired). However, potential changes in co-channel and adjacent channel protection ratios are currently under consideration in MM Docket No. 87-267, and may be further addressed in a subsequent rule making proceeding.

[10] The proscriptions in Section 73.37(a), however, would continue to apply.

[11] For example, if an existing station has an RSS of 4 mV/m and a new station is proposed on a frequency which is a second adjacent channel to the existing station, 30 mV/m skywave field strength would have to be produced by the proposed station at the site of the existing station before the interfering contribution would have to be taken into account (this assumes that the applicable protection ratio is 1:30 (desired to undesired). This is a level of field strength that exceeds the radiation capabilities of stations licensed in the United States.

[12] In E. Weaks McKinney-Smith, 22 FCC 2d 211 (1957) the Commission ruled that in the case of groundwave protection it is incorrect to apply the single- signal method, and that multiple interferences to groundwave services should be taken into account.

[13] Because we have attempted to narrowly focus this proceeding on consideration of what we believe are improved methods of computing interference, it is not intended to be a forum for debating unresolved issues associated with any other ongoing proceeding. Thus, the question of whether Class II daytime-only stations should be allowed to operate on Class I clear channels at night (*see Report and Order, Unlimited-Time Operation by Existing Daytime-Only AM Stations, Discontinuance of Authorization of Additional Daytime-Only Stations; and Minimum Power of Class III Stations*, FCC 87-356, 2 FCC Rcd 7113 (1988), 52 Fed. Reg. 48268, December 21, 1987) is outside the scope of this proceeding.

[14] Where the protected contour (groundwave or skywave) extends across the border of the U.S. into another country, or over water, the field strength calculated along the border or the shoreline of the water becomes the protected contour. The permissible interfering signal would be the calculated field strength divided by the applicable co-channel or adjacent channel protection ratio, or the signal permitted by the RSS calculation using 25% exclusion, whichever is greater.

ments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96- 354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

37. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and has been found to impose a new or modified information collection requirement on the public. Implementation of any new or modified requirement will be subject to approval by the Office of Management and Budget as prescribed by the Act.

38. For further information on this proceeding, contact Steven Selwyn, Mass Media Bureau, (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment on the desirability of modifying existing procedures for calculating nighttime interference to AM stations resulting from multiple interfering signals. Changes being proposed pertain to improvements to the FCC's Rules related to the the RSS (root-mean- square) calculation of interference for Class II and Class III stations. Consideration is also given to calculation of interference to the skywave service area of Class I clear channel stations by the RSS method. Additionally, this *Notice* gives consideration to including the effect of adjacent channel skywave signals in the RSS calculation.

II. Objective:

The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis:

Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected:

There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to procedures for calculating interference to AM stations resulting from multiple interfering signals from other AM stations. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. Indeed, the objective of the changes being proposed is to minimize new interference that could result in the future from new AM stations or changes to the facilities of existing stations.

V. Reporting Record Keeping, and other Compliance requirements:

There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules :

There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives:

There are no significant alternatives available.

APPENDIX B

The overall RSS (root-sum-square) field strength due to two or more individual co-channel and first adjacent channel interference contributions would be calculated using the expression:

$$RSS = [(a_1E_1)^2 + (a_2E_2)^2 + \ldots (a_iE_i)^2] = 1/2$$

Where:

Ei is the field strength of the i'th interfering transmitter (in uV/m);

ai is the radio frequency protection ratio associated with the i'th interfering transmitter, expressed as a numerical ratio of field strengths.

We propose that the field strength of interfering signals be arranged in descending order of magnitude (adjusted for weighting factors) and the interfering contributions of signals that are less than 25% of the RSS resulting from stronger signals be disregarded in the RSS calculation.

In the case of Class II and Class III stations, the calculations would normally be made on a transmitter site to transmitter site basis (site-to- site). In the case of Class I stations, the RSS would be calculated at the 0.5 mV/m 50% skywave contour, or the 0.5 mV/m groundwave contour, whichever extends farther along the pertinent radial. The RSS calculations would be made at as many points along the contour as are necessary to obtain an accurate indication of predicted interference.

FOOTNOTES

[1] *See , Notice on Inquiry, Review of Technical Assignment Criteria for the AM Broadcast Service*, MM Docket No. 87-267, FCC 87-245, adopted July 16, 1987, released August 17, 1987, 2 FCC Rcd 5014 (1987), 52 Fed. Reg. 31975, August 24, 1987. The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the*

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-508

In the Matter of

Improved Methods for Calculating
Skywave Field Strength in the
AM Broadcast Band

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 4, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this proceeding (*Notice)* to examine its Rules relating to skywave propagation in the AM broadcast service. In particular, the Commission is considering replacing the existing skywave propagation curves contained in the FCC Rules with a new skywave propagation model recently developed. The Commission believes that this new model is more accurate and reflects the latest understanding of skywave propagation as applied to the AM broadcast service.

2. This proceeding is an outgrowth of the *Notice of Inquiry*, MM Docket No. 87-267, 52 FR 31795, August 24, 1987, (*Inquiry)* which provided a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.[1] Its goal was to identify any needed changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.[2]

3. The Commission discussed a number of issues specifically related to skywave propagation in its *Inquiry*. In particular, one alternative discussed is to replace all of the current skywave propagation curves and procedures in the FCC Rules with a new, improved skywave propagation model recently developed by FCC staff. Several related matters were also discussed in the *Inquiry*, notably, the effects of geomagnetic latitude of a propagation path upon skywave field strength, the most appropriate hour of the night upon which to base the new propagation model (referred to as the reference hour), procedures for calculating field strength values exceeded for 10% of the time, and calculation procedures to be employed for short propagation paths.

4. We recognize that changes to the Commission's Rules to reflect new procedures for calculating skywave field strength may well have, among other things, an effect on the portrayal of existing service and interference as well as an effect upon future calculations related to new and modified AM facilities. However, we believe that consideration at this time of procedures providing improved accuracy would facilitate future consideration of other possible changes to the Commission's technical assignment criteria. This would provide accurate skywave field strength calculations for use in assessing the interrelationships of such proposed changes. Ultimately, improved accuracy in skywave calculations would ensure that proposed new or modified AM stations would provide intended protection to other stations, or, conversely, that such proposed changes would not be unnecessarily restricted.

5. A substantial number of public comments addressing skywave propagation issues were received in response to the *Inquiry*. These comments provide a general consensus supporting consideration of the new and improved methods for calculating skywave field strength suggested by the Commission in its *Inquiry*. For all of the reasons discussed, we believe that the time is now ripe for considering changes to the procedures for calculating skywave field strength as proposed in the following sections.[3] Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

6. The AM broadcast service is the oldest broadcasting service, but it still remains one of the most technically complex to administer. This is due in large part to the propagation conditions that exist in the AM broadcasting band. In contrast to the other frequency bands where broadcast services are authorized, the propagation characteristics of the AM band vary with the time of day. During day time hours, signal propagation of an AM station is predominantly by groundwave signals. Groundwave signals travel along the surface of the earth and are thus affected by the characteristics of soil conductivity along the propagation path.

7. During nighttime hours, however, skywave signals from an AM station reach distances many times greater than its groundwave signals. Skywave signals are reflected from the ionosphere[4] and can be propagated many hundreds of miles from the transmitter location. Nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave can be employed to provide skywave service many hundreds of miles from the transmitter, whereas, on the other hand, such enhanced conditions also increase the interference possibilities of co-channel stations over distances of hundreds of miles. As a consequence, co-channel stations that could be located reasonably close to one another without interference during daytime hours could cause significant mutual interference during nighttime hours.

8. Field strength calculations for determining skywave service and skywave interference are performed in accordance with Section 73.182 of the FCC Rules. Currently these procedures employ three sets of skywave field strength curves contained in Section 73.190 of the FCC Rules. The first set of curves, Figure 1a, is used for calculating the skywave service areas for Class I stations as well as the levels of interfering field strength for Class I and Class II stations on clear channels; hence, they are sometimes referred to as the FCC clear channel curves.[5] A second set of curves, Figure 2, isused for calculating levels of skywave interference on regional and local channels. Figure 1b, the third set of curves, is used for all skywave field strength calculations involving one or more stations in Alaska regardless of channel or station class.[6]

9. These three sets of skywave curves are empirically derived, that is, they are based upon observations of propagation phenomena obtained through FCC skywave field

strength measurement programs. For example, Figure 1a was derived from short-term field strength recordings taken in the spring of 1935,a relatively low solar activity period (*i. e.*, a period corresponding to low sunspot numbers).[7]

10. In order to gain a better understanding of skywave propagation phenomena, the FCC initiated a long-term field strength measurement program in 1939 which continued for a full solar activity cycle, *i. e.*, eleven years. Soon after this program began, it became clear that skywave field strength is a function of many factors, including latitude and sunspot number.[8] Figure 2 was then developed from data acquired for the year 1944 of this long-term program.[9] Minimum solar activity occurred in 1944 resulting in maximum levels of skywave field strength. Such a year represents a "worst case" for determining the effects of skywave interference upon the service provided by AM stations during nighttime hours.

11. Data from the Commission's long-term field strength measurement program for 26 propagation paths were released in 1971 and have been studied by the FCC as well as a number of researchers from different parts of the world. Among other things, it has been found that the effects of latitude are so great that the 1944 FCC data, which represents only a narrow range of latitudes, are inadequate. Consequently, in order to collect supplemental data, the Commission in 1980 initiated a low-latitude skywave measurement project (Central America to southern U.S.) and in 1981 initiated a high-latitude measurement project (coterminous U.S. to Alaska).[10] Several administrations (*e. g.*, Brazil and Mexico) have contributed a substantial amount of data from the low-latitude areas. The high-latitude field strength measurement program contributed to the development of the interim curve in Figure 1b of the FCC Rules discussed *supra*. In adopting Figure 1b, it was anticipated that a final set of curves would be developed upon conclusion of the measurement project.

DISCUSSION

12. The FCC staff has continued its efforts to develop a better understanding of skywave propagation phenomena. Based on analysis of data collected during the Commission's long-term skywave field strength measurement program as well as data collected during the more recent low-latitude and high-latitude skywave measurement projects, our understanding of skywave propagation characteristics has improved significantly. As a result, we have identified certain shortcomings of the current FCC skywave field strength curves.

13. We now know that skywave at tenuation increases by about 1 dB (in a year of low sunspot activity) for every degree of latitude that a radio path midpoint moves farther north. This reduces skywave propagation in northern areas by an appreciable amount. For example, a station in Texas may produce a skywave signal of 0.5 mV/m at a distance of 800 miles from its transmitter; that same station in Minnesota may produce a 0.5 mV/m signal at a distance of only 500 miles. Figure 1a of Section 73.190 of the FCC Rules does not provide a means for adjusting skywave field strength as a function of geomagnetic latitude. Figure 2 is partially correct in its conceptual approach because it treats interference levels as a function of geographic latitude. Geomagnetic latitude rather than geographic latitude is the more determinative factor.[11] The effect of these shortcomings is magnified by the increasing demand for spectrum and growing concerns regarding nighttime interference as the band becomes more congested.

14. Other important characteristics of skywave propagation also have been observed during the staff's on-going studies. Use of a reference hour of six hours past sunset (SS+6) rather than two hours past sunset (SS+2) is a more accurate reference upon which to base skywave calculations. Moreover, it has been determined that use of the slant distance for a propagation path rather than the great-circle path distance results in greater accuracy.[12] Finally, it has been learned that differences between skywave field strength exceeded 50% of the time and skywave field strength exceeded 10% of the time vary with the geomagnetic latitude midpoint of the propagation path.[13]

15. The following proposed changes to the Commission's current Rules for calculating skywave field strength incorporate all of these observed skywave propagation characteristics. These proposals address, *seriatum*, a new skywave propagation model, use of the slant distance of a propagation path, a new proposed reference hour for the new propagation model, and a procedure for calculating skywave field strength exceeded 10% of the time. Comments are invited on these proposed changes, and, in addition, the Commission will consider alternative proposals which may provide potential improvements related to calculating skywave field strength in the AM broadcast service.

16. *New Skywave Model.* The *Inquiry* discussed several alternatives for improving methods for performing skywave field strength calculations, including various modifications to the existing curves in Section 73.190 ofthe FCC Rules. Emphasis was placed, however, upon consideration of replacing all of the existing curves, Figures 1a, 1b, and 2 of Section 73.190 of the FCC Rules, with a new model identified as the "modified method".[14] Studies performed by members of the FCC staff indicated that this "modified method" ismore accurate than the three sets of curves currently in Section 73.190 of the FCC Rules and takes into account the effects of the geomagnetic latitude of the propagation paths.

17. Comments filed in response to the *Inquiry* were overwhelmingly in favor of using the most advanced method available and recommended use of the"modified method". Comments submitted by the Corporation for Public Broadcasting (CPB) typify several of the comments received. CPB noted that reliance on precise methodologies and current data will ensure that the assignment principles continue to reflect the real world, not a theoretical environment. Moreover, CPB indicated its belief that the imprecision of thecurrent propagation curves is, for the most part, unnecessary with the availability to the FCC and the industry of sophisticated computer technology and extensive data previously unavailable.

18. Based upon its review of the "modified method", Capital Cities/ABC, Inc. (Capital Cities) concurs that this method should be used in determining protected contours as well as interference levels. CBS, Inc. (CBS) supports the Commission's effort to implement the most current data and precise methods for calculating interference. CBS notes that where accurate measurements of interfering signals and protected contours are not available, interference may be caused where none was calculated, or the parameters of a station may be unnecessarily constrained.

The Clear Channel Broadcasting Service (CCBS), however, urges the Commission to proceed with caution in this proceeding. CCBS expressed general concerns about the potential adverse consequences of recalculating service and interference that could result with a new propagation model.

19. Based upon the comments and our own assessment of the benefits that would be derived from adoption of an improved skywave propagation model, we propose amending the Rules to incorporate the use of the new propagation model described in Appendix B of this *Notice*. This new model is based upon the empirical data collected by the Commission during its extensive skywave measurement programs and is characterized by a formula. This new model is identical to the "modified method" discussed in the *Inquiry* except for differences discussed *infra*.

20. An important element included in the new skywave propagation model is a term that fully accounts for the effect of the geomagnetic latitude of the propagation path on skywave field strength. As discussed *supra*, geomagnetic latitude has a significant effect upon propagated skywave field strength. The inclusion of this term would result in a more accurat edepiction of skywave service contours for Class I clear channel stations as well as interference calculations on all channels.[15] We are proposing to usethe geomagnetic latitude of the great-circle midpoint of the propagation path for these calculations. Appendix B also includes formulas for converting geographic latitude to geomagnetic latitude.

21. Although it is possible to derive graphical methods from the formulas for determining skywave field strength, we propose to make the formulas in Appendix B controlling in order to avoid disputes that can result from in accuracies of graphical methods. This action would be consistent with recent Commission actions in other cases where use of available formulas has been made controlling for the same reason. Additionally, since calculations based on the formulas would prevail in all cases and since the new propagation model is easily adapted for use on computers, we do not believe there is need to include curves in the FCC Rules.[16]

22. *Use of Slant Distance*. In our discussion of the "modified method" in the *Inquiry*, we had suggested that great-circle distances would be used in the calculations for propagation paths of 200 km and greater. For propagation paths less than 200 km, it was suggested that the field strength factor at 200 km could be employed in the calculations at such distances.[17] There was general support in the comments received in response to the *Inquiry* for such an approach.[18] However, recent analysis conducted by the Commission indicates that it would be more accurate to use the slant distance for all propagation paths, regardless of path distance.

23. This conclusion is consistent with CCIR Recommendation 435 which recommends use of the slant distance for calculating skywave field strength for all propagations paths.[19] The accuracy of skywave calculations is most notably improved by use of the slant distance over any propagation path where the slant distance is large in relation to the great-circle distance. Medium waves are usually reflected by the E layer of the ionosphere which spans the altitude range of approximately 90 to 130 km. The current FCC Rules assume the average height of the E layer to be 96.5 km. Thus, even for a receiving point only 1 km away from the transmitter, the skywave may travel 193 km to reach its destination. An increase between the transmitting and receiving points, within a certain range, will not result in a significant change in the slant distance. For example, if the distance between the two points is increased to 100 km, the actual slant distance only increases 24 km. Thus,the skywave signal must travel nearly as far to reach a receiver near the transmitter as it does to reach a receiver several hundred kilometers away.

24. The new propagation model that we are proposing specifies use of slant distance for all propagation paths, regardless of path distance. This ensures use of the most accurate calculation methodology without significantly adding to the complexity of the calculations. For the purpose of the new model, it should be noted that the height of the E layer of the ionosphere above the earth is assumed to be 100 km. The elevation angle for the propagation path would continue to be determined on the basis of the actual great-circle distance in accordance with the formula in Section 73.190(d) of the FCC Rules.

25. *Reference Hour*. Several decades ago, the FCC adopted two hours after sunset (SS+2) as the reference hour for its propagation models in AM broadcasting. It was believed that the ionosphere was fully stabilized and field strength maximized at two hours after sunset. This early conclusion subsequently has been found to be incorrect. Soon after the FCC started itslong-term measurement program in 1939, it became apparent that field strength sat SS+6 were appreciably stronger than those at SS+2.[20] It was assumed that the difference was one of degree only. More recent studies, however, show that propagation conditions at SS+2 and SS+6 are significantly different. It is far more than a difference of degree; it is a difference of kind. It has been shown that at SS+2 the residual effect of the D layer of the ionosphere still exists, complicating the prediction of skywave field strength. On the other hand, at SS+6 the effect of the D layer no longer exists and skywave propagation primarily occurs by reflection from the E-layer of the ionosphere and occasionally from the F-layer.

26. Recent findings also indicate that skywave field strengths at approximately SS+2 display a certain degree of frequency dependence (approximately 3 dB stronger at the higher frequencies). At SS+6, frequency dependence becomes insignificant. Thus, we have concluded from our studies that the current curves in Section 73.190 of the FCC Rules which are based on the reference hour of SS+2 are more accurate at the higher frequencies. We believe that use of the reference hour of SS+6 for the new skywave propagation model would result in improved uniformity throughout the AM band and all frequencies would be treated in the same manner.[21]

27. There are also indications that use of SS+6 as the reference hour would result in skywave field strength predictions that are more uniform for propagation paths in all directions. Based on data collected by the FCC corresponding to SS+2, Crombie (*IEEE Transactions on Broadcasting*, September 1979) reported that at tenuation by the ionosphere on east-west paths is greater than that for paths in other directions. Thus, observed field strengths on north-south paths are usually stronger than those on east-west paths of comparable lengths at SS+2. Comparison with measured data indicates that Figure 1a of Section 73.190 of the FCC Rules appears to be more accurate for north-south paths. Very recently, a large amount of data for SS+6 has been studied by Commission staff and the effects of path orientation reported for data collected at SS+2 were not noted.

28. Finally, Commission studies have determined that the attenuation of field strength related to sunspot number is less pronounced at SS+6. In preparation for the Region 2 Administrative Radio Conference to Plan the Band 1605-1705 kHz, Commission staff studied a large amount of previously unanalyzed or partially analyzed measurement data, including measurements taken at SS+6. Among other things, it has been found that the at tenuation of field strength corresponding to the number of sunspots is the greatest during the period of daytime to SS+2 (*i. e.*, during the hours that the D layer of the ionosphere affects skywave propagation). This at tenuation gradually diminishes after SS+2 and reaches a minimum at approximately SS+6.[22]

29. Most public comments received in response to the *Inquiry* on this issue generally supported using SS+6 as the reference hour for the new propagation model. For example. CCBS indicated its belief that it is imperative that SS+6 be used if the objective of the new propagation model is improved accuracy. The Association for Broadcast Engineering Standards, Inc.(ABES) recommended including this issue in this *Notice* for further consideration. On the other hand, Edward A. Schober, consulting engineer,(Schober) commented that SS+2 provides a good weighting for the time of maximum radio listenership during the night hours. Likewise, Bonneville International Corporation (Bonneville) suggested retaining SS+2 as thereference hour, or, alternatively, defining protection standards 24 hours a day by using the Commission's diurnal curves contained in Figure 12 of Section 73.190 of the Rules.

30. After considering the comments and the results of our own studies on this matter, we have concluded that use of SS+6 as the reference hour for the new propagation model has merit. We believe that this would ensure uniform calculations for all frequencies and propagation paths. Moreover, this reference hour would better represent the "worst case" for interference calculations, thus minimizing the levels of new interference that would be introduced in the future. The formula in Appendix B for the new propagation model includes a 2.5 dB factor to account for the greater field strength that occurs at SS+6.

31. *Conversion Factor for 10 % Skywave Field Strength.* A final matter that needs to be considered concerns the procedure for calculating skywave field strength exceeded 10% of the time. The new model being proposed depicts field strength values exceeded 50% of the time and it is necessary to apply a factor to convert to field strength exceeded 10% of the time. As noted earlier in this *Notice*, field strength exceeded 10% of the time is used in calculating skywave interference, whereas, skywave field strength exceeded 50% of the time is used for calculating the skywave service contours for Class I clear channel stations. Commission studies of skywave propagation data indicate that this conversion factor is affected by the midpoint geomagnetic latitude of the propagation path. Thus, this factor varies from approximately 6 dB in the low-latitude areas (*e. g.*, Mexico) to more than 10 dB in the high-latitude areas (*e. g.*, Oregon and Alaska).[23] For administrative convenience,an 8 dB factor was adopted in the Final Acts of the Region 2 Administrative Radio Conference (1981, Rio de Janeiro) and is currently specified in Section 73.190 of the Rules for use with Figure 1a in the coterminous U.S.[24]

32. Most commenting parties responding to the *Inquiry* did not provide guidance on this issue. CCBS and Schober suggest calculation of the applicable factor for each path. CCBS further suggested development of a simple curve to portray the variation between 50% and 10% field strength values with geomagnetic latitude. In contrast. Bonneville suggested that a uniform factor of 8 dB is acceptable.

33. There are several alternatives that could be considered for determining the conversion factor. One alternative would be to use a single factor, *e. g.*, 8 dB, for all propagation paths. Another would be to establish several factors that would be applicable in three zones defined by latitude. However, none of these approximations would provide the degree of accuracy that would result from specific calculations of the factor for the actual geomagnetic latitude for any given propagation path. We believe, therefore, that a procedure that would require the specific conversion factor to be determined for each propagation path is preferred and would optimize accuracy for interference calculations on such paths. A formula, shown in Appendix B,has been developed that depicts the conversion factor as a function of geomagnetic latitude. We are proposing use of this formula in determining the applicable conversion factor.

OTHER MATTERS

34. Several parties commenting in response to the *Inquiry* were concerned about the impact that use of new skywave propagation curves would have on the existing AM broadcast service. For instance, although endorsing the use of more accurate skywave curves, several commenters urged the Commission not to implement their use until other AM assignment criteria were fully considered in rule making. ABES and CBS, for example, are supportive of the "modified method", adding that a rule making proceeding on this subject should be instituted. Such a proceeding, according to ABES, would permit a more detailed evaluation of its technical aspects as well as the potential impacton existing AM broadcast service such as changes in interference levels to existing stations, issues related to the processing of applications, and the potential for added administrative burdens. CCBS cautions that adoption of a new skywave propagation model could lead to massive disruption of AM service as interference and service areas are recalculated. As a result, CCBS urges the Commission not to move forward with a change in the methods for predicting AM skywave propagation unless and until the Commission has concluded its investigation into the other related topics set forth in the *Inquiry*.

35. As we discussed *supra*, we are cognizant of the relationship between the skywave propagation model which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We noted in the *Inquiry* that use of a new propagation model could result in changes to the location of service contours and calculated levels of interference. The Commission's staff has performed calculations using the "modified method" on a limited number of regional channels and clear channels which are believed to be representative channels.[25] These studies generally indicate that the predicted nighttime service of Class III stations using a reference hour of SS+2 will be greater than previously depicted using current calculation procedures. On the other hand, use of a reference hour ofSS+6 reduces the calculated service area. In the case of clear

channel stations, the staff's calculation at a reference hour of SS+2 indicates that the skywave service areas of class I stations are substantially reduced at higher latitudes, and to a lesser degree at a reference hour of SS+6.[26]

36. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a record on this issue.[27] Such a record will guide the Commission on appropriate actions which ultimately should be taken. We believe, however, that there may be practical reasons for considering a delay in implementing a new propagation model, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, there may be merit in considering implementing simultaneously all the inter related changes that may ultimately be adopted. This approach could minimize administrative burdens for the Commission as well as uncertainties within the industry. We seek comment on the advisability of such an approach.

37. It would not be our intent to require any modifications of existing operations as a result of the changes proposed in this Notice. Moreover, we believe that the same principle would apply to applications pending at the time any changes proposed herein are implemented.

ADMINISTRATIVE MATTERS

38. Authority for the rule changes on which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

39. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **December 27, 1988** and reply comments on or before **January 11, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

40. For the purposes of this non-restricted notice and comment rulemaking proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3)issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

41. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2).if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously-filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

42. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities.The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96-354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

43. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form,information collection and/or record keeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed on the public.

44. For further information on this proceeding, contact Larry W. Olson,Mass Media Bureau, (202) 632-6955.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS I.

Reason for Action: In this proceeding, we seek public comment on the desirability of replacing the existing AM broadcast skywave propagation curves with a new propa-

gation model recently developed. The new model results from recent scientific analysis of skywave measurement data that provides a better understanding of skywave propagation phenomena. Use of the new method for calculating skywave field strength in the AM service would provide a more accurate depiction of the service and interference relationships between AM stations.

II. Objective: The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis: Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended,47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected: There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to the standards (curves and formulas) used to calculate skywave field strength. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. We will, however, consider in future rule making proceedings the related questions regarding assignment principles which, together with the propagation model, may result in new definitions of service and interference for AM broadcast stations. Such definitions are not now known but are intended to be beneficial to the AM service as a whole.

V. Reporting Record Keeping, and other Compliance requirements: There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules: There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives: There are no significant alternatives available.

FOOTNOTES

[1] The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, *(Report)* released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

[2] By *Order*, DA 87-1823, released December 15, 1987, the Commission granted a "Motion for Extension of Time for Filing Comments and Reply Comments" submitted by the National Association of Broadcasters (NAB). Inthat *Order*, the Commission bifurcated the proceeding and established separate filing periods. Phase 1 involved Sections II and III of the *Inquiry* whilePhase 2 involved Sections I and IV. For the specific issues raised in Section III (Related Technical Issues) of the *Inquiry* under which skywave propagation falls, the time for filing comments and replies was extended to February 1,1988 and March 1, 1988, respectively.

[3] This proceeding will examine only those issues pertaining to skywave propagation. Where appropriate, the Commission will institute future rulemaking proceedings to deal with the remaining issues addressed in the *Inquiry* and public comments. For example, in a similar action today, the Commissionin stituted a proceeding concerning groundwave propagation. *See , Notice of Proposed Rule Making*, MM Docket No. 88-510, FCC 88-326.

[4] The ionosphere is a region of the earth's atmosphere consisting of several layers subject to ionization. These layers are alphabetically designated and have varying effects on radio waves. Pertinent to the propagation of AM broadcast signals are three ionization layers (D, E, and F). The distance of these layers above the earth varies from approximately 50 km for the D-layer (nearest the earth) to approximately 300 km for the F-layer (farthest from the earth).

[5] A version of Figure 1a was adopted by the Region 2 Administrative Radio Conference, Rio de Janeiro, 1981.

[6] Figure 1b is an interim curve adopted for use pending completion of further analysis of field strength measurement data subsequently collected. *See , Report and Order* in MM Docket No.83-807, 49 FR 43957, November 1, 1984.

[7] The occurance of sunspots on the surface of the sun rises and falls in a periodic relationship over an eleven year cycle. Each year in the cycle is assigned a sunspot number which is proportional to the solar activity of the sun for that given year.

[8] Observations indicate that skywave field strengths increase as the sunspot number decreases.

[9] Field Strength recordings were made on more than 40 paths ranging from 165 to 4176 km with transmitting frequencies ranging from 540 to 1530 kHz. The midpoint geomagnetic latitudes of these paths are between 40 and 54 degrees North. Figure 2 differs from Figure 1a in one major respect by giving weight to the effects of geographic latitude and depicts a family of curves ranging from 36 degrees to 50 degrees geographic latitude.

[10] The high-latitude field strength measurement program has been completed and the results are expected to be published later this year.

[11] There are two latitude terms which apply to this discussion. The first, geographic latitude, refers to a physical location of a point on the surface of the earth relative to the north and south poles. The second, geomagnetic latitude, takes into account the effects of the earth's magnetic influence on radio waves and is based on the magnetic poles. Geomagnetic coordinates are similar but not identical to geographic coordinates. The geomagnetic northpole is located at 78.5 degrees North and 69 degrees West. Geophysical phenomena, including absorption of electro magnetic waves, are better related to geomagnetic latitudes.

[12] Slant distance is the total distance that a skywave signal travels along a propagation path including the distance traveled to and from the E layer of the ionosphere.

[13] The FCC Rules specify that the skywave service areas of Class I stations are to be calculated using skywave field strength exceeded 50% of the time, whereas, interfering skywave signals are computed using skywave field strength exceeded 10% of the time.

[14] In preparation for the Region 2 Administrative Radio Conference for the band 1605-1705 kHz, the Commission's staff developed the "modified method".It was adopted by that Conference as a recommended method for calculating interregional interference. *See* , "A Skywave Propagation Study in Preparation for the 1605-1705 kHz Broadcasting Conference" by J. Wang, *IEEE Transactions on Broadcasting*, Vol. BC-31, No. 1, pp. 10-17, March 1985.

[15] At one time the calculation of service contours using such a procedure was laborious, but the current wide-spread availability of computers facilitates such calculations.

[16] Parties who believe that curves should be included in the FCC Rules should provide practical reasons for that position. It is our preliminary view that parties could individually prepare curves for their own use if such convenience is desirable.

[17] It was noted in the *Inquiry* that the slant distance changed little forgreat-circle distances less than 200 km.

[18] Currently, Figures 1a and 2 of Section 73.190 of the FCC Rules contain a gap in the range of 0-100 km where no skywave field strength values are provided. Occasionally, there is a need to compute field strength for such short paths and no method is specified in the FCC Rules.

[19] The Consultative Committee on International Radio (CCIR) is a technical body of the International Telecommunication Union within which administrations from around the world contribute and exchange technical information. The CCIR develops recommendations based upon this broad base of data and information on issues where technical advances have been achieved.

[20] *See* , "Prediction of MF Skywave Field Strength in North America", *IEEE Transactions on Broadcasting*, Vol. BC-23, No. 2, pp. 43-49, June 1977.

[21] *See* , FCC Technical Memorandum OST TM83-4.

[22] As an example, consider the propagation path for WLW, Cincinnati, OH to Portland, OR (700 kHz, 3192 km, 53 degrees North geomagnetic latitude). During Sunspot Cycle 18, as the sunspot number increased from its minimum to maximum, field strength for SS+2 decreased by 16.9 dB, that for SS+4 decreased by 13.3 dB, and that for SS+6 decreased by only 7.3 dB.

[23] The populated areas of the United States cover a wide range of geomagnetic latitudes: Honolulu, 19.5 degrees North; Virgin Islands, 30 degrees North; Fairbanks, 64 degrees North.

[24] A 13 dB factor had been previously adopted by the FCC for use with Figure 1b of the Rules when stations in Alaska are involved in calculations. We now believe that it would be more appropriate to use a 10 dB factor in conjunction with the "modified method" where stations in Alaska are concerned.

[25] The results of these calculations are contained in Appendix C of this *Notice*. RSS (root-sum-square) calculations for three regional channels have been included as well as two examples of the skywave service provided by Class I stations at high-latitudes and low-latitudes.

[26] A true comparison between current calculation procedures and those proposed in this *Notice* are possible only at SS+2 because current procedures are based upon that reference hour.

[27] A related issue concerns those situations where the new skywave calculation procedures and any related technical changes to the Commission's Rules result in received levels of interference less than that permitted for the normally protected contour.

APPENDIX B - CALCULATION OF SKYWAVE FIELD STRENGTH

The following formulas are proposed to be used in place of the curves in Section 73.190 of the FCC Rules. The methods used to determine other factors such as radiation value, elevation angle, and $f(\theta)$ are unchanged and can be determined by referring to the appropriate section of the FCC Rules.

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

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

$$F_s(50) = (87.5 - 20\log D) - (2\pi + 4.95\tan^2\theta_M)\sqrt{(D/1000)} \quad \text{dB}(\mu\text{V/m}) \tag{1}$$

The slant distance, D, is given by:

$$D = \sqrt{40,000 - d^2} \quad \text{km} \tag{2}$$

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

$$\theta_M = \arcsin[\sin a_M \sin 78.5° - \cos a_M \cos 78.5° \cos(69 - b_M)] \quad \text{degrees} \tag{3}$$

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

$$d = 111.18 d° \quad \text{km} \tag{4}$$

Where:

$$d° = \arccos[\sin a_T \sin a_R + \cos a_T \cos a_R \cos(b_R - b_T)] \quad \text{degrees} \tag{5}$$

Where:
a_T is the geographic latitude of the transmitting terminal (degrees)
a_R is the geographic latitude of the receiving terminal (degrees)
b_T is the geographic longitude of the transmitting terminal (degrees)
b_R is the geographic longitude of the receiving terminal (degrees)
a_M is the geographic latitude of the midpoint of the great-circle path and is given by:

$$a_M = 90 - \arccos\left[\sin a_R \cos\left(\frac{d°}{2}\right) - \cos a_R \sin\left(\frac{d°}{2}\right)\left\{\frac{\sin a_T - \sin a_R \cos d°}{\cos a_R \sin d°}\right\}\right] \quad \text{degrees} \tag{6}$$

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

$$b_M = b_R + k\left[\arccos\left(\frac{\cos(\frac{d°}{2}) - \sin a_R \sin a_M}{\cos a_R \cos a_M}\right)\right] \quad \text{degrees} \tag{7}$$

Note(1): If $|\theta_M|$ is greater than 60 degrees, equation (1) is evaluated for $|\theta_M| = 60$ degrees.
Note(2): North and east are considered positive; south and west negative.
Note(3): In equation (7), $k = -1$ if $b_R > b_T$, otherwise $k = 1$.

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

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

$$F_s(10) = F_s(50) - \Delta \quad \text{dB}(\mu\text{V/m}) \tag{8}$$

Where:
$\Delta = 6$ when $|\theta_M| < 40$
$\Delta = 0.2|\theta_M| - 2$ when $40 \le |\theta_M| \le 60$
$\Delta = 10$ when $|\theta_M| > 60$

APPENDIX C

COMPARISON OF SKYWAVE FIELD STRENGTH CALCULATIONS

FREQUENCY: 560 KHZ

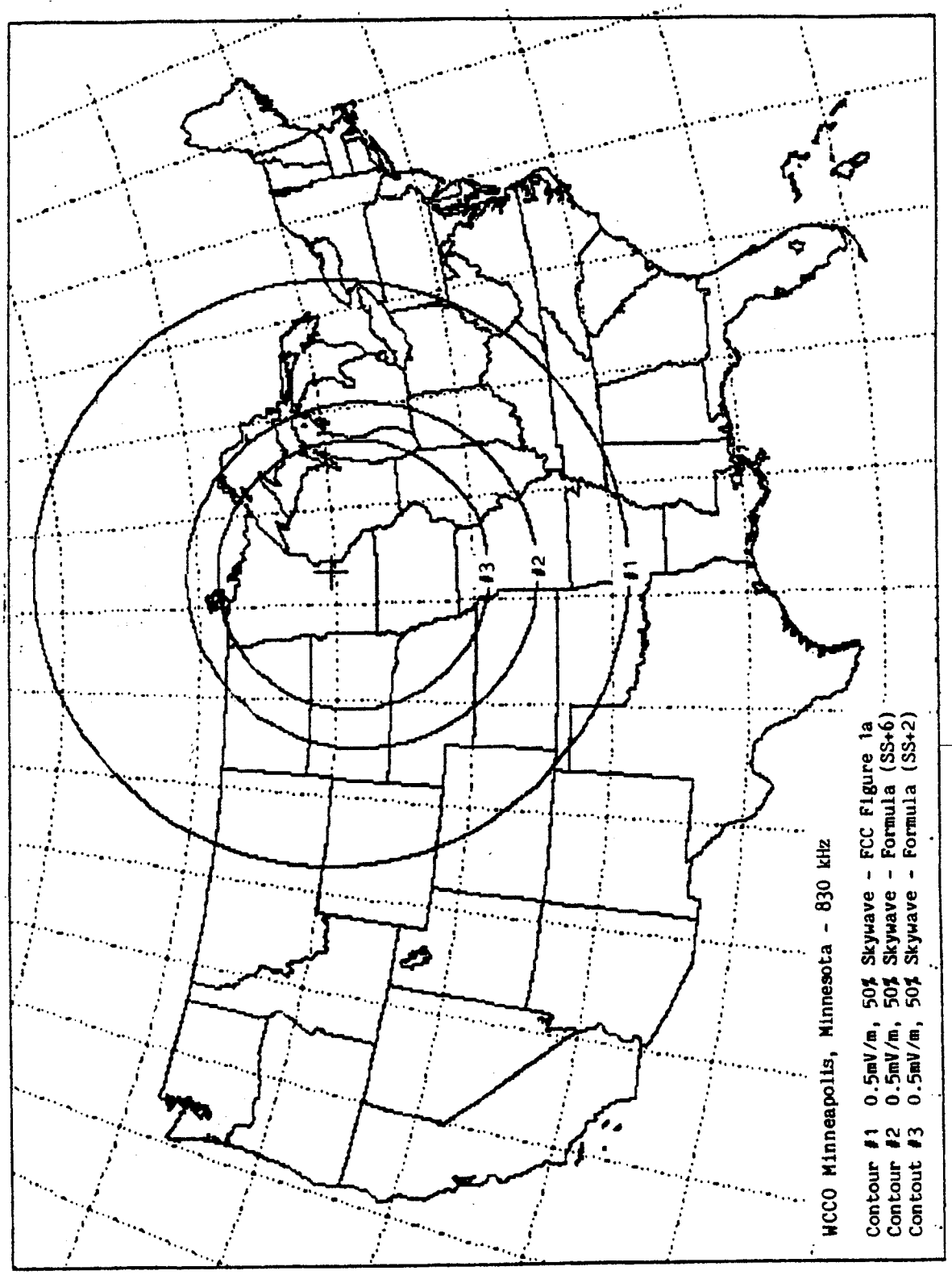
CALL SIGN	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
	FIGURE 2	SS+2	SS+6
KVOK	0.77	0.69	0.92
KBLU	6.23	4.88	6.51
KSFO	1.89	1.52	2.03
KLZ	2.41	1.71	2.28
WQAM	2.96	2.23	2.97
WIND	3.24	1.99	2.66
WHYN	4.21	4.14	5.52
WGAN	3.31	2.02	2.70
WEBC	28.38	15.47	20.63
KWTO	7.08	4.83	6.44
KMON	8.08	4.10	5.46
WGAI	18.05	14.70	19.60
WFIL	4.19	2.19	2.92
WVOC	4.66	2.74	3.65
WHBQ	9.77	6.50	8.67
KLVI	3.72	2.66	3.55
KPQ	2.83	1.61	2.15
WJLS	11.04	9.69	12.92

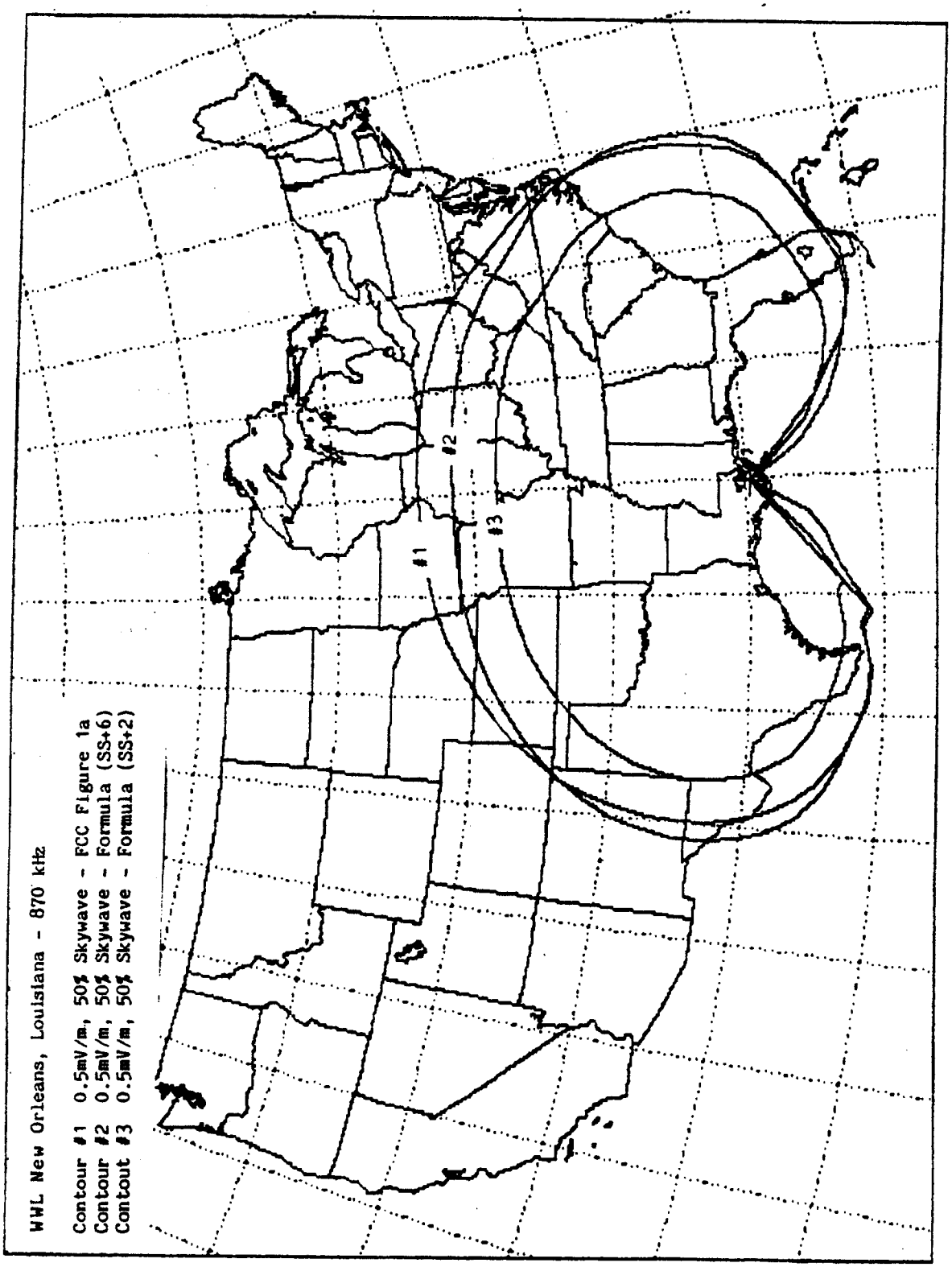
FREQUENCY: 980 KHZ

CALL SIGN	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
	FIGURE 2	SS+2	SS+6
KENY	2.11	1.85	2.47
KINS	11.13	6.83	9.10
KFWB	3.50	2.80	3.74
KGLN	14.11	10.50	14.00
WWRC	3.65	2.64	3.51
WFXP	15.76	11.59	15.46
WTOT	12.88	9.05	12.07
WWNN	5.78	4.45	5.94
WPGA	17.57	13.11	17.49
WGVT	21.06	23.70	31.61
KUPI	14.05	7.75	10.33
KSGM	9.98	8.90	11.86
WITY	18.60	16.46	21.95
WCAP	37.12	35.82	47.76
WAYL	17.50	10.71	14.28
KMBZ	2.81	2.00	2.67
WAAV	22.12	17.23	22.97
KICA	14.27	8.71	11.62
WJIW	11.00	11.84	15.78
WTRY	6.57	5.59	7.45
WONE	10.59	7.62	10.16
WILK	8.13	8.40	11.20
WBZK	24.66	21.90	29.20
KDSJ	14.59	7.81	10.42
WSIX	9.98	6.85	9.13
KSVC	14.76	10.41	13.88
WFHG	18.86	15.29	20.39
KUTI	14.83	14.45	19.27
WCUB	33.13	21.68	28.91

FREQUENCY: 1590 KHZ

CALL SIGN	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
	FIGURE 2	SS+2	SS+6
WGYJ	17.27	15.98	21.30
WVNA	5.45	4.36	5.81
KYDE	6.81	5.24	6.99
KSSU	11.31	8.28	11.04
KLIV	4.32	3.33	4.44
KOGO	7.41	7.05	9.40
WQQW	2.32	2.12	2.83
WRXB	12.05	9.89	13.19
WALG	2.83	2.65	3.53
KWBG	11.63	6.89	9.19
WONX	14.30	13.76	18.34
WNTS	8.93	8.36	11.15
KVGB	3.24	3.15	4.20
WJRO	14.95	11.55	15.40
WETT	19.72	17.16	22.88
WJBQ	26.33	31.66	42.22
WTVB	15.24	14.45	19.27
KCNN	13.17	6.49	8.65
WZRX	8.63	7.66	10.22
WSMN	15.61	17.84	23.79
WERA	12.46	14.90	19.87
WAUB	25.29	21.35	28.47
WASB	28.79	24.24	32.32
WEHH	19.53	17.08	22.78
WAKR	2.31	1.69	2.25
KTIL	5.96	4.75	6.34
WCBG	13.36	12.13	16.18
WCZN	12.77	12.07	16.09
WXRF	2.13	2.72	3.63
WARV	15.48	19.08	25.44
WUSJ	5.94	4.36	5.81
KYOK	7.83	6.20	8.27
KEND	4.95	4.44	5.93
KDAE	11.46	10.38	13.84
KMTI	13.40	8.29	11.05
KJET	4.19	3.63	4.84
WTOQ	11.97	8.90	11.87
WTRW	28.62	25.08	33.45


#3
#2
#1
WCCO Minneapolis, Minnesota - 830 kHz
Contour #1 0.5mV/m, 50% Skywave - FCC Figure 1a
Contour #2 0.5mV/m, 50% Skywave - Formula (SS+6)
Contout #3 0.5mV/m, 50% Skywave - Formula (SS+2)


WWL New Orleans, Louisiana - 870 kHz
Contour #1 0.5mV/m, 50% Skywave - FCC Figure 1a
Contour #2 0.5mV/m, 50% Skywave - Formula (SS+6)
Contout #3 0.5mV/m, 50% Skywave - Formula (SS+2)
#1
#2
#3

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-509

In the Matter of

Enhanced Nighttime Operation
for Class II-S and Class III-S
AM Radio Broadcast Stations

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 4, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this *Notice of Proposed Rule Making (Notice)* to consider changes in the rules to facilitate the enhancement of nighttime operations by Class II-S and Class III-S AM stations. The proposed rules would allow these stations to establish a separate nighttime antenna system without having to meet the minimum power, city coverage or minimum operating schedule requirements that otherwise would apply to such a change in their nighttime operations.

2. This *Notice* is part of the Commission's continuing efforts to create an environment in which AM stations can compete effectively and thereby better serve the public. To a considerable degree, recent actions involving AM stations have been based on the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, released April 3, 1986 (*Report*), and the comments received in response to it. The *Report* addressed a large number of technical, legal and policy issues, seeking to identify opportunities to change or eliminate existing rules in order to assist AM broadcasters in meeting the competitive challenges facing them, thereby improving their service to the public. Recognizing that daytime-only stations face serious disadvantages because of their inability to operate at night, the Commission has implemented a number of proceedings to remove this limitation to the maximum extent possible consistent with sound engineering practice. For example, actions taken in a series of proceedings have allowed many daytime- only stations to become full-time stations. Nonetheless, we are of the view that it may be possible to take further steps to enhance the opportunity for former daytime-only stations to improve their nighttime operations while at the same time maintaining existing interference protection requirements. Before discussing the specific proposal, however, we will provide some background information regarding the various actions taken by the Commission in this area in recent years.

BACKGROUND

3. The current proposal can be seen as a continuation of the rule making process that began with the Commission's 1983 action first authorizing post- sunset operation by daytime-only stations.[1] Although many daytime-only stations had been able to conduct pre-sunrise operations (typically beginning at 6:00 a.m. local time), similar relief had not been available for the post- sunset period because of international agreements then in effect.[2] However, with the implementation of new AM agreements with Canada and Mexico, the FCC was able to authorize post-sunset operation. Under the rules adopted by the Commission, the great majority of daytime-only stations have been permitted to operate for up to two hours beyond local sunset with a power of 0.5 kW, reduced as necessary to avoid interference. A special computer program was created by the Commission to do the calculations involved and to issue the authorizations.

4. Although these actions brought important benefits, it was clear that pre-sunrise and post-sunset operation alone could not be expected to alleviate all of the difficulties faced by daytime-only stations. This led the Commission to study other possible relief, in particular the possibility of authorizing regular licensed nighttime operation with allowable powers calculated in much the same way as the post-sunset powers had been, using a computer program devised by the Commission. Studies established the feasibility of such a step, and in MM Docket No. 84-281 the Commission authorized nighttime operation by almost all of the daytime-only stations on what had previously been 14 foreign Class I-A clear channels.[3]

5. Nighttime operation on the foreign clear channels is being initiated in stages. During the first five-year period of such operation, the Commission has authorized a maximum power of 0.5 kW, reduced as necessary to protect existing foreign and domestic full-time stations on these channels. The power to be used is based on the station's daytime (or, if applicable, the station's critical hours)[4] antenna system. Because in many cases the initial powers were quite low, the Commission encouraged these stations to take other steps, typically through the installation of directional antennas, that would permit them to employ higher powers. Stations taking advantage of this opportunity had to propose a minimum power of 0.25 kW or its equivalent.[5] In allowing these increases in power, we stated that these stations would not be required to provide interference protection to one another during the initial five-year period of nighttime operation. However, after the five-year initial period, protection would have to be afforded to all stations, including former daytime-only stations, operating at night with at least minimum power.[6] Also, subject to this limitation on interference, the permissible power for these stations will increase to 1 kW.

6. Then, in MM Docket 87-131, the Commission took a similar step and allowed qualifying daytime-only Class III stations on the regional channels (and Class II daytime-only stations on two clear channels on which no U.S. clear channel stations operate) to operate at night using their existing antenna system with a maximum power of 0.5 kW, reduced as necessary to avoid interference to existing full-time stations. Stations authorized a power of at least 0.25 kW (or equivalent) were reclassified as unlimited-time Class II or Class III stations.[7] Others receiving lesser powers were reclassified as Class II-S or Class III-S stations[8] and were exempted from the principal city signal requirement. The Commission also exempted the new

Class II-S and Class III-S stations from the requirement that unlimited-time stations operate two- thirds of the hours between 6:00 p.m. and midnight each day of the week except Sunday.

7. These various Commission actions have substantially relieved the difficulties faced by daytime-only stations and their listeners, but as discussed below, we believe that there may be additional steps that can be taken to enable these former daytime-only stations to better serve their communities.[9]

DISCUSSION

Enhanced Nighttime Operation

8. In our actions permitting daytime-only stations to operate at night, the power levels authorized were calculated based on the same antenna system that the station used to provide its daytime (or, if applicable, its critical hours) service. Since these antenna systems had been designed with only daytime protection in mind, in many cases they were not capable of providing effective nighttime service. Many in this group were restricted to low powers from sites at some distance from the population to be served. This led some to decide not to use the authorization because the station's daytime site was not close enough to the community of license to permit it to be served with the authorized nighttime power and existing antenna pattern.

9. Although a Class II-S or III-S station was permitted to seek an increase in power, it had to propose an increase to at least the minimum power level. For some affected stations, we have found that such an increase is not possible at all for interference reasons; for others, it can be accomplished only at a prohibitive cost by installing highly directionalized antennas. Moreover, because of the low power initially authorized, some stations have chosen not to take advantage of their authorizations. In other cases, stations that do operate at night are unable to obtain the coverage they desire. No relief is available unless the station is able to propose an increase to at least the minimum power level. In many cases, this situation would change if the stations were able to establish a separate nighttime antenna system, either at the current site or elsewhere, from which the desired service could be provided without having to meet the minimum power requirement. It appears as if both the station and the public could benefit if the station had this latitude in selecting a site and antenna system responsive to its needs.

10. Continuing to restrict power increases to only those stations able to achieve minimum power may well be contrary to the public interest because such action could have the practical effect of preventing many Class II-S or III-S stations from upgrading their facilities at all. Stations able to increase power to the specified minimum level already have good reasons to do so, not only by virtue of the increase in coverage it makes possible but through the interference protection that they will obtain if they reach the level of minimum power. For stations not in this fortunate position, there is no current relief available. Even if these stations are unable to reach the minimum power level, we question whether the public is served by denying them the opportunity to improve their facilities and enhance their coverage. We recognize that permitting stations to apply for lesser power increases may diminish somewhat the incentive to reach minimum power. Our experience indicates, however, that it has been practical limitations such as financial or technical considerations that have kept many Class II-S and III-S licensees from operating with minimum power. Because these licensees are thus unlikely to reach minimum power in any case, there appears to be no basis for refusing to allow such stations the opportunity to provide increased service, albeit at less than minimum power.

11. For these reasons, we propose to allow Class II-S and III-S stations to establish separate nighttime operations, utilizing either their daytime operating site or another site, at power levels below the 0.25 kW minimum.[10] This proposal can offer several advantages. It would permit the licensee to consider a wide range of choices of how best to operate at night. The licensee could install a directional antenna designed specifically for nighttime operation, either at its current site or elsewhere. It could operate non-directionally from another site closer to the community of license or it could increase power, albeit not to the minimum power level. Even if the power were not increased or in fact was marginally reduced, coverage still could be improved in the very areas where it may most be needed, thus improving service to the public.[11] In addition, this approach could also offer the licensee the opportunity to use a simple nondirectional antenna array from its existing site or from another site that would enable the licensee to provide satisfactory nighttime service and thus compete more effectively in its market.[12]

12. It is important to take into account the administrative impact that adoption of this proposal might entail. To lessen any such impact, it may be possible to simplify or streamline the application process. One possibility is to define all such proposals as minor change applications even if a power increase is involved, thus eliminating the public notice requirements and reducing processing time. Comment on this and other possible approaches to lessening the administrative impact is invited.

13. Finally, we wish to make an important observation with respect to processing procedures applicable to Class II-S and III-S licensees filing applications for modifications of facilities. Initially, the Commission calculated the permissible powers and issued the appropriate nighttime authorizations. The calculations were based upon the daytime or critical hours antenna system. In the past, AM licensees seeking a change in authorization for their daytime facilities did not recognize the need to file for any corresponding change this necessitated in their nighttime facilities. In the future, however, it will be necessary for Class II-S and III-S licensees seeking authorization for modifications to their daytime facilities that would require any change to their nighttime operations to include information specifying the requisite changes to nighttime operations in their application. We note that, in the context of this proceeding, if Class II-S or III-S licensees use separate facilities for daytime and nighttime operations, changes in daytime operations will not necessarily in such cases affect nighttime operation. In such cases, this additional information would not be required.

Relaxation of Power Minimum

14. In addition, some full-time stations have expressed an interest in operating at lower nighttime powers but are currently barred from doing so by the minimum power and city coverage requirements. We seek comments upon permitting such a voluntary power reduction. Allowing stations to reduce power to a level below the current

minimum could provide licensees with additional latitude in which to tailor their facilities to respond to existing market conditions. Greater flexibility could result in services better attuned to meeting the needs of the station's audience. Should we proceed in this fashion, we intend to maintain the interference constraints applicable to such stations. We propose, however, that a station reducing its power to a level below the established minimum would be reclassified as Class II-S or Class III-S and would lose its right to interference protection that is accorded to stations with at least minimum facilities. It is our intention at this time to retain the city coverage and minimum operating schedule requirements for stations employing voluntary power reductions. We seek comment upon whether it would be appropriate to exempt such stations from these requirements, as are existing Class II-S and III-S stations, or whether stations engaging in a voluntary power reduction below the minimum level should continue to be held to the city coverage or minimum operating schedule requirements.

ADMINISTRATIVE MATTERS

15. Authority for the rule changes upon which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

16. Pursuant to the applicable procedures set forth in 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **December 27, 1988,** and reply comments on or before **January 11, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive personal copies of their comments, an original plus nine copies must be filed. Comments and reply comments should be sent to Office of the Secretary, Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference Room (Room 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

17. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* contacts are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice stating that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever comes first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence for the resolution of issues in the proceeding. Section 1.1203.

18. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously- filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

19. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with section 603(a) of the Regulatory Flexibility Act, Pub.L. 96- 354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*,(1981).

20. The proposal herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection and/or recordkeeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed upon the public.

21. For further information on this proceeding, contact Diane L. Hofbauer, (202) 254-3394.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment upon a proposal to allow Class II-S and Class III-S AM broadcast stations to establish separate nighttime operations designed to better serve local needs without requiring them to comply with minimum power requirements.

II. Objective:

This proposal is intended to permit an expansion of the nighttime operations of Class II-S and III-S AM stations so that they may better serve the public.

III. Legal Basis:

Sections 4(i), 303, and 307 of the Communications Act, as amended, 47 U.S.C. §§154(i), 303 and 307.

IV. Description, Potential Impact, and Number of Small Entities Affected:

There are more than 1500 AM broadcast stations that could benefit from this proposal in the United States. An estimated 50 AM licensees per year are expected to utilize the options proposed in this Notice of Proposed Rule Making. This proposal is expected to increase service to local communities with minimal additional, if any, expense to the licensee.

V. Reporting, Record Keeping, and Other Compliance Requirements :

There are no reporting, record keeping or other compliance requirements.

VI. Federal Rules that Overlap, Duplicate or Conflict with Proposal:

There is no overlap, duplication or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objective:

This proposal is designed specifically to allow AM licensees to increase service with little or no impact on current operations.

FOOTNOTES

[1] Hours of Operation of Daytime-Only Stations, *First Report and Order* in BC Docket No. 82-538, 95 FCC 2d 1032 (1983).

[2] A discussion of this situation is contained in the *First* Report and Order in BC Docket No. 82-538, supra, at Paragraphs 51-52.

[3] See Report and Order adopted April 26, 1985 in MM Docket No. 84-281, FCC 85-244, 50 Fed. Reg. 24515, June 11, 1985, as modified on reconsideration, Memorandum Opinion and Order, adopted February 3, 1986, FCC 86-79, 103 FCC 2d 532 (1986).

[4] Critical hours are the first two hours after sunrise and the last two hours before sunset during which there is a potential for daytime skywave interference.

[5] For the sake of convenience, we refer to a minimum power of 0.25 kW. Operating with this power and minimum antenna efficiency, a station has an RMS of 141 mV/m at one kilometer. Thus, any operation with an RMS of 141 mV/m or greater meets the minimum even though the power may be below 0.25 kW. This occurs when an antenna system of greater efficiency is employed.

[6] The principle reason for imposition of minimum power requirements is the recognition that operations with a power below this level are likely to cause a disproportionate degree of preclusion in exchange for the service that will be provided. The same concerns, however, may not hold true in a mature medium like AM where the areas of such preclusion are likely to have been precluded already.

[7] In connection with this action, the Commission reduced the generally applicable minimum power for nighttime operation of Class III stations on regional channels to 0.25 kW.

[8] Class III-S stations are full-time stations on regional channels operating below minimum power at night. Class II-S stations operate on a like basis on clear channels.

[9] When the Commission began its actions, there were more than 2,400 authorized daytime-only stations representing about half of the total of AM stations. As a result of the recent actions, more than three quarters of these stations have been authorized to operate at night. As discussed below, not all of these stations have chosen to implement nighttime operation.

[10] When the Commission authorized nighttime operation with less than the minimum power, it recognized that it would be unrealistic to expect the station to provide the city coverage required at night. Although adoption of the proposal now before us could lead to some increase in nighttime city coverage, it appears that it likewise would serve little purpose to apply the principal city signal requirement to the nighttime operation of these stations. The same is true for the minimum operating schedule requirement. The current rules exempt Class II-S and III-S stations from both requirements, and we propose to continue these exemptions. Exemption from the principal city signal requirement, however, creates the possibility that a station could establish nighttime service in a new community at the expense of service to its community of license. This outcome could be avoided if we required nighttime service levels within the community of license to be at least as good as the service levels originally authorized (i.e. that originally authorized by the Commission for nighttime operation using daytime facilities). We seek comment as to whether this or some similar requirement is necessary. Finally, we do not hereby contemplate any changes in any daytimer preferences that these Class II-S and III-S stations might enjoy.

[11] In making this proposal, we have no intention of authorizing facilities that would be predicted to create interference to full-time stations under the criteria established in §73.37(a) of our Rules.

[12] Although problems with re-radiation and with antenna efficiency have in the past been associated with the use of rooftop antennas for nighttime operations, we are willing to consider whether utilization of rooftop antennas could provide a feasible alternative. We invite comment on this alternative and may consider whether to allow use of roof-top antennas should the commenters demonstrate that rooftop antennas are feasible and could be utilized without causing undue re-radiation concerns.

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This is an unofficial announcement of Commission action. Release of the full text of a Commission order constitutes official action. See MCI v. FCC. 515 F 2d 385 (D.C. Circ. 1975)

Report No. DC-1271 ACTION IN DOCKET CASE October 27, 1988

FCC MODIFIES RADIO DUOPOLY RULE
(MM DOCKET 87-7)

Citing the explosion of new stations in all sized markets offering a great diversity of program choices, the Commission modified the radio "duopoly" rule, which prohibits common ownership of two or more commercial radio stations in the same broadcast service whose 1 mV/m contours overlap. Specifically, the FCC relaxed the rule to a principal-city contour standard (the 5 mV/m contour for AM stations and the 3.16 mV/m contour for FM stations).

Although the duopoly rule was originally intended to ensure diversification of viewpoints and programming, the Commission found that purpose is now adequately served by the tremendous growth in the number and variety of media outlets in recent years in most markets. In addition, the economic efficiencies of scale inherent in joint ownership of stations may lead to more news and public affairs programming and a greater diversity of program formats.

The FCC noted that commenters contended that the current fixed 1 mV/m contour standard was overly restrictive and did not accurately reflect the area where most radio listening occurs. The Commission concluded that this standard disadvantaged AM broadcasters because the 1 mV/m signal of an AM station is not equivalent to the 1 mV/m signal of an FM station. Consequently, the FCC adopted a principal-city contour standard to remedy these defects. The new standard more accurately reflects stations' listenership and recognizes the differences in signal strength between AM and FM stations. Therefore, the principal-city overlap standard results in a more equitable rule for both AM and FM stations.

The principal-city contour overlap standard permits commonly owned stations to be located closer together, enabling station owners to take greater advantage of at least some of the economies of scale and related cost savings inherent in the joint ownership of stations in the same market.

Action by the Commission October 27, 1988, by Report and Order (FCC 88-343). Commissioners Patrick (Chairman) and Quello, with Commissioner Dennis issuing a statement.

-FCC-

News Media contact: Audrey Spivack at (202) 632-5050
Mass Media Bureau contacts: Michele Farquhar and Andrew Rhodes at (202) 632-7792.

PRESS 10/27/88

Statement
of
Commissioner Patricia Diaz Dennis

In Re: Amendment of Section 73.3555 of the Commission's Rules, the Broadcast Multiple Ownership Rules

I support these changes to our duopoly rules because they more accurately reflect actual listening patterns. Most stations apparently draw the great majority of their listeners from within the principal city contour--the 3.16 mV/m contour for FM stations and the 5 mV/m contour for AM stations. Therefore, our existing rule, which uses the broader 1 mV/m contour, seems overly restrictive. The new rule will not significantly affect the range of viewpoints to which a local listener is exposed, which is my paramount concern.

I reaffirm my strong commitment to the goal of diversity of viewpoints and programming, a bedrock principle under the Communications Act. The Commission has long recognized the overriding value of providing viewers and listeners the greatest possible number of diverse sources of information and opinion.

AM 8

10-21-88

SUMMARY AND CONCLUSIONS OF THE PROCEEDINGS OF THE TECHNICAL SUB-GROUP OF THE FCC'S RADIO ADVISORY COMMITTEE WITH RESPECT TO MM DOCKET NO. 87-267 IN THE MATTER OF REVIEW OF TECHNICAL ASSIGNMENT CRITERIA FOR AM BROADCAST SERVICE

On July 16, 1987 the Federal Communications Commission released a Notice of Inquiry (MM Docket No. 87-267) "In the Matter of Review of Technical Assignment Criteria for the AM Broadcast Service." In the Notice the Commission said it was initiating the Inquiry for the purpose of providing a comprehensive review of the technical principles pertaining to AM broadcast assignment criteria and related issues. The Commission also stated that it was taking this action to "identify any needed changes to its technical rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place" (Emphasis supplied).[1]

The technical aspects of the Notice were identified as follows:

I. Technical Assignment Principles

- A. Protected Contours
- B. Minimum Usable Field Strength
- C. Atmosphere and Man-Made Noise
- D. Co-Channel and Adjacent Channel Protection Ratios

II. Additional Assignment Considerations

- A. Interference Caused
- B. Interference Received
- C. Negotiation of Interference Rights

III. Related Technical Issues

- A. Emission Limitations
- B. Skywave Propagation
- C. Calculation Methodologies
- D. Groundwave Propagation

IV. Antenna Systems

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1 Portions of these comments also address issues being considered in MM Docket 88-376 and (Exp. Band Docket).

INTRODUCTION

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In response to the Notice, the Commission's Radio Advisory Committee and the Allocation and Technical Sub-Groups have had numerous meetings where the matters raised in the Notice have been considered in some depth by participants from industry and the Commission staff. At the meeting of the Radio Advisory Committee on September 13, 1988, it was suggested that a written report by the Committee to the Commission on the various issues raised in the Notice would be very helpful. To this end, several meetings have been held by members of the Technical Sub-Committee and this report outlines the results of the proceedings.

As an initial matter, it is recognized that the AM broadcasting service is a mature service, with 4,916 stations licensed as of August 31, 1988. These are stations which operate on the existing 540-1600 kHz band. The ability of the Commission to make major assignment changes in sufficient numbers of stations to effectuate meaningful improvements in interference matters, is so very limited so that the working group has concentrated on matters which can result in realistic improvement in AM reception quality. The major matters considered and recommendations follow.

EMISSION LIMITATIONS

The National Radio Systems Committee (NRSC) conducted an in depth study of technical improvements in AM broadcasting which would improve the quality of the AM service and has recommended voluntary standards for transmission pre-emphasis, receiver de-emphasis and 10 kHz transmission bandwidth. Operation of AM stations with these standards would provide an improved and consistent technical environment within which radio receiver manufacturers would likely produce receivers with a broader bandwidth and a better sound quality for the public.

Nearly twenty percent of the nation's AM stations have voluntarily incorporated the NRSC-1 audio transmission standard. Many of these stations have reported considerable satisfaction with the ease of installation, the resultant benefit of uniform sound and reduced interference with second adjacent-channel stations. In an effort to gauge the effectiveness of the audio standard, the NRSC developed NRSC-2, an emission limitation guideline for stations that have incorporated NRSC-1.

The Commission has proposed (Docket MM 88-376) that the provisions of NRSC-2 (the emission standard) be incorporated into the rules, with only minimal regard to the NRSC-1 audio standard. It can be reasoned that this method would provide the FCC with a more rational and straightforward method of compliance enforcement, but would also ignore the facets of NRSC-1 that were carefully devised to provide radio receiver manufacturers with a uniform design standard.

Since stations have been installing equipment to comply with NRSC-1 for some time now, several equipment manufacturers have had new receiver designs in production. It would not be unreasonable to expect all stations to have NRSC-1 in place and operating by the proposed January 1, 1990 implementation date. Transmission system factors such as transmitter age and condition, however, may dictate additional efforts and equipment purchases necessary to assure compliance with the proposed emission standard, NRSC-2, which is significantly more strict than the current requirements of Section 73.44.

With this in mind, the Technical Sub-Group suggests a method of incorporating these standards into the rules that would satisfy the goals of all parties involved. Using a method of "presumptive compliance,"[2] stations would be required to have NRSC-1 equipment in place and operating by the January 1, 1990 implementation date. At a later date, perhaps after an additional two years, stations would also be required to meet all specifications of the revised emission limitation as now proposed by the Commission. This method would effect a rapid and noticeable AM technical improvement, and at the same time provide the uniformity that radio receiver manufacturers have been seeking. Having the NRSC audio standard in place, stations would then have ample time to analyze and make the equipment acquisitions and corrections necessary to fully comply with the RF emission standard.

NIGHTTIME RSS INTERFERENCE CALCULATIONS

The Technical Sub-Group has received and reviewed several documents pertaining to the root-sum-square (RSS) method of estimating skywave interference to groundwave service. These documents have focused on (1) the implications of using an n-highest contributor approach to interference approximation in lieu of the present 50 percent exclusion rule, (2) the appropriateness of 50 percent as a threshold value for any exclusion-based rule, and (3) the appropriateness of any RSS method in assessing many, time-variant interfering signals in obtaining realistic nighttime interference levels.

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2 Under any proposed rule, stations complying with NRSC-1 would be assumed to be in compliance with NRSC-2 for the recommended initial two year period.

Documents Received Directly by the Sub-Group

The Technical and International Branch of the Mass Media Bureau's Policy and Rules Division furnished Sub-Group participants Elizabeth L. Dahlberg and Donald G. Everist with the ten highest interference contributors to all domestic stations operating on 11 AM frequencies. Dahlberg and Everist submitted a preliminary document setting forth the interference levels calculated under the present 50 percent exclusion rule for these stations, the four highest contributors, and the eight highest contributors, in October of 1987.[3] Sub-Group participant Karl D. Lahm presented further details concerning interference limits and thresholds for the 4 and 8 highest contributors, plus exclusion principle data based on additional interference thresholds of 1, 0.5, 0.25, and 0.1 decibels using the contributor data detailed by Dahlberg and Everist, at the meeting of January 27. 1988.[4]

Participant Donald G. Everist, with significant assistance and research by John Reiser of the Commission, presented a memorandum concerning the probability of multiple skywave signals appearing simultaneously at the May 11, 1988 Subgroup meeting.[5]

Other Documents of Which the Sub-Group is Aware

The Sub-Group is aware of the statistical RSS limitation analysis provided in Lahm's Comments in this proceeding,[6] which expand upon the earlier document submitted to the Sub-Group. That work was also cited in the Klein Report[7] submitted by the National Association of Broadcasters

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3 "Investigate Alternative Method(s) of Determining Nighttime Groundwave Limits in the Presence of More Than One Interfering Groundwave [sic] Signal," Elizabeth L. Dahlberg and Donald G. Everist, dated October 14, 1987.

4 "A Comparative Study of RSS Limit Calculation Methods," Karl D. Lahm, dated January 20, 1988.

5 "Mathematical Representation of Probability of 10% Skywave Signals Appearing at a Location Simultaneously," Donald G. Everist, dated May 10, 1988.

6 Comments of Karl D. Lahm, P.E., MM Docket No. 87-267, filed February 2, 1988.

7 "AM Technical Assignment Criteria - An Examination of Issues Raised in MM Docket No. 87-267," Harrison J. Klein, dated June 17, 1988.

(NAB) with its Comments. The Klein Report also contained as an appendix the paper "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers", by Harry R. Anderson. No information has been disclosed to the Sub-Group that is ~~in conflict~~ not contradicted with the analysis and conclusions of Anderson, Klein, and Lahm.

Conclusions of the Sub-Group

Based on the information submitted to it and the consensus of its participants, the Sub-Group concludes (1) that the n-contributor method of interference assessment is inappropriate; (2) that the 50 percent exclusion principle should be supplanted by a 25 percent principle; and (3) that the RSS (total power) method of assessment of the interfering effects of multiple, time-variant signals continues to be appropriate.

The Sub-Group believes that adoption of a 25 percent exclusion factor will yield a more realistic assessment of the actual interference suffered by AM stations. It is further believed that, by establishing new thresholds for interfering signal contribution through implementation of this principle, existing stations will be better protected from the "creeping interference" that several commenters have decried. Yet, at the same time, reasonable flexibility for facilities changes by existing stations will remain, something that would be much more haphazard if an n-contributor method of assessment were adopted.

How can it creep if spectrum is fully utilized? ↓ CLASS II-S ! + CLASS III-S ! ↓ WHAT ABOUT IBOC/MDX ↓ SILENT ON CLASS IV's !!

The Sub-Group recognizes that a reduction of the exclusion factor as recommended herein will increase the complexity of interstation interference calculations. However, the proliferation of computer-based methods of interference computation facilitates the implementation of a reduced exclusion factor. The impact on practitioners and the Commission staff is simply to make edits to one or two lines of code in the computer programs which compute interstation interference. The Sub-Group does not consider this to be a hardship ~~on its participants~~ apply to the expanded band.

FIRST ADJACENT-CHANNEL INTERFERENCE — groundwave

As confirmed by the two recent technical reports from studies commissioned recently by NAB, the existing 0 dB protection ratio of stations on adjacent frequencies has been shown to be inadequate.

The first study, detailed in the Klein report cited above, provided an objective and theoretical study of several factors affecting ideal reception of AM signals. It was shown that for virtually all transmission/reception conditions in existence that a 14 to 24 dB first adjacent-channel

protection ratio was required for a realistic co-channel protection of 26 dB. It was further demonstrated that only if broadcasters adopted a 5400 Hz audio transmission bandwidth and were willing to accept today's narrowband radios, would the current 0 dB protection ratio be reasonable. The report concluded that "[e]xisting protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers."

The second study, "AM Radio Interference Study," was conducted by the research firm B. Angell & Associates. This research involved the acceptance of average radio listeners to varying amounts of co-channel and first adjacent-channel interference levels. Depending on the desired program format, it was found that between 16 and 20 dB of attenuation of an interfering adjacent-channel signal was required to provide an acceptable listening tolerance.

In light of the direct correlation between these two studies, the Technical Sub-Group believes the existing first adjacent-channel protection ratios have become completely unrealistic and should be modified to take the described study information into account. Specifically, it is felt that a protection ratio of at least 16 dB should be mandated for new or major changed assignments in the existing band as well as all assignments in the forthcoming expanded AM broadcast band.

APPLICATION OF NEW TECHNICAL RULES

The technical rule changes recommended by the Technical Sub-Group should be applicable to all applications for new stations or for major changes in the facilities of authorized stations as defined by Section 73.3571(a)(1) of the Commission's Rules. All such applications should be required to comply fully with the recommended rule changes, with the exception of changes of existing facilities which are already non-compliant. In the case of modifications to existing non-compliant facilities, stations should be prohibited from extending in any direction existing interference as defined by the recommended rules, in a manner similar to the restrictions on grandfathered short-spaced FM stations contained in Section 73.213 of the Commission's Rules. Existing stations seeking modifications should not be allowed by the rules to create any additional interference or exchange the elimination of some interference for the creation of any new interference.

In recent times, some AM stations have sought to relieve financial strain by suspending station operation for lengthy periods of time pending sale of the station or resolution of difficulties. In many cases, long suspensions of operation by AM stations are the result of the forces of the marketplace acting to "weed out" technically inferior,

non-viable facilities. Although these stations themselves provide no service when silent and only a marginal quality of broadcast service during periods of operation, they contribute to interference received by other, viable stations, and, even while dormant, limit the ability of other stations in the crowded AM spectrum to improve their facilities.[8] Since the permanent elimination of such stations may cumulatively reduce interference and result in a net gain in valuable service, the Technical Sub-Group recommends that the AM rules be revised to allow proper functioning of the marketplace forces which remove failing stations from the air.

The Technical Sub-Group recommends that the Commission revise Section 73.1740 of its rules (minimum operating schedule) and Section 73.1750 of its rules (discontinuance of operation) to provide that, if an AM station fails to comply with the minimum operating schedule requirements for more than sixty days, the station's license must be surrendered absent the filing of a request for waiver. A high threshold of justification (such as occurrence of a severe technical difficulty, natural disaster, or death of the principal owner/operator) should be required for a waiver of the license surrender requirement. Mere financial hardship, absent other compelling factors, should not be considered adequate justification for excusing a suspension of minimum operating schedule of more than sixty days.[9] Should a former licensee or another entity desire to reinstate service sometime later, it should be required to do so as an applicant for a new station, subject to the recommended technical rule changes. This tightening of the rules would ensure that stations are not resurrected after long periods of dormancy, resulting in interference to

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8 The Commission has in the past revoked licenses for in operation, but generally only after long periods of time. See, e.g., WGRI Radio Incorporated, 2 FCC Rcd 5500 (1987) (Order to Show Cause to revoke license issued some 21 months after cessation of operation), 3 FCC Rcd 1777 (1988) (license not ultimately revoked until over two years after cessation of operation).

9 In the past, the excuse of financial problems has been used by licensees as a justification for avoiding minimum operation, resulting in great delay before revocation of license. See, e.g., Radio Northwest Broadcasting Company, 3 FCC Rcd 1597 (1988) (station given temporary authority to remain silent for "financial problems;" Order to Show Cause not ultimately issued until over three years after cessation). A sixty-day limit and a waiver procedure for exceptional cases would eliminate delay by obviating the need for an Order to Show Cause and formal hearing process for revoking the license of a dormant station.

operating stations under the recommended technical rules. Over time, the Technical Sub-Group believes that this process may contribute to a lessening of some interference existing on the crowded AM band.

OTHER TECHNICAL ISSUES

It is recommended that no changes be made in existing service areas to be protected as they pertain to either groundwave or skywave service for any class of station.

26dB for CO-CHANNE

Interference free reception from operating stations is necessary to present the highest quality service possible to the potential listener. Some studies indicate that higher levels of signal protection may be necessary to provide universally satisfactory service in the case of some particular program formats. However, it is also obvious that listeners depend upon service of lesser technical quality where program material is of interest to them or where there is a lack of program choices. Any reduction in the signal level of the service areas presently protected will only result in greater interference and reduction of service to the public. Redefining interference and/or service areas to be protected will only exacerbate the present competitive disadvantage of AM broadcasting. The changes recommended in this report are entirely possible, practical and will have a very positive impact on the viability of AM without introducing "remedies" which will increase interference or decrease the technical quality of the service.

EXPANDED AM BAND

The expanded AM band (1600-1700 kHz) has been touched on only briefly in the foregoing comments. The Technical Sub-Group considered primarily the existing AM band and possible technical changes which could be made in a mature service that has grown to approximately 5,000 stations. The goal is to improve the quality of the AM service by decreasing interference and developing of wider bandwidth receivers in order to make AM more viable and competitive as an aural service.

The expanded band does not present the complexity of 5,000 stations and existing service available to the public resulting from the Commission's Rules and technical standards which have evolved over a 50 year period.

In the 1610-1700 kHz band the above recommendations can be applied from the onset without the complexities resulting to an existing service in the 540-1600 kHz band.

The Sub-Group may be willing to further present its view of possible Rules and technical standards which would be desirable for use in the expanded band which could "mesh" with agreed upon provisions in the new expanded band agreement for Region 2 and possible bi-lateral agreements with Canada and Mexico.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-508

In the Matter of

Improved Methods for Calculating
Skywave Field Strength in the
AM Broadcast Band

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 4, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this proceeding (*Notice*) to examine its Rules relating to skywave propagation in the AM broadcast service. In particular, the Commission is considering replacing the existing skywave propagation curves contained in the FCC Rules with a new skywave propagation model recently developed. The Commission believes that this new model is more accurate and reflects the latest understanding of skywave propagation as applied to the AM broadcast service.

2. This proceeding is an outgrowth of the *Notice of Inquiry*, MM Docket No. 87-267, 52 FR 31795, August 24, 1987, (*Inquiry*) which provided a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.[1] Its goal was to identify any needed changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.[2]

3. The Commission discussed a number of issues specifically related to skywave propagation in its *Inquiry*. In particular, one alternative discussed is to replace all of the current skywave propagation curves and procedures in the FCC Rules with a new, improved skywave propagation model recently developed by FCC staff. Several related matters were also discussed in the *Inquiry*, notably, the effects of geomagnetic latitude of a propagation path upon skywave field strength, the most appropriate hour of the night upon which to base the new propagation model (referred to as the reference hour), procedures for calculating field strength values exceeded for 10% of the time, and calculation procedures to be employed for short propagation paths.

4. We recognize that changes to the Commission's Rules to reflect new procedures for calculating skywave field strength may well have, among other things, an effect on the portrayal of existing service and interference as well as an effect upon future calculations related to new and modified AM facilities. However, we believe that consideration at this time of procedures providing improved accuracy would facilitate future consideration of other possible changes to the Commission's technical assignment criteria. This would provide accurate skywave field strength calculations for use in assessing the interrelationships of such proposed changes. Ultimately, improved accuracy in skywave calculations would ensure that proposed new or modified AM stations would provide intended protection to other stations, or, conversely, that such proposed changes would not be unnecessarily restricted.

5. A substantial number of public comments addressing skywave propagation issues were received in response to the *Inquiry*. These comments provide a general consensus supporting consideration of the new and improved methods for calculating skywave field strength suggested by the Commission in its *Inquiry*. For all of the reasons discussed, we believe that the time is now ripe for considering changes to the procedures for calculating skywave field strength as proposed in the following sections.[3] Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

6. The AM broadcast service is the oldest broadcasting service, but it still remains one of the most technically complex to administer. This is due in large part to the propagation conditions that exist in the AM broadcasting band. In contrast to the other frequency bands where broadcast services are authorized, the propagation characteristics of the AM band vary with the time of day. During day time hours, signal propagation of an AM station is predominantly by groundwave signals. Groundwave signals travel along the surface of the earth and are thus affected by the characteristics of soil conductivity along the propagation path.

7. During nighttime hours, however, skywave signals from an AM station reach distances many times greater than its groundwave signals. Skywave signals are reflected from the ionosphere[4] and can be propagated many hundreds of miles from the transmitter location. Nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave can be employed to provide skywave service many hundreds of miles from the transmitter, whereas, on the other hand, such enhanced conditions also increase the interference possibilities of co-channel stations over distances of hundreds of miles. As a consequence, co-channel stations that could be located reasonably close to one another without interference during daytime hours could cause significant mutual interference during nighttime hours.

8. Field strength calculations for determining skywave service and skywave interference are performed in accordance with Section 73.182 of the FCC Rules. Currently these procedures employ three sets of skywave field strength curves contained in Section 73.190 of the FCC Rules. The first set of curves, Figure 1a, is used for calculating the skywave service areas for Class I stations as well as the levels of interfering field strength for Class I and Class II stations on clear channels; hence, they are sometimes referred to as the FCC clear channel curves.[5] A second set of curves, Figure 2, isused for calculating levels of skywave interference on regional and local channels. Figure 1b, the third set of curves, is used for all skywave field strength calculations involving one or more stations in Alaska regardless of channel or station class.[6]

9. These three sets of skywave curves are empirically derived, that is, they are based upon observations of propagation phenomena obtained through FCC skywave field

strength measurement programs. For example, Figure 1a was derived from short-term field strength recordings taken in the spring of 1935,a relatively low solar activity period (*i. e.*, a period corresponding to low sunspot numbers).[7]

10. In order to gain a better understanding of skywave propagation phenomena, the FCC initiated a long-term field strength measurement program in 1939 which continued for a full solar activity cycle, *i. e.*, eleven years. Soon after this program began, it became clear that skywave field strength is a function of many factors, including latitude and sunspot number.[8] Figure 2 was then developed from data acquired for the year 1944 of this long-term program.[9] Minimum solar activity occurred in 1944 resulting in maximum levels of skywave field strength. Such a year represents a "worst case" for determining the effects of skywave interference upon the service provided by AM stations during nighttime hours.

11. Data from the Commission's long-term field strength measurement program for 26 propagation paths were released in 1971 and have been studied by the FCC as well as a number of researchers from different parts of the world. Among other things, it has been found that the effects of latitude are so great that the 1944 FCC data, which represents only a narrow range of latitudes, are inadequate. Consequently, in order to collect supplemental data, the Commission in 1980 initiated a low-latitude skywave measurement project (Central America to southern U.S.) and in 1981 initiated a high-latitude measurement project (coterminous U.S. to Alaska).[10] Several administrations (*e. g.*, Brazil and Mexico) have contributed a substantial amount of data from the low-latitude areas. The high-latitude field strength measurement program contributed to the development of the interim curve in Figure 1b of the FCC Rules discussed *supra*. In adopting Figure 1b, it was anticipated that a final set of curves would be developed upon conclusion of the measurement project.

DISCUSSION

12. The FCC staff has continued its efforts to develop a better understanding of skywave propagation phenomena. Based on analysis of data collected during the Commission's long-term skywave field strength measurement program as well as data collected during the more recent low-latitude and high-latitude skywave measurement projects, our understanding of skywave propagation characteristics has improved significantly. As a result, we have identified certain shortcomings of the current FCC skywave field strength curves.

13. We now know that skywave at tenuation increases by about 1 dB (in a year of low sunspot activity) for every degree of latitude that a radio path midpoint moves farther north. This reduces skywave propagation in northern areas by an appreciable amount. For example, a station in Texas may produce a skywave signal of 0.5 mV/m at a distance of 800 miles from its transmitter; that same station in Minnesota may produce a 0.5 mV/m signal at a distance of only 500 miles. Figure 1a of Section 73.190 of the FCC Rules does not provide a means for adjusting skywave field strength as a function of geomagnetic latitude. Figure 2 is partially correct in its conceptual approach because it treats interference levels as a function of geographic latitude. Geomagnetic latitude rather than geographic latitude is the more determinative factor.[11] The effect of these shortcomings is magnified by the increasing demand for spectrum and growing concerns regarding nighttime interference as the band becomes more congested.

14. Other important characteristics of skywave propagation also have been observed during the staff's on-going studies. Use of a reference hour of six hours past sunset (SS+6) rather than two hours past sunset (SS+2) is a more accurate reference upon which to base skywave calculations. Moreover, it has been determined that use of the slant distance for a propagation path rather than the great-circle path distance results in greater accuracy.[12] Finally, it has been learned that differences between skywave field strength exceeded 50% of the time and skywave field strength exceeded 10% of the time vary with the geomagnetic latitude midpoint of the propagation path.[13]

15. The following proposed changes to the Commission's current Rules for calculating skywave field strength incorporate all of these observed skywave propagation characteristics. These proposals address, *seriatum*, a new skywave propagation model, use of the slant distance of a propagation path, a new proposed reference hour for the new propagation model, and a procedure for calculating skywave field strength exceeded 10% of the time. Comments are invited on these proposed changes, and, in addition, the Commission will consider alternative proposals which may provide potential improvements related to calculating skywave field strength in the AM broadcast service.

16. *New Skywave Model.* The *Inquiry* discussed several alternatives for improving methods for performing skywave field strength calculations, including various modifications to the existing curves in Section 73.190 ofthe FCC Rules. Emphasis was placed, however, upon consideration of replacing all of the existing curves, Figures 1a, 1b, and 2 of Section 73.190 of the FCC Rules, with a new model identified as the "modified method".[14] Studies performed by members of the FCC staff indicated that this "modified method" ismore accurate than the three sets of curves currently in Section 73.190 of the FCC Rules and takes into account the effects of the geomagnetic latitude of the propagation paths.

17. Comments filed in response to the *Inquiry* were overwhelmingly in favor of using the most advanced method available and recommended use of the"modified method". Comments submitted by the Corporation for Public Broadcasting (CPB) typify several of the comments received. CPB noted that reliance on precise methodologies and current data will ensure that the assignment principles continue to reflect the real world, not a theoretical environment. Moreover, CPB indicated its belief that the imprecision of thecurrent propagation curves is, for the most part, unnecessary with the availability to the FCC and the industry of sophisticated computer technology and extensive data previously unavailable.

18. Based upon its review of the "modified method". Capital Cities/ABC, Inc. (Capital Cities) concurs that this method should be used in determining protected contours as well as interference levels. CBS, Inc. (CBS) supports the Commission's effort to implement the most current data and precise methods for calculating interference. CBS notes that where accurate measurements of interfering signals and protected contours are not available, interference may be caused where none was calculated, or the parameters of a station may be unnecessarily constrained.

The Clear Channel Broadcasting Service (CCBS), however, urges the Commission to proceed with caution in this proceeding. CCBS expressed general concerns about the potential adverse consequences of recalculating service and interference that could result with a new propagation model.

19. Based upon the comments and our own assessment of the benefits that would be derived from adoption of an improved skywave propagation model, we propose amending the Rules to incorporate the use of the new propagation model described in Appendix B of this *Notice*. This new model is based upon the empirical data collected by the Commission during its extensive skywave measurement programs and is characterized by a formula. This new model is identical to the "modified method" discussed in the *Inquiry* except for differences discussed *infra*.

20. An important element included in the new skywave propagation model is a term that fully accounts for the effect of the geomagnetic latitude of the propagation path on skywave field strength. As discussed *supra*, geomagnetic latitude has a significant effect upon propagated skywave field strength. The inclusion of this term would result in a more accurat edepiction of skywave service contours for Class I clear channel stations as well as interference calculations on all channels.[15] We are proposing to usethe geomagnetic latitude of the great-circle midpoint of the propagation path for these calculations. Appendix B also includes formulas for converting geographic latitude to geomagnetic latitude.

21. Although it is possible to derive graphical methods from the formulas for determining skywave field strength, we propose to make the formulas in Appendix B controlling in order to avoid disputes that can result from in accuracies of graphical methods. This action would be consistent with recent Commission actions in other cases where use of available formulas has been made controlling for the same reason. Additionally, since calculations based on the formulas would prevail in all cases and since the new propagation model is easily adapted for use on computers, we do not believe there is need to include curves in the FCC Rules.[16]

22. *Use of Slant Distance*. In our discussion of the "modified method" in the *Inquiry*, we had suggested that great-circle distances would be used in the calculations for propagation paths of 200 km and greater. For propagation paths less than 200 km, it was suggested that the field strength factor at 200 km could be employed in the calculations at such distances.[17] There was general support in the comments received in response to the *Inquiry* for such an approach.[18] However, recent analysis conducted by the Commission indicates that it would be more accurate to use the slant distance for all propagation paths, regardless of path distance.

23. This conclusion is consistent with CCIR Recommendation 435 which recommends use of the slant distance for calculating skywave field strength for all propagations paths.[19] The accuracy of skywave calculations is most notably improved by use of the slant distance over any propagation path where the slant distance is large in relation to the great-circle distance. Medium waves are usually reflected by the E layer of the ionosphere which spans the altitude range of approximately 90 to 130 km. The current FCC Rules assume the average height of the E layer to be 96.5 km. Thus, even for a receiving point only 1 km away from the transmitter, the skywave may travel 193 km to reach its destination. An increase between the transmitting and receiving points, within a certain range, will not result in a significant change in the slant distance. For example, if the distance between the two points is increased to 100 km, the actual slant distance only increases 24 km. Thus,the skywave signal must travel nearly as far to reach a receiver near the transmitter as it does to reach a receiver several hundred kilometers away.

24. The new propagation model that we are proposing specifies use of slant distance for all propagation paths, regardless of path distance. This ensures use of the most accurate calculation methodology without significantly adding to the complexity of the calculations. For the purpose of the new model, it should be noted that the height of the E layer of the ionosphere above the earth is assumed to be 100 km. The elevation angle for the propagation path would continue to be determined on the basis of the actual great-circle distance in accordance with the formula in Section 73.190(d) of the FCC Rules.

25. *Reference Hour*. Several decades ago, the FCC adopted two hours after sunset (SS+2) as the reference hour for its propagation models in AM broadcasting. It was believed that the ionosphere was fully stabilized and field strength maximized at two hours after sunset. This early conclusion subsequently has been found to be incorrect. Soon after the FCC started itslong-term measurement program in 1939, it became apparent that field strength sat SS+6 were appreciably stronger than those at SS+2.[20] It was assumed that the difference was one of degree only. More recent studies, however, show that propagation conditions at SS+2 and SS+6 are significantly different. It is far more than a difference of degree; it is a difference of kind. It has been shown that at SS+2 the residual effect of the D layer of the ionosphere still exists, complicating the prediction of skywave field strength. On the other hand, at SS+6 the effect of the D layer no longer exists and skywave propagation primarily occurs by reflection from the E-layer of the ionosphere and occasionally from the F-layer.

26. Recent findings also indicate that skywave field strengths at approximately SS+2 display a certain degree of frequency dependence (approximately 3 dB stronger at the higher frequencies). At SS+6, frequency dependence becomes insignificant. Thus, we have concluded from our studies that the current curves in Section 73.190 of the FCC Rules which are based on the reference hour of SS+2 are more accurate at the higher frequencies. We believe that use of the reference hour of SS+6 for the new skywave propagation model would result in improved uniformity throughout the AM band and all frequencies would be treated in the same manner.[21]

27. There are also indications that use of SS+6 as the reference hour would result in skywave field strength predictions that are more uniform for propagation paths in all directions. Based on data collected by the FCC corresponding to SS+2, Crombie (*IEEE Transactions on Broadcasting*, September 1979) reported that at tenuation by the ionosphere on east-west paths is greater than that for paths in other directions. Thus, observed field strengths on north-south paths are usually stronger than those on east-west paths of comparable lengths at SS+2. Comparison with measured data indicates that Figure 1a of Section 73.190 of the FCC Rules appears to be more accurate for north-south paths. Very recently, a large amount of data for SS+6 has been studied by Commission staff and the effects of path orientation reported for data collected at SS+2 were not noted.

28. Finally, Commission studies have determined that the attenuation of field strength related to sunspot number is less pronounced at SS+6. In preparation for the Region 2 Administrative Radio Conference to Plan the Band 1605-1705 kHz, Commission staff studied a large amount of previously unanalyzed or partially analyzed measurement data, including measurements taken at SS+6. Among other things, it has been found that the at tenuation of field strength corresponding to the number of sunspots is the greatest during the period of daytime to SS+2 (*i. e.*, during the hours that the D layer of the ionosphere affects skywave propagation). This at tenuation gradually diminishes after SS+2 and reaches a minimum at approximately SS+6.[22]

29. Most public comments received in response to the *Inquiry* on this issue generally supported using SS+6 as the reference hour for the new propagation model. For example, CCBS indicated its belief that it is imperative that SS+6 be used if the objective of the new propagation model is improved accuracy. The Association for Broadcast Engineering Standards, Inc.(ABES) recommended including this issue in this *Notice* for further consideration. On the other hand, Edward A. Schober, consulting engineer,(Schober) commented that SS+2 provides a good weighting for the time of maximum radio listenership during the night hours. Likewise, Bonneville International Corporation (Bonneville) suggested retaining SS+2 as thereference hour, or, alternatively, defining protection standards 24 hours a day by using the Commission's diurnal curves contained in Figure 12 of Section 73.190 of the Rules.

30. After considering the comments and the results of our own studies on this matter, we have concluded that use of SS+6 as the reference hour for the new propagation model has merit. We believe that this would ensure uniform calculations for all frequencies and propagation paths. Moreover, this reference hour would better represent the "worst case" for interference calculations, thus minimizing the levels of new interference that would be introduced in the future. The formula in Appendix B for the new propagation model includes a 2.5 dB factor to account for the greater field strength that occurs at SS+6.

31. *Conversion Factor for 10 % Skywave Field Strength.* A final matter that needs to be considered concerns the procedure for calculating skywave field strength exceeded 10% of the time. The new model being proposed depicts field strength values exceeded 50% of the time and it is necessary to apply a factor to convert to field strength exceeded 10% of the time. As noted earlier in this *Notice*, field strength exceeded 10% of the time is used in calculating skywave interference, whereas, skywave field strength exceeded 50% of the time is used for calculating the skywave service contours for Class I clear channel stations. Commission studies of skywave propagation data indicate that this conversion factor is affected by the midpoint geomagnetic latitude of the propagation path. Thus, this factor varies from approximately 6 dB in the low-latitude areas (*e. g.*, Mexico) to more than 10 dB in the high-latitude areas (*e. g.*, Oregon and Alaska).[23] For administrative convenience,an 8 dB factor was adopted in the Final Acts of the Region 2 Administrative Radio Conference (1981, Rio de Janeiro) and is currently specified in Section 73.190 of the Rules for use with Figure 1a in the coterminous U.S.[24]

32. Most commenting parties responding to the *Inquiry* did not provide guidance on this issue. CCBS and Schober suggest calculation of the applicable factor for each path. CCBS further suggested development of a simple curve to portray the variation between 50% and 10% field strength values with geomagnetic latitude. In contrast, Bonneville suggested that a uniform factor of 8 dB is acceptable.

33. There are several alternatives that could be considered for determining the conversion factor. One alternative would be to use a single factor, *e. g.*, 8 dB, for all propagation paths. Another would be to establish several factors that would be applicable in three zones defined by latitude. However, none of these approximations would provide the degree of accuracy that would result from specific calculations of the factor for the actual geomagnetic latitude for any given propagation path. We believe, therefore, that a procedure that would require the specific conversion factor to be determined for each propagation path is preferred and would optimize accuracy for interference calculations on such paths. A formula, shown in Appendix B,has been developed that depicts the conversion factor as a function of geomagnetic latitude. We are proposing use of this formula in determining the applicable conversion factor.

OTHER MATTERS

34. Several parties commenting in response to the *Inquiry* were concerned about the impact that use of new skywave propagation curves would have on the existing AM broadcast service. For instance, although endorsing the use of more accurate skywave curves, several commenters urged the Commission not to implement their use until other AM assignment criteria were fully considered in rule making. ABES and CBS, for example, are supportive of the "modified method", adding that a rule making proceeding on this subject should be instituted. Such a proceeding, according to ABES, would permit a more detailed evaluation of its technical aspects as well as the potential impacton existing AM broadcast service such as changes in interference levels to existing stations, issues related to the processing of applications, and the potential for added administrative burdens. CCBS cautions that adoption of a new skywave propagation model could lead to massive disruption of AM service as interference and service areas are recalculated. As a result, CCBS urges the Commission not to move forward with a change in the methods for predicting AM skywave propagation unless and until the Commission has concluded its investigation into the other related topics set forth in the *Inquiry*.

35. As we discussed *supra*, we are cognizant of the relationship between the skywave propagation model which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We noted in the *Inquiry* that use of a new propagation model could result in changes to the location of service contours and calculated levels of interference. The Commission's staff has performed calculations using the "modified method" on a limited number of regional channels and clear channels which are believed to be representative channels.[25] These studies generally indicate that the predicted nighttime service of Class III stations using a reference hour of SS+2 will be greater than previously depicted using current calculation procedures. On the other hand, use of a reference hour ofSS+6 reduces the calculated service area. In the case of clear

channel stations, the staff's calculation at a reference hour of SS+2 indicates that the skywave service areas of class I stations are substantially reduced at higher latitudes, and to a lesser degree at a reference hour of SS+6.[26]

36. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a record on this issue.[27] Such a record will guide the Commission on appropriate actions which ultimately should be taken. We believe, however, that there may be practical reasons for considering a delay in implementing a new propagation model, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, there may be merit in considering implementing simultaneously all the inter related changes that may ultimately be adopted. This approach could minimize administrative burdens for the Commission as well as uncertainties within the industry. We seek comment on the advisability of such an approach.

37. It would not be our intent to require any modifications of existing operations as a result of the changes proposed in this Notice. Moreover, we believe that the same principle would apply to applications pending at the time any changes proposed herein are implemented.

ADMINISTRATIVE MATTERS

38. Authority for the rule changes on which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

39. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **December 27, 1988** and reply comments on or before **January 11, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

40. For the purposes of this non-restricted notice and comment rulemaking proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3)issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

41. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2),if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously-filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

42. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities.The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96-354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

43. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form,information collection and/or record keeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed on the public.

44. For further information on this proceeding, contact Larry W. Olson,Mass Media Bureau, (202) 632-6955.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS I.

Reason for Action: In this proceeding, we seek public comment on the desirability of replacing the existing AM broadcast skywave propagation curves with a new propa-

gation model recently developed. The new model results from recent scientific analysis of skywave measurement data that provides a better understanding of skywave propagation phenomena. Use of the new method for calculating skywave field strength in the AM service would provide a more accurate depiction of the service and interference relationships between AM stations.

II. Objective: The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis: Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended,47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected: There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to the standards (curves and formulas) used to calculate skywave field strength. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. We will, however, consider in future rule making proceedings the related questions regarding assignment principles which, together with the propagation model, may result in new definitions of service and interference for AM broadcast stations. Such definitions are not now known but are intended to be beneficial to the AM service as a whole.

V. Reporting Record Keeping, and other Compliance requirements: There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules: There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives: There are no significant alternatives available.

FOOTNOTES

[1] The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, *(Report)* released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

[2] By *Order*, DA 87-1823, released December 15, 1987, the Commission granted a "Motion for Extension of Time for Filing Comments and Reply Comments" submitted by the National Association of Broadcasters (NAB). Inthat *Order*, the Commission bifurcated the proceeding and established separate filing periods. Phase 1 involved Sections II and III of the *Inquiry* whilePhase 2 involved Sections I and IV. For the specific issues raised in Section III (Related Technical Issues) of the *Inquiry* under which skywave propagation falls, the time for filing comments and replies was extended to February 1,1988 and March 1, 1988, respectively.

[3] This proceeding will examine only those issues pertaining to skywave propagation. Where appropriate, the Commission will institute future rulemaking proceedings to deal with the remaining issues addressed in the *Inquiry* and public comments. For example, in a similar action today, the Commissionin stituted a proceeding concerning groundwave propagation. *See* , *Notice of Proposed Rule Making*, MM Docket No. 88-510, FCC 88-326.

[4] The ionosphere is a region of the earth's atmosphere consisting of several layers subject to ionization. These layers are alphabetically designated and have varying effects on radio waves. Pertinent to the propagation of AM broadcast signals are three ionization layers (D, E, and F). The distance of these layers above the earth varies from approximately 50 km for the D-layer (nearest the earth) to approximately 300 km for the F-layer (farthest from the earth).

[5] A version of Figure 1a was adopted by the Region 2 Administrative Radio Conference, Rio de Janeiro, 1981.

[6] Figure 1b is an interim curve adopted for use pending completion of further analysis of field strength measurement data subsequently collected. *See* , *Report and Order* in MM Docket No.83-807, 49 FR 43957, November 1, 1984.

[7] The occurance of sunspots on the surface of the sun rises and falls in a periodic relationship over an eleven year cycle. Each year in the cycle is assigned a sunspot number which is proportional to the solar activity of the sun for that given year.

[8] Observations indicate that skywave field strengths increase as the sunspot number decreases.

[9] Field Strength recordings were made on more than 40 paths ranging from 165 to 4176 km with transmitting frequencies ranging from 540 to 1530 kHz. The midpoint geomagnetic latitudes of these paths are between 40 and 54 degrees North. Figure 2 differs from Figure 1a in one major respect by giving weight to the effects of geographic latitude and depicts a family of curves ranging from 36 degrees to 50 degrees geographic latitude.

[10] The high-latitude field strength measurement program has been completed and the results are expected to be published later this year.

[11] There are two latitude terms which apply to this discussion. The first, geographic latitude, refers to a physical location of a point on the surface of the earth relative to the north and south poles. The second, geomagnetic latitude, takes into account the effects of the earth's magnetic influence on radio waves and is based on the magnetic poles. Geomagnetic coordinates are similar but not identical to geographic coordinates. The geomagnetic northpole is located at 78.5 degrees North and 69 degrees West. Geophysical phenomena, including absorption of electro magnetic waves, are better related to geomagnetic latitudes.

[12] Slant distance is the total distance that a skywave signal travels along a propagation path including the distance traveled to and from the E layer of the ionosphere.

[13] The FCC Rules specify that the skywave service areas of Class I stations are to be calculated using skywave field strength exceeded 50% of the time, whereas, interfering skywave signals are computed using skywave field strength exceeded 10% of the time.

[14] In preparation for the Region 2 Administrative Radio Conference for the band 1605-1705 kHz, the Commission's staff developed the "modified method".It was adopted by that Conference as a recommended method for calculating interregional interference. *See* , "A Skywave Propagation Study in Preparation for the 1605-1705 kHz Broadcasting Conference" by J. Wang, *IEEE Transactions on Broadcasting*, Vol. BC-31, No. 1, pp. 10-17, March 1985.

[15] At one time the calculation of service contours using such a procedure was laborious, but the current wide-spread availability of computers facilitates such calculations.

[16] Parties who believe that curves should be included in the FCC Rules should provide practical reasons for that position. It is our preliminary view that parties could individually prepare curves for their own use if such convenience is desirable.

[17] It was noted in the *Inquiry* that the slant distance changed little forgreat-circle distances less than 200 km.

[18] Currently, Figures 1a and 2 of Section 73.190 of the FCC Rules contain a gap in the range of 0-100 km where no skywave field strength values are provided. Occasionally, there is a need to compute field strength for such short paths and no method is specified in the FCC Rules.

[19] The Consultative Committee on International Radio (CCIR) is a technical body of the International TelecommunicationUnion within which administrations from around the world contribute and exchange technical information. The CCIR develops recommendations based upon this broad base of data and information on issues where technical advances have been achieved.

[20] *See* , "Prediction of MF Skywave Field Strength in North America", *IEEE Transactions on Broadcasting*, Vol. BC-23, No. 2, pp. 43-49, June 1977.

[21] *See* , FCC Technical Memorandum OST TM83-4.

[22] As an example, consider the propagation path for WLW, Cincinnati, OH to Portland, OR (700 kHz, 3192 km, 53 degrees North geomagnetic latitude). During Sunspot Cycle 18, as the sunspot number increased from its minimum to maximum, field strength for SS+2 decreased by 16.9 dB, that for SS+4 decreased by 13.3 dB, and that for SS+6 decreased by only 7.3 dB.

[23] The populated areas of the United States cover a wide range of geomagnetic latitudes: Honolulu, 19.5 degrees North; Virgin Islands, 30 degrees North; Fairbanks, 64 degrees North.

[24] A 13 dB factor had been previously adopted by the FCC for use with Figure 1b of the Rules when stations in Alaska are involved in calculations. We now believe that it would be more appropriate to use a 10 dB factor in conjunction with the "modified method" where stations in Alaska are concerned.

[25] The results of these calculations are contained in Appendix C of this *Notice*. RSS (root-sum-square) calculations for three regional channels have been included as well as two examples of the skywave service provided by Class I stations at high-latitudes and low-latitudes.

[26] A true comparison between current calculation procedures and those proposed in this *Notice* are possible only at SS+2 because current procedures are based upon that reference hour.

[27] A related issue concerns those situations where the new skywave calculation procedures and any related technical changes to the Commission's Rules result in received levels of interference less than that permitted for the normally protected contour.

APPENDIX B - CALCULATION OF SKYWAVE FIELD STRENGTH

The following formulas are proposed to be used in place of the curves in Section 73.190 of the FCC Rules. The methods used to determine other factors such as radiation value, elevation angle, and $f(\theta)$ are unchanged and can be determined by referring to the appropriate section of the FCC Rules.

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

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

$$F_s(50) = (97.5 - 20\log D) - (2\pi + 4.95\tan^2\theta_M)\sqrt{(D/1000)} \quad \text{dB}(\mu\text{V/m}) \tag{1}$$

The slant distance, D, is given by:

$$D = \sqrt{40{,}000 - d^2} \quad \text{km} \tag{2}$$

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

$$\theta_M = \arcsin[\sin a_M \sin 78.5° - \cos a_M \cos 78.5° \cos(69 - b_M)] \quad \text{degrees} \tag{3}$$

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

$$d = 111.18 d° \quad \text{km} \tag{4}$$

Where:

$$d° = \arccos[\sin a_T \sin a_R + \cos a_T \cos a_R \cos(b_R - b_T)] \quad \text{degrees} \tag{5}$$

Where:
a_T is the geographic latitude of the transmitting terminal (degrees)
a_R is the geographic latitude of the receiving terminal (degrees)
b_T is the geographic longitude of the transmitting terminal (degrees)
b_R is the geographic longitude of the receiving terminal (degrees)
a_M is the geographic latitude of the midpoint of the great-circle path and is given by:

$$a_M = 90 - \arccos\left[\sin a_R \cos\left(\frac{d°}{2}\right) - \cos a_R \sin\left(\frac{d°}{2}\right)\left\{\frac{\sin a_T - \sin a_R \cos d°}{\cos a_R \sin d°}\right\}\right] \quad \text{degrees} \tag{6}$$

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

$$b_M = b_R + k\left[\arccos\left(\frac{\cos(\frac{d°}{2}) - \sin a_R \sin a_M}{\cos a_R \cos a_M}\right)\right] \quad \text{degrees} \tag{7}$$

Note(1): If $|\theta_M|$ is greater than 60 degrees, equation (1) is evaluated for $|\theta_M| = 60$ degrees.
Note(2): North and east are considered positive; south and west negative.
Note(3): In equation (7), $k = -1$ if $b_R > b_T$, otherwise $k = 1$.

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

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

$$F_s(10) = F_s(50) - \Delta \quad \text{dB}(\mu\text{V/m}) \tag{8}$$

Where:
$\Delta = 6$ when $|\theta_M| < 40$
$\Delta = 0.2|\theta_M| - 2$ when $40 \le |\theta_M| \le 60$
$\Delta = 10$ when $|\theta_M| > 60$

APPENDIX C

COMPARISON OF SKYWAVE FIELD STRENGTH CALCULATIONS

FREQUENCY: 560 KHZ

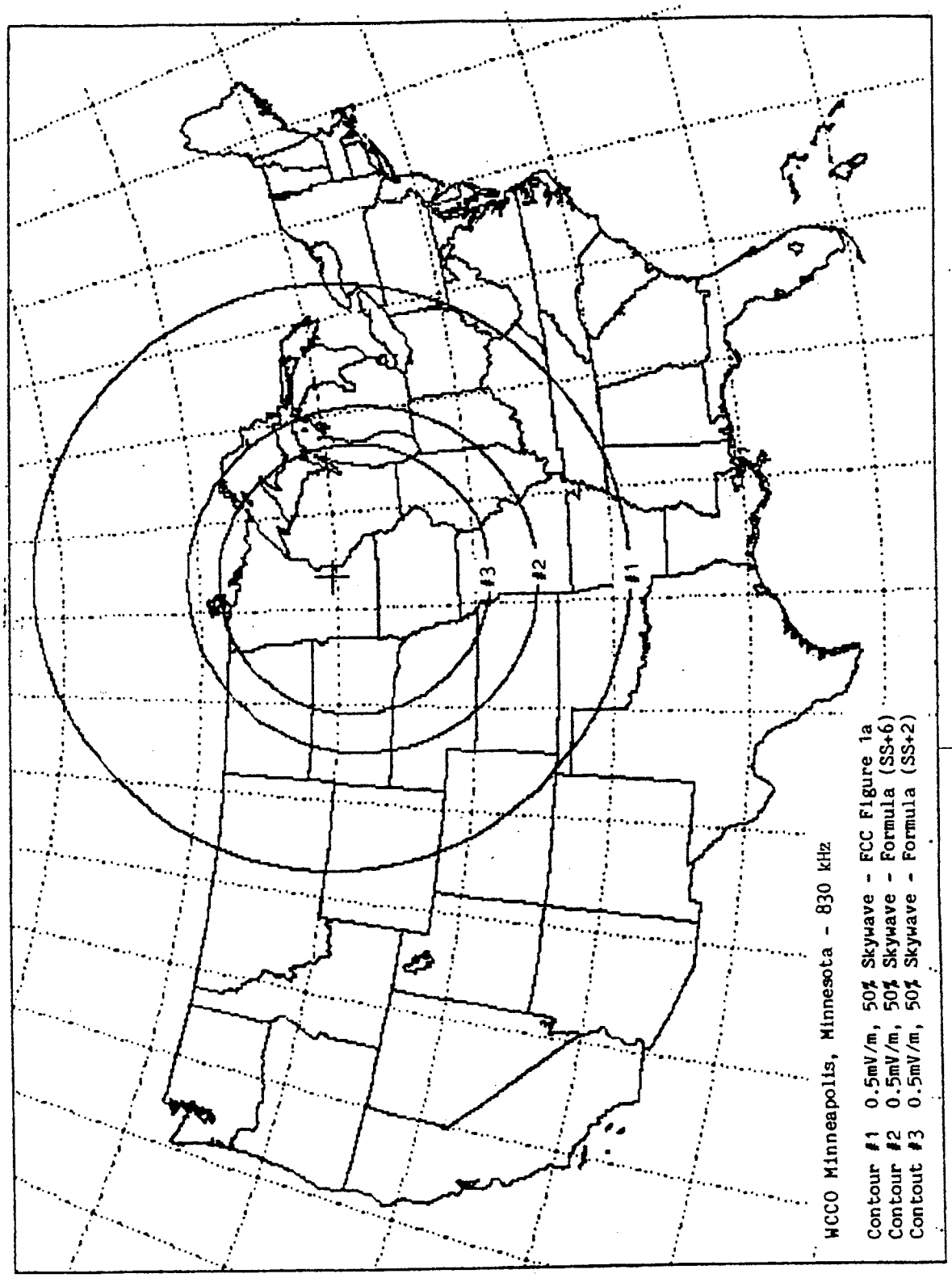
	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
CALL SIGN	FIGURE 2	SS+2	SS+6
KVOK	0.77	0.69	0.92
KBLU	6.23	4.88	6.51
KSFO	1.89	1.52	2.03
KLZ	2.41	1.71	2.28
WQAM	2.96	2.23	2.97
WIND	3.24	1.99	2.66
WHYN	4.21	4.14	5.52
WGAN	3.31	2.02	2.70
WEBC	28.38	15.47	20.63
KWTO	7.08	4.83	6.44
KMON	8.08	4.10	5.46
WGAI	18.05	14.70	19.60
WFIL	4.19	2.19	2.92
WVOC	4.66	2.74	3.65
WHBQ	9.77	6.50	8.67
KLVI	3.72	2.66	3.55
KPQ	2.83	1.61	2.15
WJLS	11.04	9.69	12.92

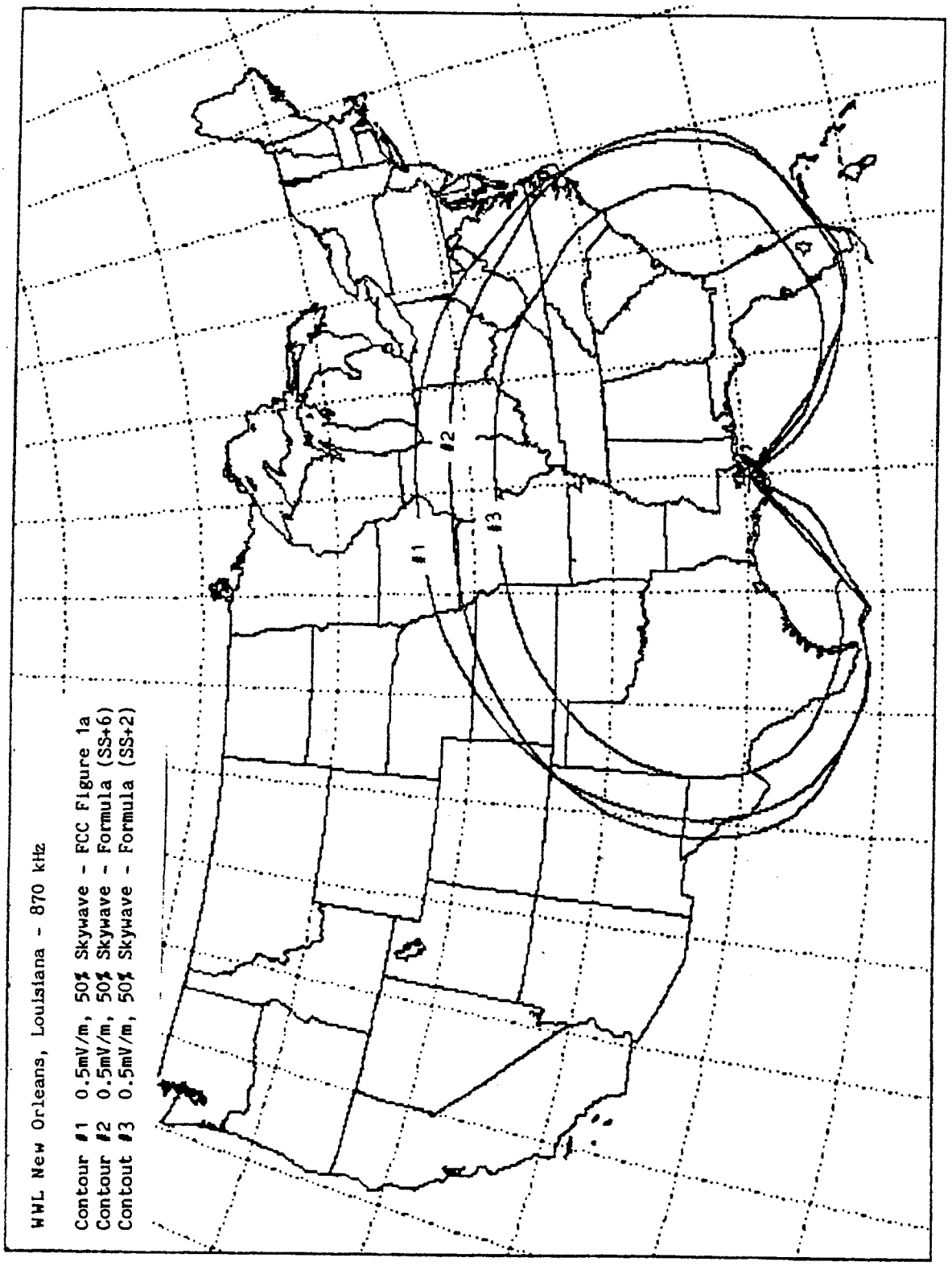
FREQUENCY: 980 KHZ

CALL SIGN	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
	FIGURE 2	SS+2	SS+6
KENY	2.11	1.85	2.47
KINS	11.13	6.83	9.10
KFWB	3.50	2.80	3.74
KGLN	14.11	10.50	14.00
WWRC	3.65	2.64	3.51
WFXP	15.76	11.59	15.46
WTOT	12.88	9.05	12.07
WWNN	5.78	4.45	5.94
WPGA	17.57	13.11	17.49
WGVT	21.06	23.70	31.61
KUPI	14.05	7.75	10.33
KSGM	9.98	8.90	11.86
WITY	18.60	16.46	21.95
WCAP	37.12	35.82	47.76
WAYL	17.50	10.71	14.28
KMBZ	2.81	2.00	2.67
WAAV	22.12	17.23	22.97
KICA	14.27	8.71	11.62
WJIW	11.00	11.84	15.78
WTRY	6.57	5.59	7.45
WONE	10.59	7.62	10.16
WILK	8.13	8.40	11.20
WBZK	24.66	21.90	29.20
KDSJ	14.59	7.81	10.42
WSIX	9.98	6.85	9.13
KSVC	14.76	10.41	13.88
WFHG	18.86	15.29	20.39
KUTI	14.83	14.45	19.27
WCUB	33.13	21.68	28.91

FREQUENCY: 1590 KHZ

CALL SIGN	VALUE OF RSS (MV/M)		
	FCC	MODIFIED METHOD	
	FIGURE 2	SS+2	SS+6
WGYJ	17.27	15.98	21.30
WVNA	5.45	4.36	5.81
KYDE	6.81	5.24	6.99
KSSU	11.31	8.28	11.04
KLIV	4.32	3.33	4.44
KOGO	7.41	7.05	9.40
WQQW	2.32	2.12	2.83
WRXB	12.05	9.89	13.19
WALG	2.83	2.65	3.53
KWBG	11.63	6.89	9.19
WONX	14.30	13.76	18.34
WNTS	8.93	8.36	11.15
KVGB	3.24	3.15	4.20
WJRO	14.95	11.55	15.40
WETT	19.72	17.16	22.88
WJBQ	26.33	31.66	42.22
WTVB	15.24	14.45	19.27
KCNN	13.17	6.49	8.65
WZRX	8.63	7.66	10.22
WSMN	15.61	17.84	23.79
WERA	12.46	14.90	19.87
WAUB	25.29	21.35	28.47
WASB	28.79	24.24	32.32
WEHH	19.53	17.08	22.78
WAKR	2.31	1.69	2.25
KTIL	5.96	4.75	6.34
WCBG	13.36	12.13	16.18
WCZN	12.77	12.07	16.09
WXRF	2.13	2.72	3.63
WARV	15.48	19.08	25.44
WUSJ	5.94	4.36	5.81
KYOK	7.83	6.20	8.27
KEND	4.95	4.44	5.93
KDAE	11.46	10.38	13.84
KMTI	13.40	8.29	11.05
KJET	4.19	3.63	4.84
WTOQ	11.97	8.90	11.87
WTRW	28.62	25.08	33.45


#3
#2
#1
WCCO Minneapolis, Minnesota - 830 kHz
Contour #1 0.5mV/m, 50% Skywave - FCC Figure 1a
Contour #2 0.5mV/m, 50% Skywave - Formula (SS+6)
Contout #3 0.5mV/m, 50% Skywave - Formula (SS+2)


WWL New Orleans, Louisiana - 870 kHz
Contour #1 0.5mV/m, 50% Skywave - FCC Figure 1a
Contour #2 0.5mV/m, 50% Skywave - Formula (SS+6)
Contout #3 0.5mV/m, 50% Skywave - Formula (SS+2)
#1
#2
#3

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-509

In the Matter of

Enhanced Nighttime Operation
for Class II-S and Class III-S
AM Radio Broadcast Stations

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 4, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this *Notice of Proposed Rule Making* (*Notice*) to consider changes in the rules to facilitate the enhancement of nighttime operations by Class II-S and Class III-S AM stations. The proposed rules would allow these stations to establish a separate nighttime antenna system without having to meet the minimum power, city coverage or minimum operating schedule requirements that otherwise would apply to such a change in their nighttime operations.

2. This *Notice* is part of the Commission's continuing efforts to create an environment in which AM stations can compete effectively and thereby better serve the public. To a considerable degree, recent actions involving AM stations have been based on the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, released April 3, 1986 (*Report*), and the comments received in response to it. The *Report* addressed a large number of technical, legal and policy issues, seeking to identify opportunities to change or eliminate existing rules in order to assist AM broadcasters in meeting the competitive challenges facing them, thereby improving their service to the public. Recognizing that daytime-only stations face serious disadvantages because of their inability to operate at night, the Commission has implemented a number of proceedings to remove this limitation to the maximum extent possible consistent with sound engineering practice. For example, actions taken in a series of proceedings have allowed many daytime- only stations to become full-time stations. Nonetheless, we are of the view that it may be possible to take further steps to enhance the opportunity for former daytime-only stations to improve their nighttime operations while at the same time maintaining existing interference protection requirements. Before discussing the specific proposal, however, we will provide some background information regarding the various actions taken by the Commission in this area in recent years.

BACKGROUND

3. The current proposal can be seen as a continuation of the rule making process that began with the Commission's 1983 action first authorizing post- sunset operation by daytime-only stations.[1] Although many daytime-only stations had been able to conduct pre-sunrise operations (typically beginning at 6:00 a.m. local time), similar relief had not been available for the post- sunset period because of international agreements then in effect.[2] However, with the implementation of new AM agreements with Canada and Mexico, the FCC was able to authorize post-sunset operation. Under the rules adopted by the Commission, the great majority of daytime-only stations have been permitted to operate for up to two hours beyond local sunset with a power of 0.5 kW, reduced as necessary to avoid interference. A special computer program was created by the Commission to do the calculations involved and to issue the authorizations.

4. Although these actions brought important benefits, it was clear that pre-sunrise and post-sunset operation alone could not be expected to alleviate all of the difficulties faced by daytime-only stations. This led the Commission to study other possible relief, in particular the possibility of authorizing regular licensed nighttime operation with allowable powers calculated in much the same way as the post-sunset powers had been, using a computer program devised by the Commission. Studies established the feasibility of such a step, and in MM Docket No. 84-281 the Commission authorized nighttime operation by almost all of the daytime-only stations on what had previously been 14 foreign Class I-A clear channels.[3]

5. Nighttime operation on the foreign clear channels is being initiated in stages. During the first five-year period of such operation, the Commission has authorized a maximum power of 0.5 kW, reduced as necessary to protect existing foreign and domestic full-time stations on these channels. The power to be used is based on the station's daytime (or, if applicable, the station's critical hours)[4] antenna system. Because in many cases the initial powers were quite low, the Commission encouraged these stations to take other steps, typically through the installation of directional antennas, that would permit them to employ higher powers. Stations taking advantage of this opportunity had to propose a minimum power of 0.25 kW or its equivalent.[5] In allowing these increases in power, we stated that these stations would not be required to provide interference protection to one another during the initial five-year period of nighttime operation. However, after the five-year initial period, protection would have to be afforded to all stations, including former daytime-only stations, operating at night with at least minimum power.[6] Also, subject to this limitation on interference, the permissible power for these stations will increase to 1 kW.

6. Then, in MM Docket 87-131, the Commission took a similar step and allowed qualifying daytime-only Class III stations on the regional channels (and Class II daytime-only stations on two clear channels on which no U.S. clear channel stations operate) to operate at night using their existing antenna system with a maximum power of 0.5 kW, reduced as necessary to avoid interference to existing full-time stations. Stations authorized a power of at least 0.25 kW (or equivalent) were reclassified as unlimited-time Class II or Class III stations.[7] Others receiving lesser powers were reclassified as Class II-S or Class III-S stations[8] and were exempted from the principal city signal requirement. The Commission also exempted the new

Class II-S and Class III-S stations from the requirement that unlimited-time stations operate two- thirds of the hours between 6:00 p.m. and midnight each day of the week except Sunday.

7. These various Commission actions have substantially relieved the difficulties faced by daytime-only stations and their listeners, but as discussed below, we believe that there may be additional steps that can be taken to enable these former daytime-only stations to better serve their communities.[9]

DISCUSSION

Enhanced Nighttime Operation

8. In our actions permitting daytime-only stations to operate at night, the power levels authorized were calculated based on the same antenna system that the station used to provide its daytime (or, if applicable, its critical hours) service. Since these antenna systems had been designed with only daytime protection in mind, in many cases they were not capable of providing effective nighttime service. Many in this group were restricted to low powers from sites at some distance from the population to be served. This led some to decide not to use the authorization because the station's daytime site was not close enough to the community of license to permit it to be served with the authorized nighttime power and existing antenna pattern.

9. Although a Class II-S or III-S station was permitted to seek an increase in power, it had to propose an increase to at least the minimum power level. For some affected stations, we have found that such an increase is not possible at all for interference reasons; for others, it can be accomplished only at a prohibitive cost by installing highly directionalized antennas. Moreover, because of the low power initially authorized, some stations have chosen not to take advantage of their authorizations. In other cases, stations that do operate at night are unable to obtain the coverage they desire. No relief is available unless the station is able to propose an increase to at least the minimum power level. In many cases, this situation would change if the stations were able to establish a separate nighttime antenna system, either at the current site or elsewhere, from which the desired service could be provided without having to meet the minimum power requirement. It appears as if both the station and the public could benefit if the station had this latitude in selecting a site and antenna system responsive to its needs.

10. Continuing to restrict power increases to only those stations able to achieve minimum power may well be contrary to the public interest because such action could have the practical effect of preventing many Class II-S or III-S stations from upgrading their facilities at all. Stations able to increase power to the specified minimum level already have good reasons to do so, not only by virtue of the increase in coverage it makes possible but through the interference protection that they will obtain if they reach the level of minimum power. For stations not in this fortunate position, there is no current relief available. Even if these stations are unable to reach the minimum power level, we question whether the public is served by denying them the opportunity to improve their facilities and enhance their coverage. We recognize that permitting stations to apply for lesser power increases may diminish somewhat the incentive to reach minimum power. Our experience indicates, however, that it has been practical limitations such as financial or technical considerations that have kept many Class II-S and III-S licensees from operating with minimum power. Because these licensees are thus unlikely to reach minimum power in any case, there appears to be no basis for refusing to allow such stations the opportunity to provide increased service, albeit at less than minimum power.

11. For these reasons, we propose to allow Class II-S and III-S stations to establish separate nighttime operations, utilizing either their daytime operating site or another site, at power levels below the 0.25 kW minimum.[10] This proposal can offer several advantages. It would permit the licensee to consider a wide range of choices of how best to operate at night. The licensee could install a directional antenna designed specifically for nighttime operation, either at its current site or elsewhere. It could operate non-directionally from another site closer to the community of license or it could increase power, albeit not to the minimum power level. Even if the power were not increased or in fact was marginally reduced, coverage still could be improved in the very areas where it may most be needed, thus improving service to the public.[11] In addition, this approach could also offer the licensee the opportunity to use a simple nondirectional antenna array from its existing site or from another site that would enable the licensee to provide satisfactory nighttime service and thus compete more effectively in its market.[12]

12. It is important to take into account the administrative impact that adoption of this proposal might entail. To lessen any such impact, it may be possible to simplify or streamline the application process. One possibility is to define all such proposals as minor change applications even if a power increase is involved, thus eliminating the public notice requirements and reducing processing time. Comment on this and other possible approaches to lessening the administrative impact is invited.

13. Finally, we wish to make an important observation with respect to processing procedures applicable to Class II-S and III-S licensees filing applications for modifications of facilities. Initially, the Commission calculated the permissible powers and issued the appropriate nighttime authorizations. The calculations were based upon the daytime or critical hours antenna system. In the past, AM licensees seeking a change in authorization for their daytime facilities did not recognize the need to file for any corresponding change this necessitated in their nighttime facilities. In the future, however, it will be necessary for Class II-S and III-S licensees seeking authorization for modifications to their daytime facilities that would require any change to their nighttime operations to include information specifying the requisite changes to nighttime operations in their application. We note that, in the context of this proceeding, if Class II-S or III-S licensees use separate facilities for daytime and nighttime operations, changes in daytime operations will not necessarily in such cases affect nighttime operation. In such cases, this additional information would not be required.

Relaxation of Power Minimum

14. In addition, some full-time stations have expressed an interest in operating at lower nighttime powers but are currently barred from doing so by the minimum power and city coverage requirements. We seek comments upon permitting such a voluntary power reduction. Allowing stations to reduce power to a level below the current

minimum could provide licensees with additional latitude in which to tailor their facilities to respond to existing market conditions. Greater flexibility could result in services better attuned to meeting the needs of the station's audience. Should we proceed in this fashion, we intend to maintain the interference constraints applicable to such stations. We propose, however, that a station reducing its power to a level below the established minimum would be reclassified as Class II-S or Class III-S and would lose its right to interference protection that is accorded to stations with at least minimum facilities. It is our intention at this time to retain the city coverage and minimum operating schedule requirements for stations employing voluntary power reductions. We seek comment upon whether it would be appropriate to exempt such stations from these requirements, as are existing Class II-S and III-S stations, or whether stations engaging in a voluntary power reduction below the minimum level should continue to be held to the city coverage or minimum operating schedule requirements.

ADMINISTRATIVE MATTERS

15. Authority for the rule changes upon which comments are invited is contained in Sections 4(i), 303. and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

16. Pursuant to the applicable procedures set forth in 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **December 27, 1988,** and reply comments on or before **January 11, 1989.** All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive personal copies of their comments, an original plus nine copies must be filed. Comments and reply comments should be sent to Office of the Secretary, Federal Communications Commission, 1919 M Street, N.W.. Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference Room (Room 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

17. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* contacts are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice stating that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever comes first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence for the resolution of issues in the proceeding. Section 1.1203.

18. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously- filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each *ex parte* presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

19. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with section 603(a) of the Regulatory Flexibility Act, Pub.L. 96- 354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*,(1981).

20. The proposal herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form. information collection and/or recordkeeping, labeling, disclosure, or record retention requirements, and will not increase burden hours imposed upon the public.

21. For further information on this proceeding, contact Diane L. Hofbauer, (202) 254-3394.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment upon a proposal to allow Class II-S and Class III-S AM broadcast stations to establish separate nighttime operations designed to better serve local needs without requiring them to comply with minimum power requirements.

II. Objective:

This proposal is intended to permit an expansion of the nighttime operations of Class II-S and III-S AM stations so that they may better serve the public.

III. Legal Basis:

Sections 4(i), 303, and 307 of the Communications Act, as amended, 47 U.S.C. §§154(i), 303 and 307.

IV. Description, Potential Impact, and Number of Small Entities Affected:

There are more than 1500 AM broadcast stations that could benefit from this proposal in the United States. An estimated 50 AM licensees per year are expected to utilize the options proposed in this Notice of Proposed Rule Making. This proposal is expected to increase service to local communities with minimal additional, if any, expense to the licensee.

V. Reporting, Record Keeping, and Other Compliance Requirements :

There are no reporting, record keeping or other compliance requirements.

VI. Federal Rules that Overlap, Duplicate or Conflict with Proposal:

There is no overlap, duplication or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objective:

This proposal is designed specifically to allow AM licensees to increase service with little or no impact on current operations.

FOOTNOTES

[1] Hours of Operation of Daytime-Only Stations, *First Report and Order* in BC Docket No. 82-538, 95 FCC 2d 1032 (1983).

[2] A discussion of this situation is contained in the *First* Report and Order in BC Docket No. 82-538, supra, at Paragraphs 51-52.

[3] See Report and Order adopted April 26, 1985 in MM Docket No. 84-281, FCC 85-244, 50 Fed. Reg. 24515, June 11, 1985, as modified on reconsideration, Memorandum Opinion and Order, adopted February 3, 1986, FCC 86-79, 103 FCC 2d 532 (1986).

[4] Critical hours are the first two hours after sunrise and the last two hours before sunset during which there is a potential for daytime skywave interference.

[5] For the sake of convenience, we refer to a minimum power of 0.25 kW. Operating with this power and minimum antenna efficiency, a station has an RMS of 141 mV/m at one kilometer. Thus, any operation with an RMS of 141 mV/m or greater meets the minimum even though the power may be below 0.25 kW. This occurs when an antenna system of greater efficiency is employed.

[6] The principle reason for imposition of minimum power requirements is the recognition that operations with a power below this level are likely to cause a disproportionate degree of preclusion in exchange for the service that will be provided. The same concerns, however, may not hold true in a mature medium like AM where the areas of such preclusion are likely to have been precluded already.

[7] In connection with this action, the Commission reduced the generally applicable minimum power for nighttime operation of Class III stations on regional channels to 0.25 kW.

[8] Class III-S stations are full-time stations on regional channels operating below minimum power at night. Class II-S stations operate on a like basis on clear channels.

[9] When the Commission began its actions, there were more than 2,400 authorized daytime-only stations representing about half of the total of AM stations. As a result of the recent actions, more than three quarters of these stations have been authorized to operate at night. As discussed below, not all of these stations have chosen to implement nighttime operation.

[10] When the Commission authorized nighttime operation with less than the minimum power, it recognized that it would be unrealistic to expect the station to provide the city coverage required at night. Although adoption of the proposal now before us could lead to some increase in nighttime city coverage, it appears that it likewise would serve little purpose to apply the principal city signal requirement to the nighttime operation of these stations. The same is true for the minimum operating schedule requirement. The current rules exempt Class II-S and III-S stations from both requirements, and we propose to continue these exemptions. Exemption from the principal city signal requirement, however, creates the possibility that a station could establish nighttime service in a new community at the expense of service to its community of license. This outcome could be avoided if we required nighttime service levels within the community of license to be at least as good as the service levels originally authorized (i.e. that originally authorized by the Commission for nighttime operation using daytime facilities). We seek comment as to whether this or some similar requirement is necessary. Finally, we do not hereby contemplate any changes in any daytimer preferences that these Class II-S and III-S stations might enjoy.

[11] In making this proposal, we have no intention of authorizing facilities that would be predicted to create interference to full-time stations under the criteria established in §73.37(a) of our Rules.

[12] Although problems with re-radiation and with antenna efficiency have in the past been associated with the use of rooftop antennas for nighttime operations, we are willing to consider whether utilization of rooftop antennas could provide a feasible alternative. We invite comment on this alternative and may consider whether to allow use of roof-top antennas should the commenters demonstrate that rooftop antennas are feasible and could be utilized without causing undue re-radiation concerns.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-508

In the Matter of

Improved Methods for Calculating
Skywave Field Strength in the
AM Broadcast Band

REPORT AND ORDER
(Proceeding Terminated)

Adopted: April 12, 1990; Released: July 18, 1990

By the Commission:

INTRODUCTION

1. On October 13, 1988, the Commission adopted a *Notice of Proposed Rule Making* (" *Notice* ") in this proceeding, 3 FCC Rcd 6431 (1988), which proposed to adopt a new method of computing skywave signal strength in the AM Broadcast Service. This new skywave model would replace three sets of propagation curves (Figures 1a, 1b and 2 in §73.190) with more accurate equations that take into account the effects of the geomagnetic latitude of the propagation paths. The new model also proposed to use "slant distance" in lieu of the traditional "great circle distance" in making calculations. We also proposed that the new model be based on propagation conditions measured six hours after sunset ("SS+6") rather than two hours after sunset ("SS+2"). Lastly, because the new model yields results for 50% skywave field strength used in determining service contours, we proposed a geomagnetic latitude-based conversion factor for the 10% skywave signals used in predicting interference. With very few exceptions, the comments and reply comments filed in response to the *Notice* strongly supported the new skywave model and its underlying assumptions.[1] We now adopt the model essentially as proposed.

BACKGROUND

2. This proceeding is one of several AM improvement proceedings initiated in response to the MM Docket No. 87-267 *Notice of Inquiry* (" *Inquiry* "), 2 FCC Rcd 5014 (1987), which undertook a comprehensive review of AM broadcast assignment criteria and other technical standards. The *Inquiry* was begun in response to comments filed on the 1986 Mass Media Bureau Report on the Status of the AM Broadcast Rules (RM-5532), which discussed a number of AM broadcast technical, legal and policy issues. Extensive participation in that *Inquiry* and in the Region 2 Administrative Radio Conference by AM broadcasters, their consulting engineers and industry representatives has produced a general consensus about many of the new technical approaches needed for AM improvement, including the so-called "modified method" of calculating skywave field strength that, with minor revisions, is the heart of this proceeding.

3. Two of the skywave propagation curves set forth in the rules were empirically derived from observations of AM band propagation phenomena completed in 1935 (for Figure 1a) and 1944 (for figure 2). However, the Commission has continued to observe AM propagation phenomena in the ensuing decades and has been able to use its experience to develop a more accurate skywave signal prediction model. For example, we have learned that skywave signal strengths are more consistent when observed six hours after sunset rather than two. Also, skywave signal strength is reduced as the geomagnetic latitude of the signal path moves north. We have also learned that using the slant distance for a propagation path, rather than the great-circle path distance results in greater accuracy, particularly when the reception point is close to the transmitter. In short, years of additional observations and measurements have revealed deficiencies in the traditional skywave propagation curves that can no longer be tolerated if AM interference is to be reduced significantly as part of our AM improvement effort.

4. Thus, the *Notice* proposed a new skywave model based on the "modified method." Its use will serve the public interest because it is more accurate than the current propagation curves and because it is easily implemented on computers. Thus, its use will avoid disputes that may arise as a result of graphical interpretation of curve data. The enthusiastic support for the new model that was expressed in the comments and reply comments derives from the fact that the "modified method" has been given careful and widespread engineering scrutiny.

DISCUSSION

General comments on the new skywave model

5. General support for the new model was unanimous. Some commenters did, however, express concerns about unintended or potentially harmful effects that could result from its adoption.

6. For example, several commenters noted that the new model would depict smaller service areas than are now predicted for clear-channel stations in northern latitudes. 3-D Communications Corporation argued that because of the protection afforded to non-existent Class I station skywave service (i.e., the service area predicted to exist using the current propagation curves minus the service area calculated with the new model), Class II stations operating on clear channel frequencies are being deprived of the ability to serve their immediate areas during the heaviest nighttime listening period. The comments of Class II Station WJAG reflect a similar opinion. E. Harold Munn, Jr. & Associates, Inc. and R. Morgan Burrow, Jr. (both professional consulting engineers) indicate that there is no justification for protecting "fictional" (Munn) or "lost area" (Burrow) domestic service when it is actually receiving interference from foreign stations.

7. These opinions are countered by comments of Class I (clear channel) licensees, who argue that current skywave service areas, even if providing weaker signals than was formerly believed, should be protected. The Clear Channel Broadcasting Service ("CCBS") argues that clear channel stations provide the only nighttime service to over one-half the land area of the United States and offer

much needed diversity within the AM band in those areas which have only one or two interference-free groundwave services at night. Thus, the CCBS concludes that during the night, clear channel stations anchor the AM band by making available a service unique to AM. The Jefferson Pilot Broadcasting Co. urges the Commission not to impair nighttime skywave service for modest gains in groundwave service.

8. In another vein, the National Association of Broadcasters ("NAB") and the CCBS request that the Commission adopt a "safety factor" to insure that no new interference result from use of the new skywave propagation model. How this "safety factor" should be determined is left up to the Commission. However, NAB indicates that the safety factor should guarantee that interference does not occur where it is predicted not to occur, and that if there is any statistical error in deriving an empirical formula from raw field strength measurements, the effects of any variances should occur below the threshold of signals causing interference. NAB adds that such a "safety factor" is appropriate in view the standards of good engineering practice.

9. Concern about the protection afforded skywave service of Class I stations is outside the scope of this proceeding. The new model will show that the service area of a northern Class I station may not be as large as formerly thought. It will also show that the interfering contour of a southern cochannel station may extend farther than previously thought. Thus, as a general rule, licensees of southern Class II stations operating on clear channels should not expect use of the new model to permit them to obtain significant increases in their facilities. Conversely, the predicted interfering contour of a northern Class II station may extend less than previously calculated. The relationship between the service and interfering contours of any two cochannel stations will be latitude and path dependent. Therefore, we can make no generalizations about facility increases that may be made possible by use of the new skywave model.

10. Moreover, the new skywave model is only one component used in depicting AM service. In MM Docket No. 88-511, 3 FCC Rcd 6448 (1988), the Commission had under consideration new methods for calculating nighttime protection for stations in the AM service. That docket will shortly be terminated without action under authority delegated to the Chief, Mass Media Bureau. However, we will continue to consider this question in MM Docket No. 87-267. *See Notice of Proposed Rule Making* adopted April 12, 1990. Predicted skywave signal strength is only one of several important factors used in determining the permissibility of proposed facilities. Analysis of its possible effects should also take into account other pending changes in the AM technical standards.

11. We are adopting the new skywave model because it is the most accurate and convenient method of predicting skywave signal strength ever developed. It simply reflects our best estimate of signal strength and coverage. Therefore, we do not agree with the suggestion of NAB and CCBS that it should be modified by some subjectively applied "safety factor." If after considering the net effect of all the technical changes adopted in the AM improvement proceedings we find that the service of Class I stations will be adversely affected, we can determine on a policy (rather than an engineering) basis whether the protected contour for those stations should be changed. But this issue is outside the scope of this proceeding.

12. The majority of commenters agree with our conclusions. Almost all of the commenters, while favoring ultimate use of the new skywave model, opposed its use unless it were part of a comprehensive AM improvement package. The Association for Broadcast and Engineering Standards ("ABES") argued that the implementation of the new model *not* be deferred so that the benefit of the higher degree of predictive accuracy would not be postponed. Karl D. Lahm and Associates ("Lahm") suggested that the new model be implemented in concert with the changes in RSS interference computation under consideration in MM Docket No. 88-511. However, Lahm indicated that it should not be implemented earlier than six months after its adoption in order to give consulting firms time to develop appropriate computer programs.

13. We agree with Lahm and the majority of commenters that implementation of the new model must be deferred at least until the matters at issue in MM Dockets No. 88-511 and 87-267 are resolved. Notwithstanding the merits of the new skywave model, we would not want a few licensees in potentially unique circumstances to be able to take advantage of short-term "loopholes" resulting from the implementation of new technical standards on a piecemeal basis. Such facility proposals, while permissible in the short-term, could require "grandfathering" in the long-term. We believe that implementing the skywave model at this time would only add to our application processing burden while potentially undermining our efforts to improve the AM service. Therefore, we will defer implementation of the new model until other related AM improvement matters have been resolved. At the same time, by adopting the new skywave model in principle at this time, we provide a technical basis for implementation and related technical proposals in the other AM improvement proceedings.

14. Several commenters noted some typographical errors and potential inconsistencies in the new skywave model as it was depicted in Appendix B of the *Notice*. For example, the term (2 Pi + 4.95 $\tan^2$ $Theta_M$) in Equation 1 in Appendix B of the *Notice* should have read (2 Pi + 4.95 $\tan^2$ Phi_M). This was corrected on November 15, 1988, by memorandum included in the docket file. H. R. Anderson and Associates, Inc. ("Anderson") believes the expression [cos $(69+b_M)$] in Equation 3 should be corrected to read [cos $(69-b_M)$].[2]

15. Anderson also questions the constant, 111.18, in Equation 4, arguing that the Handbook of Mathematical Functions by Abramowitz and Stegun (December, 1972) indicates that it should be 111.136. Anderson also notes that using a constant E layer of 100 km is inconsistent with departure angle formulas currently contained in §73.190, Figure 6a, and argues that either a single departure angle should be used for all situations (Anderson's preferred approach) or else the departure angle formula (2) in Appendix B must be corrected. Lahm expresses a similar concern, noting that a single angle is used in analyzing the impact of proposed Canadian and Mexican facilities. Lastly, du Treil, Lundin and Rackley, Inc. suggests that the results of all calculations made using the new skywave formulas be expressed to no more than three significant places so as to recognize natural limitations inherent in the technical data.

16. We appreciate the obviously close scrutiny given the proposed skywave model by the commenters and we concur with the recommendations summarized above. However, as Anderson notes elsewhere in its comments, the

constant 111.18 in Equation 4 is referenced in the 1986 U.S.-Mexican AM Agreement. We note, too, the inconsistency of the new model (which is based on a fixed E-layer height of 100 km and thus by implication a fixed departure angle) with §73.190, Figure 6a (which depicts a range of departure angles based on different E-layer heights). Other commenters noted some of these problems and questioned how the new skywave model would be applied to certain "grandfathered" facilities.

17. The purpose of the *Notice* in this proceeding was simply to obtain general approval for future use of the new skywave model. Thus, Appendix B merely defined the new model without addressing how it would be applied to or used in conjunction with other relevant AM technical standards. Discussion of any minor adjustments to the model proposed in the *Notice* required to make it conform to international treaties and other matters pertaining to its implementation is premature. The action we are taking here is limited to adopting the model on a conceptual basis. We will resolve matters related to the timing and manner of its implementation in the *Notice of Proposed Rule Making* in MM Docket No. 87-267 which is also being adopted on this date. That *Notice* will include a detailed appendix presenting all of the interrelated AM improvement proposals in their proper context for review and comment.

Use of Slant Distance

18. The *Notice* proposed substituting slant distance for the traditional great circle distance in making skywave calculations. Whereas great circle distance is the length of an arc (the curvature of which is based on the earth's radius) between two points on the earth's surface, slant distance includes an additional element which takes into consideration the additional distance required for a signal to reflect off the E-layer while travelling along the arc. For long distances, slant distance and great circle distance converge, but for very short distances they can be very different. Thus, the *Notice* pointed out that the accuracy of calculations would be improved in cases for which the slant distance is large in relation to the great circle distance. It also noted that the Consultative Committee on International Radio ("CCIR") Recommendation 435 recommended the use of slant distance for all propagation paths.

19. All of the parties filing comments addressing this issue agreed that generally substitution of slant distance for great circle distance would improve the accuracy of the calculations. Thus, "slant distance" will be used in conjunction with the implementation of the new skywave propagation model for determining the skywave service of and interference to domestic AM facilities. Predicted interference to and from foreign AM facilities will continue to be determined consistent with applicable treaties until such time as those treaties may be revised.

Reference Hour

20. The skywave model described in Appendix B of the *Notice* was based on skywave propagation data measured roughly six hours after sunset ("SS+6"). These data were considered more appropriate than SS+2 data because phenomena affecting nighttime skywave signal propagation have become stable by that time and skywave propagation conditions are most favorable. Thus, calculation of skywave interference using SS+6 data will produce a worst case result, which is consistent with the use of a conservative interference prediction model. The Commission believes that use of such a model is essential if real reductions in AM skywave interference are to be achieved.

21. Most of the comments filed relating to reference hour supported the use of SS+6. All but one of the rest favored continued use of SS+2 (the current skywave propagation curves are based on SS+2 measurements). However, Robert A. Jones, P.E. ("Jones") suggested that SS+4 data might be a better choice, particularly in the case of the expanded band. Greater Media expressed the belief that SS+6 data would yield a more stable and uniform reference, freer of frequency effects and less sensitive to path direction. However, it noted SS+6 approximates the "graveyard shift" rather than the period of maximum evening radio listening. Greater Media concluded that some stations would be afforded more protection than was necessary using SS+6 but that this was preferable to increased interference levels. The Continental Broadcasting Company agreed that SS+6 better represented the "worst case" for interference calculations. Lahm noted that use of SS+6 would result in better protection of full-time stations' service areas and enhanced prediction of the skywave service of Class I stations. The Hearst Corporation observed that SS+2 appears to be outmoded, having as its genesis old-time family listening habits of 40 years ago.

22. However, the 3-D Communications Corporation ("3-D"), licensee of a Class II station, and Bonneville International Corporation ("Bonneville") expressed the view that SS+2 should be retained as the reference hour. 3-D opposed use of SS+6 because it maximizes protection to the service of Class I stations, according greater importance to Class I skywave service than to Class II station groundwave service. Use of SS+2 would reduce the predicted service areas of Class I stations and afford greater opportunity for Class II stations to increase their facilities. Thus, 3-D argues that at the least, the Commission should adopt a two step procedure whereby a Class II station would protect a Class I station's SS+2 contour until SS+6. It could then reduce power to protect the SS+6 contour. Bonneville argues that SS+2 is more appropriate because all stations' listenership is higher at that time, and because it believes SS+6 is meaningless as a reference point without identifying the season and latitude (*e.g.*, SS+6 in Alaska would be post-sunrise in the summertime).

23. 3-D's support of SS+2 clearly reflects a belief that Class I stations should no longer be protected as extensively as they have been. The protection afforded Class I skywave service is, however, a policy decision that is essentially unrelated to the technical merits of the new skywave propagation model. [3] Therefore, we do not wish to deal with it in this proceeding. It may be true, as Bonneville observes, that listenership levels peak at SS+2. A significant reduction in interference levels in the AM service could lead to increased listenership later in the evening. Because use of SS+2 would result in greater interference levels most of the night, we believe its use would be inconsistent with our desire to improve the quality of AM service. Because SS+6 measurements were obtained during winter months when the night at northern latitudes was very protracted, we find irrelevant the fact that SS+6 is latitude and season dependent. Winter data yield greater skywave coverage areas and concomitantly higher interference levels. Thus, their use reflects a

more conservative approach and would more effectively reduce overall interference levels. Because we believe that every possible means of reducing interference levels in the AM service should be pursued, we believe the public interest would best be served by use of the SS+6 measurement data. Therefore, we decline to modify the model to use SS+2 data instead of SS+6 measurement data.

Conversion factor for 10% skywave field strength

24. The *Notice* also proposed a formula (number eight in Appendix B) for calculating 10% skywave interference levels based upon the new model, noting that the correction factor varies from approximately 6 dB in southern latitudes to roughly 10 dB in northern latitudes.[4] However, the *Notice* described two possible alternatives to this approach. The first would simply be to use the average correction factor (8 dB) nationwide. The other would be to establish three zones based on latitude with different correction factors.

25. The majority of the comments favored using the formula proposed in the *Notice* although many commenters did not give a reason. However, Jones argued that the formula could be safely eliminated, because a standard conversion factor would overprotect all stations and use of an 8 dB correction factor would make the Commission's Rules consistent with those adopted at the 1981 Region 2 Conference. Bonneville likewise expressed the belief that use of an 8 dB correction factor was an acceptable compromise. However, Greater Media supported use of the formula, arguing that only by calculation can the best possible accuracy be obtained and noting that such calculations are readily and inexpensively performed using computers.

26. We disagree with Jones' opinion that a uniform 8 dB value would overprotect all stations. In fact, we find that it would tend to overprotect stations in southern latitudes and underprotect stations in northern latitudes. Thus, we continue to believe that because experience has provided us with the information needed to develop a highly accurate skywave signal strength prediction model, all components (such as the 10% skywave correction factor) of the model should be as accurate as possible. We agree with Greater Media that the effort required to implement the 10% skywave correction formula on computers is negligible and the calculation time minimal. Therefore, we are adopting the 10% skywave correction factor as proposed.

CONCLUSION

27. We conclude that no amendment of the skywave propagation model set forth in Appendix B of the *Notice* is necessary. Therefore, we adopt that model exactly as proposed. However, consistent with the discussion in paragraphs 12 and 13, *supra*, we will not incorporate the model into the rules at this time. Instead, in the MM Docket No. 87-267 AM improvement proceeding, we propose rules that will implement the new skywave model in conjunction with other related changes in the AM technical standards. Thus, interested parties have an opportunity to comment on the final effect of all of our recent AM improvement actions, including any minor refinements of the skywave model that may be necessary to conform it to domestic policy and international agreements. We also find that the purpose of this proceeding has been fulfilled and therefore conclude that it should be terminated.

FINAL REGULATORY FLEXIBILITY ANALYSIS

28. Pursuant to the Regulatory Flexibility Act of 1980, the Commission's final analysis is as follows:

I. Need and Purpose of this Action:

The Commission is replacing the AM skywave propagation curves with a new model based on a data developed over many decades which offer extensive information on skywave propagation characteristics. Use of the new skywave model will enable the Commission to more accurately predict skywave coverage and interference, and will provide us with an important means of potentially improving the quality of the AM service.

II. Summary of Issues Raised by the Public Comments in Response to the Initial Regulatory Flexibility Analysis :

No commenters addressed the Initial Regulatory Flexibility Analysis.

III. Significant Alternatives Considered and >Rejected:

There are no alternatives to the action taken here that would accomplish the stated purpose.

29. The Secretary shall send a copy of this *Report and Order*, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration in accordance with paragraph 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96-354, 94 Stat. 1164, 5 U.S.C. Section 601 *et seq.*, (1981)).

PAPERWORK REDUCTION ACT STATEMENT

30. While a new skywave propagation model is being adopted in this action, its effective date is being deferred. Therefore, no rule changes are being implemented at this time, so no new or modified form, information collection, and/or record keeping, labeling, disclosure, or record retention requirements subject to the Paperwork Reduction Act of 1980 will result at this time. Neither will the burden hours placed upon the public be increased or decreased. We believe that implementation of the new skywave model will have little, if any impact on the Paperwork Reduction Act concerns listed above, except that the burden hours placed upon the public may be decreased through automation of skywave signal calculations on inexpensive and widely available computers.

ORDERING CLAUSES

31. Accordingly, IT IS ORDERED That pursuant to the authority contained in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended, the skywave signal strength prediction model described by the formulas contained in Appendix A below IS ADOPTED. However, its implementation will be deferred pending action on related AM improvement proceedings.

32. IT IS FURTHER ORDERED that this proceeding IS TERMINATED.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

Comments

3-D Communications Corporation
Association for Broadcast Engineering Standards, Inc.
Bonneville International Corporation
CBS, Inc.
Capital Cities/ABC, Inc.
Clear Channel Broadcasting Service
Continental Broadcasting
Cox Enterprises, Inc.
du Treil, Lundin & Rackley, Inc.
E. Harold Munn Jr., & Associates, Inc.
Empire Radio Partners, Ltd.
Greater Media, Inc.
H & C Communications, Inc.
H. R. Anderson & Associates, Inc.
Hearst Corporation
Karl D. Lahm & Associates
National Association of Broadcasters
Outlet Broadcasting, Inc.
Robert A. Jones, P.E.
Timothy C. Cutforth, P.E.

Reply Comments

Clear Channel Broadcasting Service
Eric Chandler Communications of San Diego, Inc.
Ex Parte Comments filed by R. Morgan Burrow, Jr., P.E.
Fisher Broadcasting, Inc.
Jefferson Pilot Broadcasting Company
Nolte Communications, Inc.

MM Docket No. 88-508

APPENDIX B – CALCULATION OF SKYWAVE FIELD STRENGTH

The following formulas are to be used in place of the curves in Section 73.190 of the FCC Rules. The methods used to determine other factors such as radiation value, elevation angle, and f(θ) are unchanged and can be determined by referring to the appropriate section of the FCC Rules.

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

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

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

The slant distance, D, is given by:

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

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

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

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

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

Where:

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

Where:
a_T is the geographic latitude of the transmitting terminal (degrees)
a_R is the geographic latitude of the receiving terminal (degrees)
b_T is the geographic longitude of the transmitting terminal (degrees)
b_R is the geographic longitude of the receiving terminal (degrees)
a_M is the geographic latitude of the midpoint of the great-circle path and is given by:

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

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

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

Note(1): If $|\phi_M|$ is greater than 60 degrees, equation (1) is evaluated for $|\phi_M| = 60$ degrees.
Note(2): North and east are considered positive; south and west negative.
Note(3): In equation (7), $k = -1$ if $b_R > b_T$, otherwise $k = 1$.

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

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

$$F_c(10) = F_c(50) + \Delta \ \text{dB}(\mu\text{V/m}) \quad (8)$$

Where:
$\Delta = 6$ when $|\phi_M| < 40$
$\Delta = 0.2|\phi_M| - 2$ when $40 \le |\phi_M| \le 60$
$\Delta = 10$ when $|\phi_M| > 60$

For the complete text of this revised CFR Section, See the Notice of Proposed Rule Making in MM Docket No. 87-267, FCC 90-136 at 55 FR

FOOTNOTES

[1] A list of parties filing comments and reply comments is given in Appendix A. A skywave signal is that portion of a station's transmitted signal that is reflected by the ionosphere back to the earth. The strength of the reflected signal is generally negligible during the day and increases gradually after sunset.

[2] However, we have verified that Equation 3 as depicted in Appendix B is correct. The negative term sought by Anderson would appear to follow from the convention indicated in Note 2, which states that western longitudes should be considered negative.

[3] *See* ¶¶ 10-12, *supra*.

[4] The correction factor is used to derive the 10% skywave interfering signal strength (or contour) from the 50% skywave service signal strength (or contour). The Commission traditionally uses 50% reliability signals or contours to define service and 10% reliability signals or contours to define interference.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 89-46

In the Matter of
Policies to Encourage
Interference Reduction Between
AM Broadcast Stations

REPORT AND ORDER
(Proceeding Terminated)

Adopted: April 12, 1990; Released: July 18, 1990

By the Commission:

1. The Commission has before it the *Notice of Proposed Rule Making* in this proceeding, 4 FCC Rcd 2430 (1989). That *Notice* looked toward the development of formal procedures for AM licensees to reduce interstation interference through agreements among stations, and considered related changes in our AM processing rules that may facilitate such procedures. In the *Notice*, we requested comment concerning the existing policy of "grandfathering" deleted AM facilities, the Commission rule of proscribing contingent applications, the requirement that a major change in AM facilities be subject to competing applications, and the establishment of a "local service floor." Thirteen parties filed comments and/or reply comments.[1] After careful consideration and review of these comments, we are adopting the proposals presented in the *Notice*.

BACKGROUND

2. The *Notice* in this proceeding is an outgrowth of both the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, released April 3, 1986, and the subsequent *Notice of Inquiry*, 2 FCC Rcd 5014 (1987), addressing the technical, legal, and policy issues pertaining to AM broadcasting.[2] In response to the *Notice of Inquiry*, commenters have emphasized the need to improve the overall quality of the AM service. In order to address these concerns, we have initiated four different dockets.[3] Today we are adopting a *Notice of Proposed Rule Making* in MM Docket No. 87-267, through which we intend to refine and integrate the proposals made in these earlier dockets into a master plan for achieving a significantly improved AM broadcast service. As an integral part of that master plan, we now remove regulatory barriers that prevent or discourage individual AM stations from lessening the amount of interstation interference and improving the quality of service through private agreements. The result of these negotiations between AM stations may be the filing of contingent applications as discussed in paragraphs 5, 6, 7 and 8, *infra*, or one station's deleting or modifying its facilities. In order to provide this opportunity, it is necessary to make certain changes in our AM rules and procedures.[4] After providing background information, we discuss these changes below.

3. In order to put these proposals into perspective, it is necessary to discuss current AM assignment criteria, which are based on the concept of protected contours.[5] Under our Rules, AM proposals are examined to determine whether a proscribed interfering contour would overlap the protected service contour of the existing station. The propagation characteristics of the AM signal differ during daytime and nighttime hours. During daytime hours, the extent of the service and interfering contours can be calculated on the basis of frequency, power, and ground conductivity. These contours are referred to as groundwave contours. Sections 73.37(a) and (b) of the Rules set forth the permitted overlap of groundwave contours between protected and interfering stations. Due to ionospheric reflection of AM signals during nighttime hours, AM signals propagate over significantly greater distances at night than during daytime hours. The contour of such nighttime signals is referred to as the skywave contour. In regard to AM nighttime interference criteria, Section 73.182 of the Rules sets forth interference protection criteria based on groundwave and skywave contour protection as well as the class of the protected AM station.

4. The comments we received were unanimous concerning the need to improve the technical quality of the AM service. We received several relevant comments pertaining to the present AM assignment scheme. Both the Association for Broadcasting Engineering Standards ("ABES") and Radio WADO, Inc., referred to our 1964 action in Docket No. 15084 establishing Section 73.37 of the Rules, commonly referred to as the "go-no-go" rules. *AM Station Assignment Standards*, 45 FCC 1515 (1964). The expression "go-no-go" refers to the decision to evaluate proposals on the basis of prohibited contour overlap rather than a subjective weighing of audience gains and losses. In that action we noted the increase in the percentage of AM stations causing or receiving objectionable interference within a prescribed service area during the years 1952 to 1962. Specifically, we stated the following:

> The number of new stations causing more than 1% of 'objectionable interference' rose from 2% in 1952 to 21% in 1962. The percentage receiving more than 1% rose from 18% to 36% in the same period. A further study of 60 consecutive "pre-freeze" applications for new stations granted from April 1962, to April 1963, showed that 42% either caused or received some degree of "objectionable interference."

AM Station Assignment Standards, *supra* at 1522. Radio WADO, Inc. made two additional observations. First, Radio WADO observes that the "go-no-go" rules did not end the creation of objectionable AM interference because Section 73.37(b) of the Rules permits interference received under certain situations, and propagation conditions, in some situations, lead to stronger signals and therefore more interference than was predicted. Radio WADO also notes that the "go-no-go" rules did nothing to reduce existing interference in the AM band. The ABES makes a similar observation, noting that in 1964, approximately 4,000 AM stations were in existence, and a significant proportion of these stations were causing or receiving objectionable interference. Of the approximately

974 stations authorized since 1964, ABES correctly notes that many of these were "shoehorned in" with interfering contours closely approaching the protected contours of existing stations.

" GRANDFATHERING " DELETED AM STATIONS

5. When an AM station is deleted, we have, as a matter of policy, maintained the radiofrequency radiation rights for a period of one year for parties wishing to file an application to replace the deleted facility.[6] In many cases, however, this policy leads to the perpetuation of AM stations' causing or receiving objectionable interference. We concur with Group W that our present policy of maintaining these deleted AM facilities is actually a disincentive to bringing these stations into compliance with current AM assignment standards. Parties filing comments supported our proposal to require applicants for such deleted facilities to comply with the technical requirements in effect at the time that they file their applications. Therefore, we are adopting this new policy that new applicants must meet current technical standards.

CONTINGENT APPLICATIONS

6. Section 73.3517 of the Rules prohibits the acceptance of contingent applications for construction permits proposing either new or modified facilities. Currently, parties cannot file such applications even though the applications might lead to the improvement in one station's facilities made possible by changes to the facilities of the other station, and a concomitant overall reduction in AM interference. We continue to believe that, as a general matter, accepting such speculative applications contingent on the grant of another application imposes an unwarranted burden on our administrative resources. However, the *Notice* proposed permitting contingent applications leading to an overall reduction in AM interference. For example, one station may conclude an agreement with a nearby station on an adjacent channel whereby the second station reduces its daytime and nighttime power. This would reduce interference caused to the first (and other) stations and could allow the first station to improve its daytime facilities. This proposal envisions two or more applications being filed and granted simultaneously. The comments that we received supported this proposal.

7. We agree with the National Association of Broadcasters ("NAB") that there is a need for a full public interest evaluation of such proposals and while we do not foresee any particular types of abuse, we will be alert for such problems. On the other hand, we disagree with the NAB that such contingent applications should be limited to situations in which one station actually terminates operation, thereby affording "finality" to the process. In addition to terminating operation, AM stations may significantly reduce interference by reducing power, terminating nighttime operation or using a directional antenna. We believe that giving AM stations this additional option for reducing interference is consistent with our goal of improving the quality of the AM radio service. The amended contingent application rule will apply to both deletions and modifications of existing AM stations.[8] We believe that "finality" will be achieved by the fact that any subsequent application by the modified station, or a party filing for a deleted facility, will have to comply with the technical rules then in effect.

8. We are amending Section 73.3517 of the Rules to permit contingent applications that would assure a reduction in overall AM interference.[9] This amendment should provide two incentives for stations to enter into such agreements. Both of these incentives will benefit the station making the payment to the other station. First, as discussed in paragraph 10. *infra*, we are protecting the station improving its facilities from competing applications. This protection will be afforded to both major change applications such as an increase in power, and also to minor changes such as modifying a directional antenna pattern. The second incentive for contingent application arrangements concerns the calculation of the RSS limit.[10] During nighttime hours, an existing station is protected from its transmitter to its RSS contour. The effect of reducing interference toward a station would be to reduce the RSS limit at the old RSS contour, thereby expanding that station's protected service area. As indicated in paragraph 38 of the *Notice*, recalculation of the RSS occurs upon deletion or modification of an AM station contributing to the RSS limit.[11] Termination or modification of an AM station's facilities may also reduce the RSS limit of an AM station not a party to the contingent application arrangement. In turn, this reduction in the latter's RSS limit may preclude a station that is party to the arrangement from improving its nighttime operation even if it were willing to pay other stations to allow it to do so. To remedy this potential problem, all associated contingent applications will be granted simultaneously. This will require a station seeking an improvement in nighttime operation to protect only existing RSS contours of all stations not a party to the contingent application arrangement.

COMPETING APPLICATIONS

9. The contingent application procedure discussed above assumes that one station will either delete or modify its facilities in order to permit the other station to improve its area of signal coverage or service quality. This improvement might be achieved through a major or a minor facilities change.[12] Under our current application processing procedures, applications for either type of change are subject to competing applications.[13] A competing application, or the possibility of a competing application, might discourage parties from initiating such proposals due to the costs of a comparative hearing, or the risk that a competing applicant may prevail in a comparative proceeding. These factors could discourage proposals that would lead to a reduction in AM interference.

10. To reduce this deterrent substantially, the *Notice* proposed that any competing application would have to protect the licensed facilities of the stations participating in the contingent application arrangement even though there might be no conflict with any licensed facility after the arrangement is implemented. In addition, the competing application would be subject to the applicable cut-off date. The commenters all supported this proposal. We are amending Section 73.3571 of the Rules to codify this proposal. We find such action to be in the public interest because it removes a potentially significant deterrent to our efforts to improve the quality of the AM service. It is

clearly within our authority to promulgate rules limiting eligibility to submit a competing application when we determine that such action promotes a specific public interest objective. *U. S. v. Storer Broadcasting Company*, 351 U.S. 192 (1956). Such action, accordingly, does not violate the holding in *Ashbacker Radio Corp. v. FCC*, 326 U.S. 327 (1945), which prohibits us from granting one of two mutually exclusive applications for an available frequency filed by two eligible applicants without comparatively considering the two applications. In connection with this, we note that under our amended procedure, the currently licensed facilities of any party to a contingent application arrangement would preclude consideration of any competing application proposal. *See Amendment of the Commission's Rules Regarding Modification of FM and TV Authorizations to Specify a New Community of License*, 4 FCC Rcd 4870, 4873 (1989), *recon. pending*.

LOCAL SERVICE FLOOR

11. We emphasize that a significant factor underlying our decision to grant or deny a contingent application arrangement involving deletion or reduction in AM facilities would be whether it satisfies the public interest requirement of a local service floor - a level of broadcast service that must be maintained subsequent to any deletion or reduction in AM facilities. The comments concurred that there was a need to require a minimum level of service. After careful consideration of the comments, we agree with the NAB that we cannot establish a quantifiable service floor that can be uniformly applied with respect to the replacement of deleted facilities or our public interest evaluation of contingent application arrangements. Instead, we will consider the issue of a local service floor on a case-by-case basis. However, the comments were helpful to our efforts to identify some guidelines that could be of value in regard to a local service floor.

12. At the outset, we agree with Great American Television and Radio Company, Inc., ABES and Karl D. Lahm that, consistent with longstanding precedent, we should consider the availability of both AM and FM service in determining whether an area affected by a deletion or a contingent application arrangement has sufficient service, since AM and FM are part of a single aural service. *Anamosa and Iowa City, Iowa*, 60 FCC 2d 1041 (1976). Also, like du Treil, Lundin, and Rackley, Inc., we do not envision our being able to make the public interest finding necessary for the grant of a contingent application arrangement or deletion request if the proposal would create "white" or "gray" areas.[14] In most cases, our public interest evaluation will weigh the amount of AM interference that will be eliminated against the number of AM and FM services remaining available to the areas that will lose service. Our evaluation will also take into account the areas and populations that will gain service as a result of the proposal and the availability of other services to these areas.

13. Both the decision to eliminate the grandfathering of deleted AM facilities and the possibility of contingent application arrangements that would delete such a facility trigger our concern for a community possibly losing its only broadcast service. We do not, however, believe that we must establish an exception to our new policy of not grandfathering deleted AM facilities if the deleted station happens to be a community's only local service. We reach this conclusion for two reasons. First, in regard to stations close to metropolitan areas, the community losing the facility could very well be receiving primary and city grade service from many other stations. We believe that the availability of two or more primary services coupled with a reduction in AM interference would justify our not permitting a party to restore a deleted AM station that would not comply with current technical requirements. We would also use this guideline in evaluating a contingent application arrangement proposing deletion of a community's only local aural service. Second, in regard to the deletion of an AM station in a more remote area, we believe another AM station could restore local service, albeit with less powerful or directional facilities, and comply with our technical requirements. We believe it extremely unlikely that, in an area where there is no primary or city grade service, lack of available spectrum is the cause. It is far more likely the case that economic factors make it impossible to profitably operate a station. In such situations, there would moreover generally be adequate AM or FM spectrum available for a local aural service at a later date, if demand warrants.

CONCLUSION

14. We continue to believe that it is in the public interest to encourage interstation agreements proposing a reduction in AM interference and to provide a procedural framework that would facilitate such agreements. Based on our consideration of the record in this proceeding and for the reasons set forth above, we conclude that it is appropriate to terminate the current policy of grandfathering deleted AM facilities, to permit contingent applications that result in overall interference reduction, to require that competing applications filed against such contingent applications protect the licensed facilities of those stations participating in the contingent application arrangement, not to establish a specific local service floor that would be applicable to all situations, and to amend Sections 73.1750, 73.3517, and 73.3571 of the Rules as set forth in the attached Appendix B.

FINAL REGULATORY FLEXIBILITY ANALYSIS

15. Pursuant to Regulatory Flexibility Act of 1980, our final analysis is as follows:

I. Need for and Purpose of the Rule

We have concluded that current rules and policies are an unnecessary deterrent to improving the technical quality of the AM band and agreements between AM stations looking toward a reduction in AM interference.

II. Flexibility Issues Raised in the Comments

No regulatory flexibility issues were raised in the comments.

III. Significant Alternatives Considered but Not Adopted

The alternative would be to make no change in current rules and policies. This would not achieve the public interest benefit of facilitating reductions in AM interference.

PAPERWORK REDUCTION ACT STATEMENT

16. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980, and found to impose a new or modified information collection requirement on the public. Implementation of any new or modified requirement will be subject to approval by the Office of Management and Budget as prescribed by the Act.

ORDERING CLAUSES

17. Accordingly, IT IS ORDERED, That the amendments to Part 73 of the Commission's Rules and Regulations set forth in Appendix B below ARE ADOPTED. The effective date of these amendments will be established by further Commission action in MM Docket No. 87-267.

18. IT IS FURTHER ORDERED, That this proceeding IS TERMINATED.

19. Authority for the action taken herein is contained in Sections 4(i) and (j), and 303(r), of the Communications Act of 1934, as amended, 47 U.S.C. §154(i), (j), 303(r).

20. For further information concerning this proceeding, contact Robert Hayne, Mass Media Bureau, (202) 634-6530.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

The following parties submitted comments and or reply comments:

Association for Broadcast Engineering Standards, Inc.

Glenn F. Bircher

Capital Cities/ABC, Inc.

CBS, Inc.

Corporation for Public Broadcasting

du Treil, Lundin & Rackley, Inc.

Great American Television and Radio Company, Inc.

Karl D. Lahm, P.E.

The KICD Stations

Harold Munn Jr. & Associates, Inc.

National Association of Broadcasters

Radio WADO, Inc.

Westinghouse Broadcasting Company, Inc.

APPENDIX B

Part 73 of Title 47 of the CFR is amended as follows:

1. The authority citation for Part 73 continues to read as follows:

Authority: 47 U.S.C. 154 and 303.

2. Section 73.1750 is amended to add the following language at the end to read as follows:

§ 73.1750 Discontinuance of operation

***If a licensee surrenders its license pursuant to an interference reduction arrangement, and its surrender is contingent upon the grant of another application, the licensee surrendering the license must identify in its notification the contingencies involved.

3. Section 73.3517 is amended by adding new paragraph (c) to read as follows:

§ 73.3517 Contingent applications

* * * * *

(c) Upon payment of the filing fees prescribed in §1.1111 of this chapter, the Commission will accept two or more applications filed by existing AM licensees for modification of facilities that are contingent upon granting of both, if granting such contingent applications will reduce interference to one or more AM stations or will otherwise increase the area of interference-free service. The applications must state that they are filed pursuant to an interference reduction arrangement and must cross-reference all other contingent applications.

4. Section 73.3571 is amended by adding new paragraph (c)(1) to read as follows:

§ 73.3571 Processing of AM broadcast station applications

* * * * *

(c) * * *

(1) In order to grant a major or minor change application made contingent upon the grant of another licensee's request for a facility modification, the Commission will not consider mutually exclusive applications by other parties that would not protect the currently authorized facilities of the contingent applicants. Such major change applications remain, however, subject to the provisions of §§73.3580 and 1.1111. The Commission shall grant contingent requests for construction permits for station modifications only upon a finding that such action will promote the public interest, convenience and necessity.

* * * * *

FOOTNOTES

[1] A list of those parties is contained in Appendix A.

[2] The 107 AM channels are divided into three groups of channels: clear channels, regional channels and local channels. Four basic classes of stations evolved to operate on these three channel groups. Class I and Class II stations operate on clear channels. Class I stations provide extensive primary

(groundwave) service during the day and night, with skywave service during nighttime hours generally extending out to 750 miles or more from the transmitter. Class II stations protect the Class I station on the channel and provide primary service only, the area of which depends upon station location, power and frequency. Class III stations represent an intermediate category and operate on regional channels, providing service to larger cities and the surrounding rural areas. Class IV stations operate on local channels and provide primary service to a community and the immediately contiguous surburban or rural areas. *See* 47 C.F.R. §§73.21-37, 73.182. Shortly, there will be ten additional AM channels in the expanded AM band between 1605 and 1705 kHz. Rules governing these stations are being considered in a companion item in MM Docket No. 87-267.

[3] *See Improved Methods for Calculating Skywave Field Strength in the AM Broadcast Band*, MM Docket No. 88-508, 3 FCC Rcd 6431 (1988); *Enhanced Nighttime Operation for Class II - S and III - S AM Radio Broadcast Stations*, MM Docket No. 88-509, 3 FCC Rcd 6444 (1988); *Improved Methods for Calculating Groundwave Field Strength in the AM Broadcast Band*, MM Docket No. 88-510, 3 FCC Rcd 6577 (1988); *Review of the Methods for Calculating Nighttime Protection for Stations in the AM Broadcast Service*, MM Docket No. 88-511, 3 FCC Rcd 6448 (1988).

[4] Group W and duTreil, Lundin & Rackley, Inc. have suggested the issuance of tax certificates pursuant to Section 1071(a) of the Internal Revenue Code, 28 U.S.C. §1071(a), as an additional means of encouraging reductions in AM interference. The use of tax incentives was not proposed in the *Notice*, and is therefore outside the scope of this proceeding. In the *Notice of Proposed Rule Making* we adopt today in MM Docket No. 87-267, however, we propose the use of Section 1071(a) tax certificates in connection with stations turning in their licenses as part of a voluntary agreement to reduce interference, and request comment on the use of tax certificates when stations reduce interference as part of a voluntary agreement.

[5] Objectionable interference to particular service contours is defined in Sections 73.37 and 73.182 of the Commission's Rules.

[6] The one year period commences upon release of a *Public Notice* announcing the deletion of the facility. Parties may file applications for the deleted facility after release of the *Public Notice*.

[7] Section 73.3517 of the Rules does permit a modification application by a proposed assignee or transferee in connection with an assignment or transfer application.

[8] We emphasize that after deletion of an AM station, a third party may file an application, in accordance with current AM technical requirements, proposing, in substantial part, reestablishment of the deleted AM station.

[9] The NAB has suggested a waiver approach to contingent applications based on AM interference reduction. In view of the benefits that would flow from such applications, we believe that a general rule would better serve the public interest. A rule gives certainty and would be preferred over an *ad hoc* case by case approach, especially where a processing rule is involved.

[10] The RSS limit is derived by calculating the effect of skywave interference from other nighttime AM stations on the potential service area of the AM station. *See* Section 73.182 of the Rules. In a separate action today in MM Docket No. 87-267, the Commission is proposing that the RSS method for calculating interference be replaced by a single signal method.

[11] This recalculation will occur upon either release of a *Public Notice* announcing the deletion of the AM station, or, in the case of modified facilities of a station contributing to another station's RSS limit, upon licensing of those modified facilities.

[12] It is also conceivable that a station could benefit by having its RSS limit decreased, which would not require the filing of an application.

[13] Section 73.3571(c) of the Rules provides for a cut-off list for major change applications. For minor change applications, we will consider any mutually exclusive application filed prior to acceptance and grant of the earlier-filed minor change application.

[14] A "white" area is an area that receives no full-time aural service. A "gray" area receives one full-time aural service.

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-510

In the Matter of

Improved Methods for Calculating Groundwave Field Strength in the AM Broadcast Band

REPORT AND ORDER
(Proceeding Terminated)

Adopted: April 12, 1990; Released: July 18, 1990

By the Commission:

INTRODUCTION

1. The Commission has decided to replace its current AM broadcast band groundwave propagation curves with a new set of curves. Over a significant range of distances, the current curves are a result of "curve fitting" that estimated values between the curve segments that could be calculated. A 1986 computer program allowed mathematical calculation of predicted groundwave field strengths at all distances. The new curves are derived from data generated by that computer program. While the new curves are more accurate than the old curves, we will not make the change effective until related changes in technical assignment criteria are adopted.

BACKGROUND

2. The *Notice of Proposed Rule Making* (" *Notice* ") proposed replacing the existing AM groundwave propagation curves with a new, more accurate set of curves for depicting groundwave service and interference.[1] In addition, the *Notice* raised the matter of improving the FCC ground conductivity map, Figure M3, but proposed no revision because adequate funds were not available to pursue this extensive project. The "Kirke method," which is the procedure currently specified in our rules for calculating groundwave field strength over paths containing more than one ground conductivity value, was also discussed. Finally, we requested comments on whether the proposed changes should be implemented in a "piece meal" fashion or coordinated with action in related proceedings to change other AM technical assignment criteria.

3. To put this proceeding in context, it is one of several that are outgrowths of the MM Docket No. 87-267 *Notice of Inquiry* (" *Inquiry* ").[2] The *Inquiry* is the Commission's comprehensive review of AM broadcast assignment criteria and other technical standards. It followed comments filed on a 1986 Mass Media Bureau Report on the Status of the AM Broadcast Rules (RM-5532). Through the *Inquiry* and the Region 2 Administrative Radio Conference, the AM broadcast industry has reached general agreement on many of the new technical approaches needed for AM improvement, including the revised groundwave propagation curves considered in this proceeding.

COMMENT SUMMARY

4. Ten parties filed comments and five parties filed reply comments. [3] There is unanimous support in the comments for adopting the proposed new groundwave propagation curves. Several commenters request that the Commission continue allowing field strength measurements to be made in lieu of the calculations using the curves. Three parties make suggestions regarding the physical characteristics of the graphs on which the curves are plotted.[4]

5. Comments vary on the importance of improving the Figure M3 ground conductivity map. NAB argues that it is less important than adopting the new curves. Cox urges the Commission to proceed cautiously, starting with thorough data collection. WGN, CBS and especially ABES and Nolte indicate that revision of Figure M3 is a significant task that merits immediate, high-priority Commission attention. ABES suggests that when we adopt new curves, we should keep this Docket open to expedite Figure M3 revision. Nolte suggests that the Commission require conductivity information to be submitted in applications in order to begin building a data base for Figure M3 revision.

6. Generally, retaining the "Kirke method" was supported by the comments that addressed it. Lahm suggests that when resources are available, the Commission should conduct a study to find an improved methodology.

7. The consensus of comments favored coordinated implementation with the other related AM improvement proceedings. Those supporting this approach included WGN, Clear, Empire, Cox, du Treil, NAB, Fisher, Outlet, and Pilot. NAB also suggested that we need to revise the first adjacent channel protection ratio at the same time as the current proposals are implemented. Outlet contends that implementation should occur only after international agreements are ratified. A few commenters did not agree. ABES takes the position that groundwave changes don't need to wait for resolution of skywave issues. Lahm suggests limited interim uses of the new curves, but urges the Commission to allow six months before use of the new curves is required. A few other miscellaneous implementation matters were raised in comments.[5]

DISCUSSION

8. In light of the comments, we are adopting the proposed change in the groundwave propagation curves. We find that the new curves more accurately reflect groundwave signal coverage than the existing curves and should lead to better prediction of when objectionable interference does or does not exist.

9. We also considered the suggested changes in the horizontal and vertical scales, but conclude that the current format offers the best compromise between ease of distinguishing values and range of values included. As proposed, we are also amending the language in §73.184 pertaining to Figure 20 to refer to metric units. In addition, we were surprised by the concern expressed in some comments that the proposal may have prohibited field

strength measurements in lieu of calculations. We did not intend to alter that provision of §73.183 and it is not being changed.

10. We continue to believe that updating Figure M3 is a beneficial project that we should pursue. However, current funding and staffing levels do not allow it at this time and we find no benefit to keeping this proceeding open until Figure M3 revision can be undertaken. Such revision will undoubtably require additional notice and comment before changes can be adopted. We will act on this matter in a future Rule Making proceeding.

11. As we pointed out in the *Notice*, the Commission's rules currently specify a procedure for calculating groundwave field strengths over paths containing more than one ground conductivity value. This procedure is referred to as the equivalent distance method or "Kirke method." The information submitted in comments did not convince us that there is likely to be an alternative that is appreciably more accurate. Therefore, we believe our resources are better spent in other areas and we do not intend to pursue further at this time the possibility of using an alternative method.

12. We do not agree with the suggestion of NAB that the new groundwave model should be modified by some subjectively applied "safety factor." The model is being adopted because it is the most accurate method of predicting groundwave field strength available. If, after considering the net effect of all the technical changes proposed in the AM improvement proceedings, we discover that some stations will be adversely affected, arguments can then be made on a policy (rather than an engineering) basis that the protection standards should be altered.

13. The implementation date for the new curves will be established in the AM improvement proceeding in which we consider related assignment criteria. We find that Lahm's recommendation for limited uses in the interim would create administrative confusion. Canadian and Mexican negotiations and du Triel's 3-digit accuracy proposals are more appropriately considered in the assignment criteria Rule Making. All we adopt today is a propagation model with improved accuracy over the current model. The implementation details associated with the model's use, along with protection standards and other related matters, will be considered in conjunction with the *Notice of Proposed Rule Making* adopted today in the AM improvement proceeding, MM Docket No. 87-267.

14. Currently, Section 73.184 does not contain the actual groundwave propagation curves, but is instead followed by a note that these graphs are available by contacting the Commission. Thus, adopting new curves does not require Section 73.184 or the following note to be changed. Instead, we will prepare and make available sets of the new curves in the near future. Until implementation, the new curves will be labeled "Curves adopted April, 1990 are not in effect pending further action of the FCC." We fully expect that they will be available in this form for at least six months before they become effective, as Lahm requests. The individual data points which define field strength at various distances and which form the basis of the curves also will be made available.

CONCLUSION

15. After consideration of the record developed in this proceeding, we conclude that adoption of the proposed changes is in the public interest. The new groundwave model produces more accurate field strength predictions, allowing more confidence in service and interference determinations. Consistent with the discussion in paragraphs 13 and 14, *supra*, the model will not become effective at this time. In the AM improvement proceeding, MM Docket No. 87-267, we propose additional rules to integrate the new groundwave model with related AM technical and assignment standards. Thus, parties to this proceeding have an opportunity to comment on the final intended effect of all of our recent AM improvement actions, including any implementation refinements of the groundwave model.

FINAL REGULATORY FLEXIBILITY ANALYSIS

16. Pursuant to the Regulatory Flexibility Act of 1980, the Commission's final analysis is as follows:

I. Need and Purpose of this Action:

The Commission is replacing the AM groundwave propagation curves with a new model based on recent scientific analysis of groundwave measurement data and theory. Use of the new method will provide a more accurate depiction of service and interference relationships between AM broadcast stations.

II. Summary of Issues Raised by the Public Comments in Response to the Initial Regulatory Flexibility Analysis:

No commenters addressed the Initial Regulatory Flexibility Analysis.

III. Significant Alternatives Considered and Rejected:

There are no alternatives to the action taken here that would accomplish the stated purpose.

17. The Secretary shall send a copy of this *Report and Order*, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration in accordance with paragraph 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96-354, 94 Stat. 1164, 5 U.S.C. Section 601 *et seq.*, (1981)).

PAPERWORK REDUCTION ACT STATEMENT

18. The rule changes adopted here have been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection, and/or record keeping, labeling, disclosure, or record retention requirements; and will not increase or decrease the burden hours on the public.

ORDERING CLAUSES

19. Accordingly, IT IS ORDERED That pursuant to the authority contained in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended, the groundwave field strength prediction model described by the Graphs 1 to 19, and 20 that are available pursuant to the note following §73.184(f) IS ADOPTED. The effective date of this change will be established by further Commission action in related AM improvement proceedings. For the complete text of this revised CFR Section, *See* the

Notice of Proposed Rule Making in MM Docket 87-267, FCC 90-136 at 55 FR _____. IT IS FURTHER ORDERED that this proceeding IS TERMINATED.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

FOOTNOTES

[1] *See Notice of Proposed Rule Making* in MM Docket 88-510, 3 FCC Rcd 6577 (1988).

[2] *See Notice of Inquiry* in MM Docket 87-267, 2 FCC Rcd 5014 (1987).

[3] Comments were filed by Robert A. Jones, P.E. (Jones), WGN Continental Broadcasting Company (WGN), Clear Channel Broadcasting Service (Clear), Empire Radio Partners, Ltd. (Empire), CBS, Inc. (CBS), Association for Broadcast Engineering Standards, Inc. (ABES), Cox Enterprises, Inc. (Cox), National Association of Broadcasters (NAB), du Treil, Lundin & Rackley, Inc. (du Treil), and Karl D. Lahm, P.E. (Lahm). Reply comments were filed by Fisher Broadcasting, Inc. (Fisher), Jefferson Pilot Broadcasting Company (Pilot), Nolte Communications, Inc. (Nolte), and Clear. In addition, the submission of Outlet Broadcasting, Inc. (Outlet) was labelled comments, but clearly was intended to be reply comments, and will be treated as such.

[4] Lahm suggests changing the horizontal scale to range from 0.5 to 50 kilometers (km) for the upper curves and from 50 to 5000 km for the lower curves, claiming this would eliminate the hard to read, seldom used 0.1 to 0.5 km section and expand the remaining portion, making the curves easier to use. He also proposes using graph paper with a less dense grid structure to facilitate curve reading and data plotting. Nolte opposes Lahm's suggestions and instead offers that the vertical scale should be extended at least to 2000 mV/m because measurement data of some high power stations plot off the current scale. Nolte also suggests that the curves be reprinted in two contrasting shades of black. Jones wants the existing scales to be retained so that NAB printed graph paper can still be used.

[5] Lahm requests that the Commission generate and make available new data tables that are compatible with its GWAVE computer program. He also suggests that we urge Canada and Mexico to adopt the new curves and supports the conversion of Graph 20 of §73.184 to metric as was suggested in the *Notice*. Du Treil supports making Graph 20 metric and also suggests a requirement that all calculations be expressed to no more than three significant digits. NAB suggests the use of a "safety factor" when implementing new curves. Nolte agrees with du Treil on 3 digit accuracy, but disagrees with NAB on a safety factor. Nolte argues that the new prediction method must improve accuracy or it isn't useful, and that a safety factor would make the prediction less accurate. Finally, Outlet suggests that the computer program for predictions would be most useful if it is compatible with personal computers.

National Association of
NAB
BROADCASTERS

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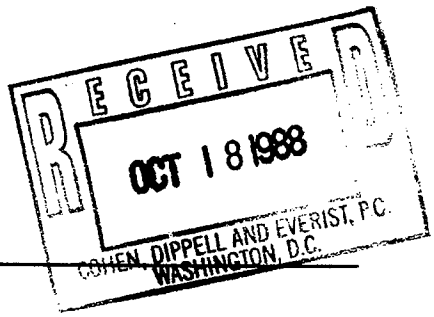
MEMORANDUM

TO: National Radio Systems Committee

FROM: Stanley Salek, NRSC Coordinator/NAB

DATE: October 14, 1988

SUBJECT: NRSC Rulemaking (FCC Docket 88-376)



Enclosed is a copy of FCC Docket 88-376, the Notice of Proposed Rulemaking which covers regulation of the NRSC standards. Also included is an issue brief, written by NAB Science and Technology, which reviews the Docket and comment procedures.

The next mailing, in about 1 week, will include:

- The minutes of the September 13 meeting, with attachments
- Schedule and agenda for the first FM Subgroup meeting (to be held in Washington D.C. on or about November 15)
- Further information regarding the Docket 88-376 NPRM

In the meantime, please call if you have further questions.

Stanley Salek

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ISSUE BRIEF

FCC Regulation of the NRSC Standard Acceptance of Interference

September 12, 1988

On September 12, the FCC released the text of its Notice of Proposed Rulemaking proposing (1) regulation of the NRSC standards and (2) permitting AM stations to accept interference (MM Docket No. 88-376). We anticipate a great deal of interest in this proceeding from radio receiver manufacturers, AM broadcasters, and NRSC participants. As your AM station will be affected, you may wish to participate in this important FCC proceeding.[1]

On November 6, 1988, NAB petitioned the FCC to require AM stations to use the NRSC standard effective January 1, 1990. This NRSC standard -- dubbed NRSC-1 -- is now in use by over 850 AM stations in the U.S. and Canada. On June 17, 1988, the NRSC completed work on NRSC-2, a supplemental standard dealing with AM transmitters and antennas.[2] Both standards can be reviewed in NAB's NRSC booths 545-547.

NAB's petition sought regulation of the NRSC-1 audio standard. However, the Commission now proposes to require AM stations to comply with NRSC-2, a potentially more complicated and costly standard to implement. The Commission also suggests that it may find that a station implementing NRSC-1 would presumptively comply with NRSC-2.

Also included in the Commission's rulemaking is a proposal to allow AM stations the option of constructing transmission facilities whose coverage area would be subject, in part, to some interference from other stations. Under the Commission's proposal, AM licensees would be permitted to seek an increase in station power, provided (1) that the 0.5 mV/m contours of other co-channel facilities, and the relevant contours of adjacent channel facilities, would continue to be protected in accordance with the Commission's technical rules; and (2) that the 1.0 mV/m contour of the proposed facility is not overlapped by the 0.05 mV/m contour of any other co-channel authorized facility.

This proposal is somewhat controversial. While some stations could increase power, stations that do so also would increase the amount of interference-susceptible service area. The Commission would allow stations to degrade their own service areas as a "price," paid for the "benefit" of increasing station power.

NAB Science & Technology contacts: Michael Rau or Stan Salek

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[1]Simply send an original and five copies of comments to Secretary, FCC, Washington, D.C., 20554 Attn: Docket No. 88-376. Also, NAB would appreciate a copy of any comments that are filed. Comments are due on November 22, with replies due December 22, 1988.

[2]The difference between NRSC-1 and NRSC-2 is as follows: NRSC-1 is an audio processing standard and characterizes the station's audio signal before entry into the AM transmitter. NRSC-2 characterizes the station's RF signal after emission from the transmitter and antenna.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

FCC 88-252

In the matter of	)	
	)	
Amendment of the Commission's Rules to improve the quality of the AM Broadcast Service by reducing adjacent channel interference and by eliminating restrictions pertaining to the protected daytime contour.	)	MM Docket No. 88-376
	)	RM-5532
	)	RM-6174

NOTICE OF PROPOSED RULEMAKING

Adopted: July 20, 1988 Released: September 12, 1988

By the Commission:

INTRODUCTION

1. The Commission has under consideration comments and reply comments in response to the Notice of Inquiry ("Inquiry") in MM Docket No. 87-267, which solicited comments on a comprehensive review of the technical assignment principles currently applicable to AM broadcasting.[1] This review was prompted by comments filed in response to the Mass Media Bureau's 1986 Report on the Status of the AM Broadcast Rules ("Report") which noted a consistent decline in public satisfaction with the quality of AM broadcast service in recent years, largely because of deficiencies related to its current technical limitations.[2] Based upon the information developed in the Inquiry, we intend to explore, in successive and separate rule making proceedings, a wide variety of technical and policy issues and related rule

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1 See Notice of Inquiry, FCC 87-245, (52 Fed. Reg. 31795, August 24, 1987). In a subsequent Order (52 Fed. Reg. 48844, December 28, 1987), reference was made to the various sections of the Notice of Inquiry and comment and reply comment deadlines were set for each as follows:

Section I	(Technical Assignment Principles)	6-17-88 and 8-17-88
Section II	(Additional Assignment Considerations)	2-1-88 and 3-1-88
Section III	(Related Technical Issues)	2-1-88 and 3-1-88
Section IV	(Antenna Systems)	6-17-88 and 8-17-88

Thus, the comment period is still open on Sections I and IV of the Notice of Inquiry.

2 See Report on the Status of the AM Broadcast Rules, April 3, 1986, p. 24.

amendments that we believe will enable AM broadcasters to compete more effectively in the audio service delivery marketplace.

2. This particular Notice will address two technical proposals mentioned in the Inquiry that we believe can effect near-term improvement in the AM broadcasting service: 1) the adoption of a new emission limitation and possibly a new audio processing standard, both of which are intended to reduce the level of adjacent channel interference, thereby encouraging the development of better quality AM receivers; and, 2) elimination of the restrictions currently contained in Section 73.37(b) concerning daytime contour protection, to allow some stations to use additional power.

BACKGROUND

3. Our Inquiry addressed a wide variety of fundamental but nevertheless complex assignment criteria used in the AM radio service. For example, it included a review of the suitability of the current signal strength values which define the protected contours (or service areas) of AM stations, as well as consideration of the minimum usable signal strength as a function of listener preference, atmospheric and man-made noise, and receiver design. It discussed the equally important co-channel and adjacent channel signal ratios that constitute the basic tradeoff in the AM service between the quality of received signals and the quantity of stations authorized. In addition, it invited comments on a new proposal to permit AM broadcasters to enter into mutual agreements concerning the degree of interference protection to be afforded in specific cases, as well as approval for the use of new, internationally developed AM service propagation curves.

4. Other potentially less complex issues included discussion of the suitability of the current AM emission limitations, audio signal processing practices and the method of determining the cumulative interference resulting from the reception of multiple signals. We also solicited comment on the desirability of amending Section 73.37(b) of the Rules to permit AM station licensees to increase their transmitter output power provided that no additional interference would be caused to co-channel or adjacent channel licensees, and notwithstanding the fact that interference from other stations would be caused to areas within the expanded service area. The intent of this change was not necessarily to increase the size of the original service area (although some expansion is possible), but rather to increase the signal level within the original service area, thereby improving the quality of service in areas normally subject to protection from interference.

5. On November 6, 1987 (subsequent to issuance of the Inquiry), the Commission received a petition (RM-6174) from the National Association of Broadcasters ("NAB") requesting formal adoption of an AM transmitter audio

standard developed by the National Radio Systems Committee ("NRSC").[3] Because the NRSC standard is intended to reduce adjacent channel interference by requiring substantial attenuation of audio signals above 10 kHz, and by limiting the maximum amount of audio pre-emphasis below 10 kHz, it will be considered in connection with a new emission limitation proposed herein, with which it is closely related.

DISCUSSION

6. Since thorough analysis of the many comments filed in response to the Notice of Inquiry is expected to be a time-consuming process, we propose early treatment of the less complicated issues in order that improvement in the quality of AM service can be achieved without unnecessary delay. Accordingly, we will address the radio frequency ("RF") emission limitations (including the NRSC audio standard recommended by NAB), as a means of reducing adjacent channel interference, and address whether Section 73.37(b) should be amended to generally permit received overlap[4] to occur where requisite protection is provided to other stations. These matters are discussed at length below.

REVISION OF THE EMISSION LIMITATIONS

7. The existing AM service transmission system emission limitations are set forth in Section 73.44 of the Rules.[5] Basically, they permit an AM broadcaster to transmit an unattenuated audio signal between 0 and 15 kHz. However, the best possible AM performance is seldom ever approached in

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3 See Petition for Rulemaking (RM-6174), filed on November 6, 1987 by the National Associations for Broadcasters, Public Notice No. 895, December 9, 1987. The NRSC is a joint venture between NAB and the Electronic Industries Association ("EIA") and is tasked with developing proposals conducive to the improvement of AM radio service.

4 By "received overlap" we mean the acceptance of interference to the 0.5 mV/m signal contour that normally defines a station's daytime service area. Section 73.37(b) currently allows certain licensees to accept protection of their 1.0 mV/m contour in lieu of the usual 0.5 mV/m contour. This allows some stations to be authorized that would not otherwise be able to conform with the standard signal protection ratios specified in Section 73.37(a).

5 Section 73.44 currently requires that any emission appearing on a frequency removed from the carrier by between 15 kHz and 30 kHz inclusive, must be attenuated by at least 25 dB below the level of the unmodulated carrier. Emissions removed from the carrier by 30 kHz up to and including 75 kHz must be attenuated at least 35 dB below the level of the unmodulated carrier. Lastly, any emission appearing on a frequency removed from the carrier by more than 75 kHz must be attenuated by at least 43 + 10 Log P (P= transmitter output power in watts) dB below the unmodulated carrier, or 80 dB, whichever is less.

practice for many reasons, one of which is the narrow receiver bandwidth that is necessary because frequency assignments in the AM service are made in 10 kHz increments throughout the band.[6] This can result in situations (particularly at night, when reception of very distant stations is common) where the emissions of adjacent channel stations overlap each other substantially. Partial sideband overlap during daytime groundwave service also can occur in the case of stations separated in frequency by 20 kHz (second adjacent channel stations). Thus, a desired station's sideband emissions are susceptible to being contaminated by signals of first and second adjacent channel stations.

8. To limit the interference caused by these overlapping sidebands, the Commission developed various co-channel and adjacent channel signal protection ratios that essentially define both the quantity (i.e., the number of stations) and the quality of AM service.[7] These ratios ensure that the signal of any particular AM station is substantially stronger (in its service area) than the signals of the other stations. However, in order to provide for diversity in what was then effectively the sole aural service, the Commission was compelled to limit the interference protection afforded individual stations in order to be able to authorize a greater number of stations. As a result, AM receivers must cope with adjacent channel interference levels that effectively preclude reception of high fidelity AM service.[8]

9. In order to reduce the effects of permissible levels of adjacent channel interference, AM receiver manufacturers generally have designed receivers with substantially restricted radio frequency ("RF") and intermediate frequency ("IF") bandwidths. This typically results in an upper limit receiver audio frequency response of 3 kHz to 5 kHz.[9] In an attempt to overcome this limitation, AM broadcasters often try to "brighten"

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6 To provide substantial protection to a 30 kHz emitted bandwidth (the 15 kHz modulating bandwidth is radiated more or less symmetrically above and below the station's carrier frequency), station assignments would need to be made in 30 kHz increments.

7 The protection ratios for the various classes of AM radio stations are listed in Section 73.37(a) of the Rules. Compliance with these ratios is obtained by through one or more of the following methods: controlling the geographic location of the stations relative to one another, by limiting station power, or by requiring the use of directional antennas.

8 Since emission limitations are relevant only with respect to adjacent channel interference, a discussion of co-channel interference considerations has been omitted here. However, co-channel signal levels also can have a significant effect on the quality of AM service.

9 A 3 kHz response is similar to that obtained in typical wireline telephone circuits.

their sound by boosting the higher audio frequencies. This improves fidelity somewhat, but not nearly enough to overcome the effect of the narrow receiver bandwidth. Moreover, boosting the higher audio frequencies can exacerbate adjacent channel interference.

10. Other audio processing techniques are used by broadcasters to improve the apparent receiver signal-to-noise (or signal-to-interference) ratio. For example, dynamic compression techniques increase the average signal-to-noise ratio. Audio "limiters" and "clippers" are used to reduce high amplitude audio transients that could cause overmodulation. In doing this, such devices also increase the average loudness of the program material by reducing its dynamic range.[10] The penalty paid for this increase in loudness is increased (albeit unobjectionable) program distortion and the generation of additional higher order sidebands that, like the "boosting" described above, can increase adjacent channel interference levels.

11. To break this vicious circle, broadcasters have concluded that fundamental changes are necessary in the AM transmission standards. As an initial effort, NAB has petitioned the Commission to adopt new rules that would mandate use of the NRSC audio standard by AM stations in order to effectively limit their occupied bandwidth to 20 kHz (this would permit a 10 kHz audio baseband). We concur with NAB in concluding that widespread use of the NRSC audio standard would constitute an important step toward reducing adjacent channel interference. Also, most of the comments filed in response to the NAB petition agree that reduced adjacent channel interference in the AM service would encourage the design and introduction of wider bandwidth receivers with substantially improved fidelity compared to current models. Such an improvement in fidelity, they argue, would make the AM service more competitive with the FM broadcast service.

12. The rules recommended by NAB are based on one of two voluntary standards developed by the NRSC to reduce adjacent channel interference: One recommended NRSC standard would define the characteristics of the audio signals fed to the input of a transmitter. The other would define the characteristics of the radio frequency signal emitted by the transmission system. NAB recommends the FCC mandate compliance with the NRSC input standard. It has two parts. One would limit the maximum audio frequency at the transmitter input to 10 kHz so as to limit the potential for adjacent channel interference. The other part would limit the maximum amount of

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10 The dynamic range of an audio signal may be described as the ratio of the highest amplitude signal to the lowest amplitude signal. In many cases the latter could be the residual "tape hiss" or "surface noise" (in the case of conventional records) when no signal is present. Eliminating the occasionally substantial peaks or transients in program audio permits an increase in the average signal level.

pre-emphasis[11] that can be applied to audio signals below 10 kHz in order to set a limit on the amount of interference that may be caused to first adjacent channel stations.[12] The reduction in adjacent channel interference is expected to encourage the production of receivers employing a standard de-emphasis which in turn would lead to better reception. Although about 15% of AM licensees have already adopted the NRSC audio standard voluntarily, NAB, nevertheless, requests that the Commission mandate its use beginning January 1, 1990. This, NAB argues, will give receiver manufacturers an incentive to promptly design and market the better quality receivers made possible by the reduction in adjacent channel interference and universal use of a specific audio pre-emphasis characteristic.

13. We agree that if the NRSC audio pre-emphasis is used at an otherwise properly adjusted and operating station, adjacent channel interference should be substantially reduced because the NRSC audio pre-emphasis standard would effectively limit the highest permissible audio frequency to just under 10 kHz. Frequencies above this limit would be substantially attenuated[13] and sideband components outside the 20 kHz bandwidth channel would be reduced, thereby alleviating the second (and higher) adjacent channel interference potential. Use of the NRSC pre-emphasis characteristic may also aid receiver manufacturers in designing better receivers since it would provide them with an augmented upper-end frequency response that could be de-emphasized either through a specific de-emphasis filter, or by new receiver selectivity characteristics. Such pre-emphasis could even benefit reception on current receivers to a limited extent, since upper mid-range frequencies would also be given some pre-

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11 "Pre-emphasis" consists of increasing the amplitude of selected regions of the audio spectrum to compensate for deficiencies in the transmission-reception system. Generally, the higher audio frequencies are pre-emphasized because noise energy is usually greater at higher audio frequencies. Also, many AM broadcasters use high frequency pre-emphasis to "brighten" the sound reproduced at the receiver (see paragraph 9, supra). The NRSC pre-emphasis standard proposed for use by NAB would boost audio at 2 kHz by about 2.5 dB, at 5 kHz by about 7 dB and at 9.5 kHz about 10 dB, relative to the response below 1 kHz and frequencies above 10 kHz would be severely attenuated (see, footnote 13, infra).

12 First adjacent channel stations are those whose carrier frequency is 10 kHz above or below the station to which they are referenced.

13 See Interim voluntary national standard, audio standard for AM broadcast stations, January 10, 1987, National Radio Systems Committee. Basically, under the proposed NRSC standard, the audio is attenuated as follows: -14 dB at 10 kHz; smoothly decreasing to -30 dB at 10.5 kHz; remaining at -30 dB to 11 kHz; -40 dB at 11 kHz; and smoothly decreasing to -50 dB at 15 kHz.

emphasis. Thus, it appears that broadcasters have a number of natural incentives to comply with the NRSC pre-emphasis standard.[14]

14. However, the goal of reduced adjacent channel interference may be only partially met through use of the NRSC pre-emphasis standard alone. While in theory (i.e., in a properly adjusted and perfectly functioning broadcast system) this would control emissions within and emissions outside a 20 kHz bandwidth, several factors associated with audio, transmitter and antenna system performance can increase radiated emissions beyond the desired limit.

15. For example, effective use of the NRSC audio pre-emphasis as a means of reducing first adjacent channel interference appears to based on the assumption that no initial pre-emphasis of signals above 5 kHz is applied by equipment located before the NRSC filter in the audio line. However, this may not always be the case. Also, some transmitters contain clipping or limiting circuits that are intended to prevent overmodulation. Any clipping or limiting done to the audio after it is passed through the NRSC filter could introduce harmonic baseband signal components that could circumvent, to some degree, the benefits intended to result from the filter's use. Also, improper transmitter tuning may produce incidental phase modulation with excessive bandwidth.

16. Moreover, compliance with the NRSC audio standard does not preclude problems arising from overmodulation. As Harrison J. Klein, a professional AM consulting engineer, notes: "...overmodulation is one of the basic mechanisms by which an amplitude modulated carrier can be degraded. On the surface, overmodulation appears a straightforward phenomenon which should be easily understood and prevented. Yet many stations overmodulate, some intentionally, implying that overmodulation mechanisms are not fully understood or that the stations do not believe there are benefits to preventing overmodulation. On the other hand, receiver manufacturers consider overmodulation a significant AM problem. In numerous industry meetings they have indicated their belief that splatter caused by overmodulation is a major factor preventing the manufacture of improved, high-fidelity AM radios."[15] [Emphasis in original]

17. It is therefore our tentative view that greater attention should be given to the radiated emissions that directly cause interference to other stations than to the characteristics of the audio signals fed to a transmitter. Audio processing pursuant to the NRSC standard alone cannot ensure the absence of interference. To be guaranteed effective, the NRSC audio standard would need to be supplemented by additional rules concerning

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14 NAB advises in its petition that in excess of 400 AM stations (about 15% of those currently authorized) are now operating pursuant to the NRSC audio pre-emphasis standard.

15 See, Modulation, Overmodulation and Occupied Bandwidth: Recommendations for the AM Broadcast Industry, Harrison J. Klein, P.E., in the 41st Annual NAB Engineering Conference Proceedings (1987), p1.

transmitter distortion limits. The current record is deficient with respect to proposals in these areas. Moreover, input standards are of the "how-to" variety that the Commission has consistently striven to eliminate over the years, because they potentially limit licensees' flexibility in achieving compliance in the least cost way and reduce their ability to implement new technology quickly and to respond to changing circumstances in the communications marketplace.

18. At this point in time, it appears that the better alternative is adoption of the NRSC's recently developed emission limitation standard.[16] This standard defines an RF emission mask that would effectively restrict the emissions from an AM broadcast transmitter to a 20 kHz bandwidth channel.[17] Emissions outside the channel would be attenuated to the point where their levels would not cause significant adjacent channel interference.[18]

19. Moreover, relying on emission limitations to control interference would obviate complex rules addressing modulation and transmission parameter limits that imposing the NRSC audio processing standard as a means of reducing adjacent channel interference would entail. Excessive bandwidth resulting from overmodulation also would be limited.[19] Enforcement of emission limitations might also be more easily accomplished, since our enforcement personnel could monitor off-the-air signals of AM stations and determine compliance without the need for a physical inspection of the

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16 We recognize that the new NRSC emission limitation is still considered interim in nature, and that its final approval by industry could take two more years. However, we consider significant changes in the interim standard unlikely. Any necessary refinements could be handled expeditiously in a subsequent rule making action.

17 See Interim voluntary national standard, emission limitation for AM broadcast stations, September 9, 1987, National Radio Systems Committee.

18 See, Appendix B, proposed NRSC emission limitations.

19 We note that Section 73.1570(b)(1) of our rules already limits AM transmitter overmodulation. However, we believe adoption of the NRSC emission limitation would give us additional "muscle" in enforcing this provision by allowing an additional citation to be issued to those stations whose overmodulation is severe enough to cause adjacent channel interference.

transmitter facilities.[20] Such a standard is also more consistent with our efforts at technical deregulation, and could therefore better maximize efficiencies in the rendition of aural service, potentially improve the quality of programming and more effectively ensure the development of receivers better able to satisfy public quality concerns. This course of action would not only provide the benefit sought by NAB, but would be compatible with voluntary use of the NRSC audio standard.[21]

20. In spite of the many arguments in favor of adopting the NRSC emission limitation in lieu of its audio standard, concerns have been expressed that implementation and compliance costs associated with the former may be greater than the latter. The allegation has also been made that adoption of the audio standard would do more to reduce first adjacent channel interference.

21. At this juncture, we can find little evidence to support these contentions. Inasmuch as licensees are already responsible for assuring compliance with the emission standards, it is unclear how alteration of these standards would affect compliance cost. Furthermore, test equipment would undoubtedly be required to install and maintain the equipment needed to comply with the audio standard. Therefore, compliance costs under either an emission or an audio standard appear to be roughly equivalent. We therefore seek comment on the cost of complying with either the emission or the audio standard. We also request information as to whether differences in compliance cost between the two standards may be disproportionately large for certain categories of stations.

22. It is also difficult, at this point, to assess either standard's effect on adjacent channel interference because little information is known about the current audio pre-emphasis practices of AM broadcasters. The limits on amplitudes of frequencies above 10 kHz imposed by the NRSC audio standard are substantial and would clearly help in the reduction of adjacent channel interference generally. However, adherence to the NRSC emission limitation should be just as effective. It is true that below 10 kHz, the emission standard imposes no limits, whereas the audio standard appears to

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20 We understand that a type of "splatter monitor" has just been made available for purchase. It is claimed that this monitor would permit licensees and their consulting engineers to make easy and economical measurements of their transmitted signals for conformance with the NRSC emission limitations. While this monitor is not a complete substitute for an expensive spectrum analyzer, it may provide an adequate capability for the detection and measurement of spurious emissions. This modulation monitor, which is expected to cost about $2150.00, is described at some length in the comments filed by Delta Electronics, Inc. in response to the NAB petition (RM-6174).

21 In view of the statement of Klein, cited previously, we believe that adoption of the NRSC emission limitation alone would provide receiver manufacturers with sufficient incentive to develop better quality AM receivers.

impose an absolute limit of 10 dB pre-emphasis of frequencies between 9 and 10 kHz. This may or may not be less than what broadcasters currently use. Also, we seek comments confirming that broadcasters perceive the NRSC audio pre-emphasis characteristic as an absolute audio frequency response limit, rather than merely as a post-audio processing signal adjustment, and identifying any other regulations (e.g., frequency response limits applicable to equipment preceding the NRSC filter in the audio line) that may be necessary to ensure this result.

23. On the basis of the record to date, we tentatively conclude that revision of our emission limitations is the most effective way to reduce adjacent channel interference and encourage production of higher quality receivers. Accordingly, we propose to modify Section 73.44 by adopting new emission limitations based on the NRSC draft Emission limitation for AM broadcast transmission (June 17, 1988).[22] The proposed rules also include certain measurement instrument parameters as suggested by the NRSC (e.g., spectrum analyzer resolution bandwidth, filtering, and hold time) in order to eliminate any ambiguity about proper measurement procedure. However, we propose that licensees be permitted to determine compliance with the NRSC emission limitation with any appropriate measurement device, provided that any dispute over measurement accuracy be resolved in favor of measurements provided by a properly calibrated swept frequency spectrum analyzer.

24. Our tentative conclusions on this matter notwithstanding, as a result of information submitted responding to the discussion in paragraphs 14 through 23, supra, may lead us to conclude that, at least for some stations, a more favorable public interest benefit cost comparison would result if a greater reliance were placed on the NRSC audio standard than on the emission standard. Therefore, commenters are also asked to assess the advantages and disadvantages of modifying the proposed emission limitation standard to establish a presumption that stations complying with the NRSC audio standard are also in compliance with the emission standard. We envision that under this approach the finding of presumptive compliance could be rebutted by evidence of interference to adjacent channel operations which is attributable to non-compliance with the emission standard.

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22 The proposed NRSC emission limitations would require that emissions between 10 kHz and 20 kHz be attenuated by 25 dB relative to the unmodulated carrier. Emissions between 20 kHz and 30 kHz would have to be attenuated by at least 35 dB, those emissions between 30 kHz and 60 kHz by at least 5 dB + 1 dB/kHz (removed from carrier), those emissions between 65 and 75 kHz by at least 70 dB, and those above 75 kHz by at least 80 dB below carrier level. We propose that stations be required to comply with these emission limitations beginning January 1, 1990 to coincide with the proposed implementation date suggested for mandatory use of the NRSC audio standard as requested by NAB in its petition. However, this implementation date is possible only if action in response to this Notice of Proposed Rule Making is not unduly delayed.

ELIMINATION OF THE RESTRICTIONS CONTAINED IN SECTION 73.37(b)

25. Section 73.37(a) of the Commission's Rules specifies the necessary desired-to-undesired signal contour ratios applicable to the various classes of AM stations. More particularly, it proscribes overlap of the 0.5 mV/m daytime contour of a new station by the 0.025 mV/m contour of any other co-channel station. Section 73.37(b) provides for an exception to this rule in cases where the new station would be the first AM broadcast facility in a community located outside of an urbanized area, or the first AM broadcast facility in a community of 25,000 or more population wholly or partly within an urbanized area, or when the facilities would provide the first primary service to at least 25% of the interference-free area within the proposed 0.5 mV/m contour. However, the proposed new station must meet the requirements of Section 73.37(a) in all other respects, and no overlap may occur between the the 1 mV/m contour of the proposed station and the 0.05 mV/m contour of any other co-channel station.

26. All but Class I ("clear channel") AM stations are afforded 26 dB co-channel protection to their 0.5 mV/m daytime contours. The effect of Section 73.37(b) is to fully protect the 0.5 mV/m contours of existing stations, but to permit assignment of new stations based on protection of the 1 mV/m contour. Interference between the two contours has been considered acceptable, since a substantial amount of new service would still be afforded the public.

27. It is conceivable that if applicants or licensees were free to accept a greater amount of interference than the rules now permit (while continuing to provide full protection to other stations), service to the public could be improved significantly. For example, the power of some stations currently not operating pursuant to Section 73.37(b) could be increased if they choose to afford the 26 dB protection to their 1 mV/m contours rather than their 0.5 mV/m contours. (They would be expected to continue to protect the 0.5 mV/m contours of other co-channel stations.) While interference would be accepted in some of the "expanded" service area that would normally be expected to result from the power increase, received signal levels would still be increased throughout the original service area.[23] Thus, the additional power could be useful in overcoming the effects of natural and man-made noise, and signal attenuation within larger (metallic) buildings.

28. We wish to emphasize that any power increase made possible as a result of eliminating the restrictions in Section 73.37(b) would be possible only if the 0.5 mV/m contours of other co-channel stations continue to be afforded the 26 dB protection currently provided for in the rules. Stations that could be affected by this rule change are those that currently are receiving more than 26 dB protection. Such protection, however, is the

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23 Depending upon the particular circumstances, such as the geographic location and power of the co-channel and adjacent channel stations, a significant increase in the actual service area may be possible. Power increases on the order of 10 dB may be possible in many cases.

result of fortuitous circumstances rather than by design. The listeners at or outside of these stations' 0.5 mV/m contours are likely to be few. Any marginal service such listeners currently receive must be weighed against the improved service that would be afforded to the many listeners within the service areas of the station applying for the power increase. We believe the latter is more important and it is the fundamental assumption underlying our proposal. We solicit additional comment on whether this assumption is correct, since the comments filed in response to the Notice of Inquiry on this matter were divided.

29. NAB, for example, opposed any action that would increase interference levels in the AM service. It expressed the view that permitting increased interference would make a mockery of the Commission's technical standards, and that by permitting interference beyond that currently provided by the technical standards would encourage the manufacture of receivers designed for a commensurately lower quality, higher interference environment. NAB also expressed the view that individual broadcasters should not be given the right to make a decision to accept additional interference, since their decision would affect other licensees who would suffer from the institutionalization of a lower standard of quality.

30. However, GSM Media Corporation ("GSM") disagreed with this view. It noted that the extra power would enable AM service to better penetrate buildings and overcome atmospheric and man-made noise. Hence, populated areas near the station would gain improved reception. GSM also expressed the belief that relaxation of Section 73.37(b) could allow stations to maintain more stable radiation patterns, since many stations now have highly suppressed patterns designed to prevent now-forbidden overlaps between the station's protected contour and another station's interfering contour. GSM also supported the Commission's view that while a new area of predicted interference would be created, it would occur in areas not previously served, and that there would be a net gain in interference-free service area. Lastly, GSM proposed that Section 73.37(b) be modified to allow licensees, by mutual agreement, to increase radiation toward each other by accepting interference up to their 1.0 mV/m contours, but without causing interference to existing service areas.[24]

31. After reviewing these and other arguments submitted in response to the Notice of Inquiry, it is our tentative belief that significant benefits for AM licensees and their listeners could result from giving applicants for new and modified facilities some latitude as to the amount of interference they would receive in the new or expanded portion of their proposed service areas, so long as interference is not increased for other

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24 We believe the issue of negotiated interference rights is sufficiently complicated and controversial as to warrant its separate treatment in a later phase of this proceeding. Therefore, we intend to defer consideration of any such proposals at this time.

stations.[25] Accordingly, we propose to amend Section 73.37(b) as set forth in Appendix A to generally permit licensees to seek an increase in station power, provided: that the 0.5 mV/m contours of other co-channel facilities, and the relevant contours of adjacent channel facilities, would continue to be protected in accordance with the requirements of Section 73.37(a); and that the 1.0 mV/m contour of the proposed facility is not overlapped by the 0.05 mV/m contour of any other co-channel authorized facility.[26]

32. The rule changes proposed herein have been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection, and/or record keeping, labeling, disclosure, or record retention requirements; and will not increase or decrease the burden hours imposed on the public.

COMMENT PROCEDURE

33. Under procedures set out in Section 1.415 of the rules and regulations, 47 CFR §1.415, interested persons may file comments on or before November 22, 1988 and reply comments on or before December 22, 1988. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. In reaching its decision, the Commission may take into consideration information and ideas not contained in the comments, provided that such information or a writing indicating the nature and source of such information is placed in the public file, and provided that the fact of the Commission's reliance on such information is noted in Report and Order.

34. In accordance with the provisions of Section 1.419 of the Rules and Regulations, 47 CFR §1.419, formal participants shall file an original and 5 copies of their comments and other materials. Participants wishing each Commissioner to have a personal copy of their comments should file an original and 11 copies. Members of the general public who wish to express their comments are given the same consideration, regardless of the number of copies submitted. All documents will be available for public inspection during

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25 We wish to emphasize that the scope of our proposal in this regard is narrow in that it does not contemplate authorizing an established station to accept interference within the geographic area defined by its existing service contour (normally 0.5 mV/m), if that interference results from a change in another station's facilities.

26 The change we are proposing herein merely removes some restrictive language in §73.37(b) relating to eligibility and service. It does not change any technical criteria. We solicit comment as to whether we should revise the contour values specified in §73.37(b)(2) and in particular to examine whether higher value contours would be more appropriate. Commenters are also asked to address the desirability of granting waivers of the interference acceptance prohibition under certain conditions, and what criteria the Commission might use in evaluating the requests for such waivers.

regular business hours in the Commission's Public Reference Room at its headquarters in Washington, D.C.

EX PARTE CONSIDERATIONS

35. For purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that ex parte presentations are permitted except during the Sunshine Agenda period. See, generally, Section 1.1206(a) of the Commission's Rules. The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission: (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or, (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. During the Sunshine Agenda period, no presentation, ex parte or otherwise, are permitted unless specifically requested by the Commission or staff for clarification or adduction of evidence, or the resolution of issues in the proceeding (see Section 1.1203).

36. In general, an ex parte presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which: (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. See Section 1.1202(b) of the Commission's Rules. Any person who submits a written ex parte presentation must provide on the same day it is submitted, a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral ex parte presentation that presents data or arguments not already reflected in that person's previously filed written comments, memoranda or filings in the proceeding, must provide on the day of the oral presentation, a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and statements. Each ex parte presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates (see Section 1.1206).

ORDERING CLAUSE

37. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis ("IFRA") of the expected impact on small entities of the proposals advanced herein. Written public comments are requested on the IFRA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the Notice, but they must have a separate and distinct heading designating them as responses to the regulatory flexibility analysis. The copy shall order that a copy of the Notice, including the initial regulatory flexibility analysis, be sent to the Chief Counsel for Advocacy of the Small Business Administration, as required by Section 603(a) of the Regulatory Flexibility Act (Pub. L. No. 96-354, 94 Stat. 1164, 5 U.S.C. Section 601 et seq., (1981)).

38. Further information on this matter may be obtained from Hank VanDeursen, Mass Media Bureau, Engineering Policy Branch, (202) 632-9660.

FEDERAL COMMUNICATIONS COMMISSION

H. Walker Feaster, III
Secretary

Attachments: Appendices A, B and C.

APPENDIX A

47 CFR 73 is proposed for modification as follows:

1. In Section 73.37, subparagraph (b) would be amended to read as follows:

Section 73.37 Applications for broadcast facilities, showing required.

* * * * *

(b) An application for a new daytime station or a change in the daytime facilities of an existing station may be granted notwithstanding overlap of the proposed 0.5 mV/m contour by the 0.025 mV/m contour of another co-channel station, provided that:

(1) * * *

(2) * * *

* * * * *

2. Section 73.44 would be replaced in its entirety to read as follows:

Section 74.44 Emission Limitations.

Effective January 1, 1990, the emissions of stations in the AM service shall be attenuated in accordance with the requirements specified in subsection (a) of this Section. Emissions shall be measured using a suitable swept-frequency RF spectrum analyzer using a 300 Hz resolution bandwidth, a peak hold duration of 10 minutes, and no video filtering. Alternatively, other specialized receivers or monitors with appropriate characteristics may be used to determine compliance with the provisions of this section; provided that any disputes over measurement accuracy are resolved in favor of measurements obtained by using a calibrated spectrum analyzer adjusted as set forth above.

(a) Emissions 10 kHz to 20 kHz removed from the carrier must attenuated at least 25 dB below the carrier level, emissions 20 kHz to 30 kHz removed from the carrier must attenuated at least 35 dB below the carrier level, emissions 30 kHz to 60 kHz removed from the carrier must attenuated at least [5 + 1 dB/kHz] below carrier level, emissions between 60 kHz and 75 kHz of the carrier frequency are attenuated at least 65 dB below carrier level, and emissions removed by more than 75 kHz must be attenuated at least 80 dB below carrier level.

APPENDIX B

Summary of proposed technical parameters

Current emission limitations

(Attenuation below carrier):

Carrier to 15 kHz: 0 dB
15 kHz to 30 kHz: -25 dB
20 kHz to 75 kHz: -35 dB
more than 75 kHz: -[43 + 10 Log P] dB or -80 dB (lesser attenuation)

Proposed emission limitations:

(Attenuation below carrier):

Carrier to 10 kHz: 0 dB
10 kHz to 20 kHz: -25 dB
20 kHz to 30 kHz: -35 dB
30 kHz to 60 kHz: -[5dB + 1 dB/kHz] (see Note 1)
65 kHz to 75 kHz: -70 dB
more than 75 kHz: -80 dB

Note 1: (e.g., -40 dB at $\pm$ 35 kHz, -70 dB at $\pm$ 65 kHz)

Proposed audio standard:

(Attenuation below 1 dB above 90% modulation):

10.0 kHz to 10.5 kHz: -[15 + 30 unit/kHz] dB (see Note 2)
10.5 kHz to 11.0 kHz: -30 dB
11.0 kHz to 15.0 kHz: -[40 + 2.5 unit/kHz] dB (see Note 3)
above 15 kHz: -50 dB

Note 2: unit = displacement from 0 (in kHz) minus 10 kHz

Note 3: unit = displacement from 0 (in kHz) minus 11 kHz

Maximum pre-emphasis

+10 dB at 10 kHz (referenced to 0 dB at 0 kHz)

Single zero curve with break frequency = 2122 Hz pre-emphasis and single pole with break frequency = 8700 Hz de-emphasis.

APPENDIX C

Initial Regulatory Flexibility Act Analysis

I. Reason for Action

The proposed action is intended to alleviate technical shortcomings characteristic of the AM broadcast service in an effort to make it more competitive with alternative audio delivery services (principally, the FM radio service).

II. Objectives

The objectives of this proceeding are to adopt a new emission limitation that is intended to reduce the second and third adjacent channel interference to AM broadcast stations, and to relax rules prohibiting overlap of the 0.5 mV/m AM station daytime signal contour, provided that no additional interference would be caused to other stations.

III. Legal Basis

The action taken by this Notice is authorized by Sections 4(i) and (j), 302, 303 and 403 of the Communications Act of 1934, as amended.

IV. Description, Potential Impact and Number of Small Entities Affected

The action proposed in this proceeding would benefit nearly 5,000 AM broadcast station licensees by reducing second and third adjacent channel interference. The cost of modifying transmitters to comply with the new emission standard may be on the order of several hundred dollars per station. Costs associated with an increase in station power are unknown, but would be incurred entirely on a voluntary basis.

V. Recording, Record Keeping and Other Compliance Requirements

None.

VI. Federal Rules which Overlap, Duplicate or Conflict with this Rule

None.

VII. Any Significant Alternative Minimizing Impact on Small Entities and Consistent with the Stated Objectives

None.

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This is an unofficial announcement of Commission action. Release of the full text of a Commission order constitutes official action. See MCI v. FCC. 515 F 2d 385 (D.C. Circ. 1975)

Report No. DC-1261 ACTION IN DOCKET CASE October 13, 1988

FCC PROPOSES RULE CHANGES TO ENHANCE NIGHTTIME OPERATIONS BY AM STATIONS, IMPROVE SKYWAVE AND GROUNDWAVE FIELD STRENGTH CALCULATIONS, AND REVISE METHODS FOR CALCULATING NIGHTTIME PROTECTION FOR AM STATIONS (MM DOCKETS 88-508, 88-509, 88-510, AND 88-511)

In four separate actions, the Commission has proposed changes to its rules to facilitate enhancement of nighttime operations by AM stations (Class II, Class III, Class II-S, and Class III-S), to improve methods for calculating skywave and groundwave field strength in the AM broadcast band, and to review the methods of calculating nighttime protection for AM stations.

First, the Commission proposed allowing Class II-S and Class III-S AM stations to establish a separate nighttime antenna system without having to meet the minimum power, city coverage or minimum operating schedule requirements that otherwise would apply to such a change in their nighttime operations. Comments were also solicited concerning permitting full service Class II and Class III stations to voluntarily reduce power below minimum power of 250 watts. Class III-S stations are full-time stations on regional channels operating below minimum power at night. Class II-S stations operate on a like basis on clear channels. This item is part of the FCC's continuing efforts to alleviate the severe problems faced by daytime-only stations because of their inability to operate during nighttime hours.

On August 17, 1987, the FCC initiated an inquiry to provide a comprehensive review of the technical principles pertaining to AM broadcast assignment criteria and to identify any needed changes to better enable AM stations to compete effectively in the marketplace and thereby better serve the public. The other three rulemaking actions taken by the Commission are an outgrowth of the inquiry.

Second, the FCC proposed replacing the existing AM broadcast skywave propagation curves with a new propagation model recently developed. The new model results from recent scientific analysis of skywave measurement data that provides a better understanding of field strength in the AM service, providing a more accurate depiction of the service and interference relationships between AM stations. The new skywave propagation model lends itself to easy computerization and using such a computerized approach ensures accuracy.

(over)

Third, the FCC proposed replacing the existing groundwave propagation curves with new curves recently developed. The new curves are derived from analytical techniques that overcome mathematical deficiencies associated with the existing curves. Use of the new curves will provide a more accurate depiction of groundwave service and interference in the AM braodcast band.

Lastly, the fourth rulemaking notice proposed revisions to the methods used for calculating the protection to be afforded nighttime service of AM stations. Specifically, the Commission proposed modifying its rules that relate to the calculation of nighttime RSS (root-sum-square) skywave interference levels to the protected groundwave contours of Class II and Class III AM broadcast stations and the skywave service contours of Class I clear channel stations. It also asked for comments on including adjacent channel skywave signals in such calculations.

Actions by the Commission October 13, 1988, by Notices of Proposed Rulemaking (FCC 88-324, FCC 88-325, FCC 88-326, and FCC 88-327). Commissioners Patrick (Chairman), Quello and Dennis.

-FCC-

News Media contact: Audrey Spivack or Bonnie Gay at (202) 632-5050

Mass Media Bureau contacts: Diane Hofbauer at (202) 254-3394 (Class II-S and III-S), Wilson LaFollette at (202) 632-5414 (Calculating AM nighttime protection), and Larry Olson at (202) 632-6955 (Groundwave and skywave calculations)

AM 11.
9/29/88

FEDERAL COMMUNICATIONS COMMISSION RULES - PART 0

0.121 LOCATION OF FIELD INSTALLATIONS.

EDITOR'S NOTE: Section 0.121 has been so completely revised as of August 2, 1988, that the previous wording is not shown.

(a) Field offices are located throughout the United States. For the address and phone number of the closest office contact the Field Operations Bureau or see the U.S. Government Manual.

(b) Protected field offices are located at the following geographical coordinates:

Allegan, Michigan
42</d>36'20" N. Latitude
85</d>57'20" W. Longitude

Anchorage, Alaska
61</d>09'43" N. Latitude
149</d>59'55" W. Longitude

Belfast, Maine
44</d>26'42" N. Latitude
69</d>04'58" W. Longitude

Canandaigua, New York
42</d>54'48" N. Latitude
77</d>15'59" W. Longitude

Douglas, Arizona
31</d>30'02" N. Latitude
109</d>39'12" W. Longitude

Ferndale, Washington
48</d>57'21" N. Latitude
122</d>33'13" W. Longitude

Grand Island, Nebraska
40</d>55'21" N. Latitude
98</d>25'42" W. Longitude

Kingsville, Texas
27</d>26'29" N. Latitude
97</d>53'00" W. Longitude

Laurel, Maryland
39</d>09'54" N. Latitude
76</d>49'17" W. Longitude

Livermore, California
37</d>43'30" N. Latitude
121</d>45'12" W. Longitude

Power Springs, Georgia
33</d>51'44" N. Latitude
84</d>43'26" W. Longitude

Sabana Seca, Puerto Rico
18</d>27'23" N. Latitude
66</d>13'37" W. Longitude

Santa Isabel, Puerto Rico
18</d>00'26" N. Latitude
66</d>22'32" W. Longitude

Vero Beach, Florida
27</d>36'21" N. Latitude
80</d>38'06" W. Longitude

Waipahu, Hawaii
21</d>22'45" N. Latitude
157</d>59'54" W Longitude

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AM ALL 12
FROM JACK
9/21/88

PUBLIC NOTICE

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1075

News media information 202/254-7674. Recorded listing of releases and texts 202/632-0002.

December 11, 1981

AM DIRECTIONAL ANTENNAS TO USE METRIC SYSTEM BEGINNING JANUARY 4, 1982

In the Report and Order in Docket No. 21473 (adopted January 29, 1981, and released February 9, 1981), the Commission amended its Rules to require that directional antenna patterns submitted on or after January 4, 1982, use units of "millivolts per meter at one kilometer" instead of "at one mile" as is the current practice. See Section 73.181(f). Also, beginning on January 4, 1982, the method of computing "Q" for standard patterns will change because of the change to the metric system. See Section 73.150(b)(1)(i).

Applications submitted prior to January 4, 1982, should continue to use units of millivolts per meter at one mile, and compute Q according to the current method. Applications which are amended should use the units in effect as of the day of submission of the amendment. Applications which are on file prior to January 4, 1982, need not be amended solely for the purpose of conversion to the metric units. Applications and amendments which are submitted using the wrong units will be returned unless they are promptly amended to use the correct units.

This change does not affect FM or TV broadcast applications. In fact, it only affects the unit of "mV/m at one mile" as used in conjunction with AM station directional patterns and does not change the use of any other units currently applicable to directional antennas such as tower heights in feet. Tower heights should continue to be specified in feet after January 4, 1982.

The Commission will be converting from "millivolts per meter at one mile" to "millivolts per meter at one kilometer" by multiplying by 1.609344. To avoid discrepancies, we suggest that all applicants also use 1.609344. Also, to avoid confusion, patterns, tabulations, etc., should be clearly labeled to show the units "mV/m at one kilometer."

- FCC - 1.609

9/13/84
13

TELEX 90 1963

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354-3350

DELTA ELECTRONICS

DELTA ELECTRONICS, INC.
5730 GENERAL WASHINGTON DR.
P. O. BOX 11268
ALEXANDRIA, VIRGINIA 22312 - 0268
U.S.A.

STEREO NOISE GENERATOR

The National Radio Systems Committee (NRSC) has included in its standard for AM radio transmission a definition of a test signal. This test signal is designed to be used instead of program material for measurement of the actual preemphasis characteristic under operating conditions as well as a more precise measurement of RF spectrum.

The test signal is pulsed USASI noise. USASI noise is white noise which has been filtered to produce a spectrum which closely resembles the audio spectrum of typical program material. The NRSC adopted a modification of USASI to include pulsing of the noise to represent the dynamics of program material so that the audio processing equipment would be more likely to vary the gain, equalization, and clipping of the test signal similar to how the equipment operates on program material.

In the NRSC standard, the noise is burst on and off at a 2.5 Hz rate with an on duration of 12.5 percent. The amount of noise during the off period is set so that the average to peak ratio of the total signal is -20 dB which is the same as typical unprocessed program material.

For stereo operation, the final NRSC specification also called for two separate USASI noise sources, cross coupled for correlation of 1.4:1. This means that L-R will be 3 dB lower than L+R.

The Stereo Noise Generator provides outputs which conform to the recommendations of the NRSC. In addition, the generator will produce white or pink noise test signals, pulsed or continuous with correlation from zero to 100 percent. This correlation represents outputs which vary from 100 percent L-R (uncorrelated) to zero L-R (L+R only, fully correlated).

The outputs are balanced or unbalanced, capable of driving 600 ohm loads to approximately a +10 dBm peak level.

In addition to measurement of the preemphasis and bandwidth of AM broadcast transmission systems, the Stereo Noise Generator provides FM and TV engineers the capability to test and adjust audio processing equipment for proper performance.

9/13/84
14.

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U.S.A.

Measures total energy
5.5 to 10 KHz
But not individual
frequencies
Looks at output modulation Monitor

PREEMPHASIS MONITOR

The National Radio Systems Committee AM broadcasting transmission standard includes several important technical specifications for the improvement of the transmission and reception of AM radio.

A very sharp low pass filter is specified for the reduction of second adjacent channel interference. The effectiveness of the filtering at a radio station can be measured with the Delta SM-1 AM Splatter Monitor. The attenuation of the audio baseband above the filter cutoff frequency can be measured by connecting a sample of the audio to the transmitter input to the SM-1 external audio input and reading the levels of the audio in the region above 11 kHz compared to the baseband audio below 11 kHz.

The most basic feature of the AM Splatter Monitor is the ability to monitor the RF spectrum of an AM station and indicate the levels of sideband attenuation out to 100 kHz removed from the carrier frequency. The maximum amplitude of RF sideband level is also specified in the NRSC standard.

Another very important feature of the NRSC standard is the maximum amount of inband preemphasis. It is very important that the level of preemphasis used by AM radio stations be made more uniform so that receiver manufacturers can confidently increase the bandwidth of their AM receivers without fear of the reception of harsh, brittle and very irritating audio from stations operating with over preemphasized audio transmission.

Currently, receiver manufacturers have been able to produce excellent sounding AM stereo receivers with bandwidths approaching 6 dB down at 6 kHz. This is about as wide as AM stereo receivers have been made by high volume receiver manufacturers. It is the critical region between about 6 kHz and 10 kHz where there continues to be wide variations in treble response among AM radio stations. The purpose of the Preemphasis Monitor is to provide a convenient means for broadcasters to monitor their transmissions on those frequencies to determine if they conform to the NRSC transmission standard.

PREEMPHASIS MONITOR

The Federal Communications Commission has adopted a Notice of Proposed Rulemaking which seeks industry comment on making the NRSC standard part of the FCC regulations. Parts or all of the NRSC standard may become regulation which would be enforced by the FCC. If this came to be, broadcasters would then be required to maintain their AM broadcast transmissions in conformance with the FCC regulations. The Preemphasis Monitor and the Delta SM-1 AM Splatter Monitor are designed specifically to provide indications of technical parameters to determine if stations' transmissions are within the NRSC standard.

The Preemphasis Monitor operates by measuring the level of audio in the region below 1.5 kHz and comparing it with the level of audio in the region above 5.5 kHz. This is done by filtering, detecting the audio in these bands and applying a very linear DC signal proportional to the energy in these bands to logarithmic amplifiers. This essentially converts the audio amplitude to dB. The outputs of the two log amplifiers are compared and the resulting difference signal drives a bargraph display.

The display is arranged for an approximate 30 dB range allowing observations of preemphasis from 10 dB below flat response to full preemphasis (approximately 10 dB above flat response) to preemphasis levels which are as much as 10 dB higher than the standard (20 dB above flat response).

The monitor is calibrated by monitoring pulsed USASI noise both unpreemphasized and preemphasized through the standard NRSC preemphasis filter. Pulsed USASI noise is the test signal recommended by the NRSC for precise measurement of the preemphasis and bandwidth of AM broadcast transmission systems. In the NRSC standard, the noise is burst on and off at a 2.5 Hz rate with an on duration of 12.5 percent. The amount of noise during the off period is set so that the average to peak ratio of the total signal is -20 dB which is the same as typical unprocessed program material. The Delta Stereo Noise Generator provides outputs which conform to the recommendations of the NRSC. In addition, the generator will produce white or pink noise test signals, pulsed or continuous with correlation from zero to 100 percent.

The Preemphasis Monitor is also useful for general observations of the high frequency content of AM, FM and TV transmissions. This is useful for detecting wide variations in audio response due to poor tape alignment on cart machines or excessive "essing" which would require special processing or equalization to reduce.

15-
AM.

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Report No. DC-1213 ACTION IN DOCKET CASE July 20, 1988

FCC PROPOSES IMPROVING QUALITY OF AM SERVICE BY REDUCING ADJACENT CHANNEL INTERFERENCE AND ELIMINATE PROTECTED DAYTIME CONTOUR RESTRICTIONS (MM DOCKET 88-376)

The FCC moved forward with two major technical proposals to improve the quality and coverage of AM stations as an outgrowth of its comprehensive AM improvement proceeding.

Specifically, the Commission proposed to reduce substantially interference to AM broadcast stations caused by stations operating on adjacent channels and to modify its acceptance criteria so as to permit stations to improve coverage.

On adjacent channel interference, the Commission decided that the merits of several approaches need to be fully explored. Therefore, it is seeking comment on a revised emission standard, an audio standard such as that recommended by the National Radio Systems Committee, and a combination of these.

AM stations currently are permitted to transmit a radio frequency signal with a bandwidth of up to 30 kHz. However, the majority of consumer receivers are designed with a much narrower bandwidth so as to reduce the effects of interference from adjacent channel stations. This narrow receiver bandwidth severely reduces the audio fidelity of AM reception. In an attempt to overcome this fidelity limitation, many broadcasters pre-emphasize (or "boost") the higher audio frequencies to brighten their sound. But this pre-emphasis exacerbates adjacent channel interference.

In this regard, the National Association of Broadcaster's (NAB) requested that the FCC mandate use of a new audio standard developed by the National Radio Systems Committee (NRSC). NRSC is a joint venture by NAB and the Electronic Industries Association. The NRSC audio standard would limit the maximum audio frequency to about 10 kHz and would also limit the amount of audio pre-emphasis. However, a variety of transmission system performance factors could mitigate the effectiveness of this approach.

Another approach developed by the NRSC is an RF emission limitation which would take into account all factors that would cause interference. This would offer licensees more flexibility and control over their audio signal but may be more difficult to apply on a day-to-day basis.

(over)

In the second portion of this proceeding, the FCC proposed giving AM stations the option of proposing facilities whose coverage area would be subject, in part, to some interference from other stations. Currently, such permission is granted only to the first station proposing to provide service to an unserved community. The Commission proposed allowing all stations the flexibility of accepting increased interference in a portion of new service areas provided they do not cause objectionable interference to other stations.

The FCC noted that this proposal could permit significant improvements of AM service quality. For example, the proposal would allow increases in signal strength within licensees' service contours, thereby rendering service in that area much more resistant to man-made and natural interference. While interference would be accepted in some of the expanded service area that would normally be expected to result from the power increase, the new signal strength will increase the overall coverage of the affected station.

Action by the Commission July 20, 1988, by Notice of Proposed Rulemaking (FCC 88-252). Commissioners Patrick (Chairman), Quello and Dennis.

-FCC-

News Media contact: Audrey Spivack at (202) 632-5050.
Mass Media Bureau contact: Hank VanDeursen at (202) 632-9660.

STATEMENT OF CHAIRMAN DENNIS R. PATRICK ON INCREASING QUALITY OF AM

By our action today, the Commission takes a giant step forward in our continuing commitment to improve the quality of AM radio. Our action today also demonstrates this Commission's willingness and ability to set technical standards where appropriate and necessary. So far, I am very encouraged by the preliminary technical reports of FCC engineers and the NTIA report suggesting that these standards could ensure that the public receives a first class signal on the AM band. With the cooperation and expertise of both the broadcast and electronic manufacturing industries, I'm confident that better quality AM reception will become a reality in the homes and cars of the American public.

16 AM 1605-1705 kHz

released June 1, 1988. The full text of this Commission decision is available for inspection and copying during normal business hours in the FCC Dockets Branch (Room 230), 1919 M Street NW., Washington, DC. The complete text of this decision may also be purchased from the Commission's copy contractors, International Transcription Service, (202) 857-3800, 2100 M Street NW., Suite 140, Washington, DC 20037.

Provisions of the Regulatory Flexibility Act of 1980 do not apply to this proceeding.

Members of the public should note that from the time a Notice of Proposed Rule Making is issued until the matter is no longer subject to Commission consideration or court review, all *ex parte* contacts are prohibited in Commission proceedings, such as this one, which involve channel allotments. See 47 CFR 1.1204(b) for rules governing permissible *ex parte* contact.

For information regarding proper filing procedures for comments, See 47 CFR 1.415 and 1.420.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Federal Communications Commission.

Steve Kaminer,

Deputy Chief, Policy and Rules Division, Mass Media Bureau.

[FR Doc. 88-14027 Filed 6-21-88; 8:45 am]

BILLING CODE 6712-01-M

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47 CFR Part 73

[Gen. Docket No. 84-467; FCC 88-72]

Radio Broadcasting Services; Expanded Band (1605-1705 kHz)

AGENCY: Federal Communications Commission.

ACTION: Fourth notice of inquiry.

SUMMARY: In response to the upcoming Second Session of the Administrative Radio Conference (RARC-88) on the use of the expanded AM band from 1605 kHz to 1705 kHz, the Commission adopted the *Fourth Notice of Inquiry*. The inquiry was commenced in order to develop a record for the domestic implementation of broadcasting in the 1605-1705 kHz band. This will foster the earliest possible introduction of broadcasting in the expanded band and thus be in keeping with the Commission's commitment to use this newly available broadcast spectrum promptly and efficiently.

DATES: Comments may be filed with the Secretary of the Commission no later than July 11, 1988; and reply comments no later than July 26, 1988.

ADDRESS: Federal Communications Commission, Washington, DC 20554.

FOR FURTHER INFORMATION CONTACT: Freda Lippert Thyden, Policy and Rules Division, Mass Media Bureau (202) 254-3394; and John Boursy, Audio Services Division, Mass Media Bureau (202) 634-6315.

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's *Fourth Notice of Inquiry*, in Gen. Docket No. 84-467, FCC 88-72, adopted February 25, 1988, and released June 3, 1988.

The full text of this Commission document is available for inspection and copying during normal business hours in the FCC Dockets branch (Room 230), 1919 M Street, NW., Washington, DC. The complete text of this *Fourth Notice of Inquiry* may also be purchased from the Commission's copy contractor, International Transcription Services, (202) 857-3800, 2100 M Street, NW., Washington, DC 20037.

Summary of the Fourth Notice of Inquiry

1. In order to develop a record for the domestic implementation of broadcasting in the 1605-1705 kHz band, the Commission adopts this *Fourth Notice of Inquiry*. This inquiry is commenced now rather than waiting until the completion of the Second Session of RARC-88, which is to take place in Rio de Janeiro, Bazil, from May 23 through June 9, 1988, to foster the earliest possible introduction of broadcasting in the expanded band. Through the record developed in response to this *Notice*, it is likely that the Commission will be able to formulate specific rulemaking proposals in line with the results of RARC-88. Deferring inquiry on domestic issues until the Second Session is concluded could only delay this process. Finally, discussing these issues now will send a clear signal to receiver manufacturers that the Commission intends to move expeditiously on this matter, a step which should encourage the early design and production of new receivers.

2. In considering domestic implementation of the expanded band, there are a large number of specific issues that must be analyzed. However, there is one central issue whose determination will affect many other interrelated issues. The basic question is whether we should use a regulatory scheme that is quite similar to that which applies to the existing AM band, or whether we should adopt a fundamentally different regulatory scheme. Also, as a third option, it is possible to adopt a new regulatory scheme for some of the expanded band channels and to use the more traditional scheme for the remaining expanded band channels. Thus, we are led to consider a national licensing approach under which, if adopted, licensees could be granted a nationwide license to operate on a particular frequency in the expanded AM band. Under such a plan, licensees would be free to construct and operate as few or as many AM operations as they wished. For example, licensees mighty choose to construct a small number of 10 kW operations spaced relatively far apart throughout the country, or a larger number of 250 watt or 1 kW operations located in a larger number of places. Moreover, the licensee could decide how close to locate operations to each other, since the licensee, not the Commission, would determine the acceptable level of interference between its own operations conducted on the same frequency. Licensees would have an economic incentive to choose that combination of operations that generated the largest advertising revenues or operation profits and hence would likely be the combination of operations that provided the most valuable set of services to consumers or listeners.

3. We are aware that this proposal represents a substantial departure from the regulatory approach that we have used with respect to the existing AM band. However, we believe that there are a number of factors that may support its use. First, we note that there are currently a large number of radio stations licensed in the U.S. yet AM stations have not been doing as well as FM stations when comparisons are made based upon station profits, revenues, station sales prices or audience ratings. Hence, it may be desirable to consider a new approach that might well encourage further growth of the AM band, and especially the use of the expanded AM band to provide those services most valued by listeners. In considering which licensing approach to apply, we must also consider section 307(b) of the Communications Act. We solicit comment as to whether section 307(b) requires us to make detailed, individualized determinations with respect to every radio facility we authorize. In this regard, we request comment on the applicability of this statutory provision to the proposed national licensing scheme.

4. Licensees might find that there are a variety of advantages from obtaining a national license—advantages which would redound to the benefit of listeners. In particular, there may be

efficiency advantages in the acquisition and distribution of programs as well as in the purchasing of radio advertisements by national licensees. To the extent that such efficiencies allow a station to operate at lower costs, not only the station but also its listeners are likely to benefit. Also, we believe that the concept of nationwide licensing of the expanded AM band may provide a spur to the development of receivers capable of receiving the signals on the full expanded AM band.

5. Although a national licensee might choose to assume full responsibility for establishing all the stations on a channel, it also might prefer to play a coordinating role, allowing others a role in station operation. We need to consider whether to allow operation by other entities which is coordinated through the national licensee or other steps to promote optimum use. If the "national licensing" approach is adopted, in whole or in part, as the procedure to govern the licensing of the expanded band, criteria will need to be developed for establishing basic qualifications of a national licensee. This may be of particular importance if there are mutually exclusive applications. Thus, we need to address what financial, legal and technical criteria should be utilized for establishing the eligibility of an applicant to be a national licensee. Also related to eligibility critieria is the question of what to do with those Travelers Information Stations currently operating on 1610 kHz once broadcasting has been implemented on the expanded AM band.

6. If the Commission were to adopt the national licensing plan on all of the expanded band channels, there would be no need to adopt many of the technical rules necessary if a traditional licensing approach is adopted. Provisions concerning such matters as domestic co-channel interference would not be required. However, if any or all expanded band channels are licensed in the traditional mode, technical rules providing for station classes, protected contours and concerning other like matters will be necessary.

7. In regard to technical standards, the Commission has proposed to treat the expanded band as an extension of the existing AM band rather than as a separate part of the spectrum. We believe that this would foster the early development of transmitters and receivers for the expanded band and therefore aid its prompt and effective use. Many of the fundamental parameters are those adopted at the First Session of the Expanded Band Conference and which are expected to be incorporated in the Technical Annex to the Agreement to be adopted at the Second Session. Under these circumstances, we do not believe that it is desirable or practical to vary them domestically. However, certain parameters can be varied domestically, providing that there is no conflict with international requirements.

8. When the expanded band becomes available for broadcast use it can be treated as new spectrum. We wish to adopt processing procedures which will ensure that it is used effectively and efficiently. Subsidiary concerns include treating applicants fairly and ensuring that Commission resources are not overwhelmed by an avalanche of applications. We have every expectation that these goals can be fulfilled.

9. Internationally, the U.S. supported the allotment approach to the expanded band usage rather than the assignment method. Region 2 countries agreed, and at the First Session of the Expanded Band Conference, the allotment planning method was adopted. Under an assignment plan, an assignment for each station is entered into the plan with a specific location, power and other pertinent characteristics, whereas an allotment plan makes designated frequencies available for use anywhere within a specified area. At this stage in the proceeding, it is appropriate to inquire into whether an allotment system or assignment system should govern the domestic implementation of the expanded band, assuming that national licensing is not adopted on at least some channels.

10. The primary benefit of the allotment approach is organized planning for the future. The allotment approach allows consideration of the spectrum as a whole, rather than looking at it on a case-by-case basis. With assignments, the spectrum could be filled up quickly on a first-come, first-serve basis, meeting short-term needs, but with little or no regard for long-term requirements. What may appear to be efficient and desirable in individual cases may turn out to have an adverse impact on overall spectrum use. The allotment approach might also be a worthwhile alternative to national licensing. Allotments could be made for a large area, such as a region, rather than for individual communites, thereby permitting more than one station to be established in an allotment area. This could provide some of the same efficiencies of service and other positive traits of national licensing while being more limited in its reach.

11. Desirable as the allotment approach may seem at first impression, there are significant problems with its implementation. First, it is difficult to develop a method of predicting future needs. Also, the many technical variables in AM broadcast make allotments difficult to work with. Many of the benefits of the assignment approach resolve the deficiences of the allotment approach. When the actual antenna site, conductivities, and directional antenna pattern can be adjusted precisely in an individual case, it is often possible to squeeze in a station where the allotment approach would preclude it. Also to be considered is whether "national licensing" is consistent with one or both of these planning methods.

12. The subject of negotiating interference rights should be considered by commenters. Where there are opportunities for *new* AM stations, and these are limited, the current interference standards place severe additional restrictions on commencement of such service and may well limit service to areas with newly developed population centers. Likewise, the rigid application of interference limitations may prevent opportunities for expanded band licensees to obtain greater interference protection so as to more effectively compete with other stations and it can necessitate unnecessary levels of protection against interference in areas not actually being served. As it would be impossible, as well as inappropriate to attempt to administratively remedy such interference situations, we wish to examine the relative advantages of allowing the matter of interference protection to be resolved through private agreements between affected broadcasters.

13. Regardless of the procedure utilized by the Commission to implement the expanded band, those wishing to operate expanded band stations will be required to file an application. We tentatively believe that a processing system consisting first of a one-time filing period, to be followed by a "first come first served" procedure would meet the objectives of essential fairness and reduce any potential processing delays. Also, to avoid administrative delay in processing applications, we believe it advisable to explore the imposition of a cap on the number of applications any one entity may file in this newly available broadcast spectrum.

14. In mutually exclusive application situations where different communities of license are involved, to meet section

307(b)'s requirements, a comparative hearing is held to determine which proposed community of license has a greater need for the broadcast outlet. In order to determine this, a detailed examination is made as to the need of each applicant's proposed service area for additional reception and transmission services. Once it has been determined which mutually exclusive proposal would result in the most effective use of that frequency, a section 307(b) preference is given to the applicant proposing that community. This preference can be dispositive of a comparative hearing. In view of the many AM stations (4,867) already operating, we question whether we should apply this traditional approach to section 307(b) to the licensing of stations in the expanded band. Should section 307(b) be applied in a different way considering today's marketplace with its abundance of services? For example, we might consider regions of the country rather than individual communities with regard to licensing on the expanded AM band.

15. Selecting among mutually exclusive applicants for new broadcast stations has posed a continuing problem for the Commission. Comparative hearings, in which applicants are evaluated by numerous complicated criteria, are lengthy and expensive. As the Commission is commited to prompt and effective use of the expanded band, the question arises as to whether some procedure other than oral comparative hearings can be utilized for selecting licensees for stations in the expanded band. Specifically, should the Commission consider alternatives to an oral hearing such as a paper hearing or a lottery procedure pursuant to section 309(i) of the Communications Act?

16. The goal of the Commission is a more dynamic and robust AM service fully responsive to the needs of the listening public. Yet, the state of AM broadcasting today is problematic. In terms of revenues/profits, audience/ratings and station sale prices, AM broadcasting has declined, while its FM aural broadcasting counterpart has grown. We need to keep the current state of AM broadcasting in mind when developing the various aspects of the regulatory scheme for the expanded band. This is particularly important in the area of multiple ownership. Rather than impose the same regulatory constraints that have restricted broadcasters in the 535–1605 kHz band, we recognize the possibility that our multiple ownership regulations could adversely inhibit the establishment of stations in the expanded AM band and thereby limit service to the public. Indeed, if the Commission were to adopt the proposal for nationwide licensing within all or part of the expanded AM band, it seems that it would not be appropriate to apply the 12 station limit (§ 73.3555(d)(1)) to such national licensees. Only by allowing these licensees the freedom to locate as many or as few stations as they wished anywhere throughout the U.S. would they truly have the ability to decide for themselves what appeared to be the most efficient distribution of those stations.

17. Even if we decide not to adopt a national licensing scheme, we believe it would still be appropriate to consider a temporary waiver of the national ownership rules for some period of time, such as five years, with respect to AM stations operating in the expanded band. Because we wish to encourage entry into that band, we believe it may be desirable to place a few limitations on entry as possible. Considering the large numbers of AM and FM stations which operate throughout the country, the possibility that even a nationally licensed entity could exert any significant amount of market power in any local radio market or even throughout the country seems remote. Furthermore, there seems to be even less reason to be concerned if individual rather than national licensing is the procedure adopted.

Authority Citation

18. Authority for the action taken is contained in sections 4(i), 303(r), 307(b) and 403 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303(r), 307(b) and 403.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Federal Communications Commission.

H. Walker Feaster III,

Acting Secretary.

[FR Doc. 88–13994 Filed 6–21–88; 8:45 am]

BILLING CODE 6712-01-M

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47 CFR Part 73

[MM Docket No. 88–237, RM–6130]

Radio Broadcasting Services; Joshua Tree, CA

AGENCY: Federal Communications Commission.

ACTION: Proposed rule.

SUMMARY: This document requests comments on a petition filed by Craig L. Fox, seeing the allotment of Channel 221A to Joshua Tree, California, as that community's first local broadcast service.

DATES: Comments must be filed on or before July 22, 1988, and reply comments on or before August 8, 1988.

ADDRESS: Federal Communications Commission, Washington, DC 20554. In addition to filing comments with the FCC, interested parties should serve the petitioner, as follows: Craig L. Fox, 1213 Madison Street, Syracuse, NY 13210–2027.

FOR FURTHER INFORMATION CONTACT: Nancy Joyner, Mass Media Bureau, (202) 634–6530.

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's Notice of Proposed Rule Making, MM Docket No. 88–237, adopted April 29, 1988, and released May 31, 1988. The full text of this Commission decision is available for inspection and copying during normal business hours in the FCC Dockets Branch (Room 230), 1919 M Street, NW., Washington, DC. The complete text of this decision may also be purchased from the Commission's copy contractors, International Transcription Service, (202) 857–3800, 2100 M Street, NW., Suite 140, Washington, DC 20037.

Provisions of the Regulatory Flexibility Act of 1980 do not apply to this proceeding.

Members of the public should note that from the time a Notice of Proposed Rule Making is issued until the matter is no longer subject to Commission consideration or court review, all *ex parte* contacts are prohibited in Commission proceedings, such as this one, which involve channel allotments. See 47 CFR 1.1204(b) for rules governing permissible *ex parte* contact.

For information regarding proper filing procedures for comments, See 47 CFR 1.415 and 1.420.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Federal Communications Commission

Steve Kaminer,

Deputy Chief, Policy and Rules Division, Mass Media Bureau.

[FR Doc. 88–14014 Filed 6–21–88; 8:45 am]

BILLING CODE 6712-01-M

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	]	
	]	
Review of Technical	]	MM Docket No. 87-267
Assignment Criteria	]	
for the AM Broadcast	]	
Service.	]	

COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS ON SECTIONS I AND IV OF THE NOTICE OF INQUIRY

National Association of Broadcasters
1771 N Street, N.W.
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Barry D. Umansky
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June 17, 1988

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Appendices:

Appendix A	"AM Technical Assignment Criteria, An Examination of Issues Raised in MM Docket No. 87-267," by Harrison J. Klein, P.E., June 17, 1988.
Appendix B	"AM Radio Interference Study, Final Report, MM Docket No. 87-267," by B. Angell And Associates, Inc., June 1988.
Appendix C	Tape Index, B. Angell AM Radio Interference Study

SUMMARY

In these comments on the two remaining sections of the Commission's Notice of Inquiry, the National Association of Broadcasters reiterates its view that the Commission should promptly begin rule making proceedings to improve the quality of -- and reduce the interference on -- the AM broadcast band. In the context of this proceeding, we can think of no more urgent technical activity for the Commission. In order to aid the Commission in this task, NAB has submitted with this filing two in-depth reports. The first is a technical analysis of the issues raised in the proceeding; the second is an audience listening study examining the tolerance of contemporary AM listeners to co-channel and first adjacent channel AM interference.

The results of these studies emphasize the need for the Commission to revise many of its AM technical standards. Indeed, NAB's studies provide several of the tools with which the Commission can pursue this task. Because of the need to examine further the results of these studies, especially in conjunction with our review of other parties' comments on this phase of the inquiry, NAB has not offered specific details on how these technical standards should be revised. However, we intend to provide additional guidance for the Commission in Reply Comments to be submitted later this summer.

As fundamental principles of AM allocations policy, NAB believes that the public interest is best served when the Commission's technical standards accurately predict coverage and interference. We believe that accurate technical standards best serve the interests of the AM industry as a whole. These technical standards should be rooted in the subjective expectations of AM service quality held by the listening public. Finally, the outcomes of these proceedings should be applied to future AM allocations in the expanded AM band, 1605-1705

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	]	
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Review of Technical	]	MM Docket No. 87-267
Assignment Criteria	]	
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Service.	]	

COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS ON SECTIONS I AND IV OF THE NOTICE OF INQUIRY

The National Association of Broadcasters ("NAB")[1] hereby submits its comments pursuant to Section 1.415 et seq. of the Commission's Rules, in response to the Notice of Inquiry ("Notice")[2] in the above-captioned proceeding.

A. INTRODUCTION AND SUMMARY

On February 1, 1988, NAB filed comments in response to Sections II and III of the Commission's Notice.[3] We challenged the premise underlying many of

[1]NAB is a nonprofit incorporated association of radio and television broadcast stations and networks. NAB membership includes more than 5000 radio stations, 960 television stations and the major commercial broadcast networks.

[2]Notice of Inquiry in MM Docket No. 87-267, FCC 87-245, 2 FCC Rcd 5014 (1987).

[3]In response to a "Motion for Extension of Comment and Reply Comment Dates" submitted by NAB on December 1, 1987, the Commission, on December 15, 1987, released an Order Granting Motion for Extension of Time for Filing Comments and Reply Comment (DA 87-1823). NAB's Motion referred to our undertaking of major technical and audience perception studies that would be relevant to many of the issues raised in the Commission's Notice. In its Order, the Commission decided to bifurcate the inquiry in terms of the deadlines for the submission of comments on particular issues. The Commission decided to require comments on February 1, 1988 on Sections II and III of the Notice (dealing with "additional assignment considerations" and "related technical issues," respectively). It deferred the comment date on Sections I and IV (dealing with "technical assignment principles" and "antenna systems," respectively) to today.

the proposals embodied in the Notice -- that the Commission should provide enhanced opportunities for new stations and expansion of existing operations as well -- all of which, without accurately defined technical standards, would contribute significantly to the levels of intolerable interference now experienced by AM radio listeners. We also urged the Commission to revise its AM technical standards and policies to ensure less interference on the band.

Today we reaffirm our position on these "phase one" issues. As described in more detail below, in the Comments submitted today we offer significant evidence that the Commission's current technical standards fail to depict with accuracy the levels of interference actually experienced by AM listeners. Interference levels predicted by current FCC methods and protection ratios simply do not reflect what listeners hear and in many cases, are forced to suffer. Application of FCC standards to a particular AM station significantly overestimates that station's actual coverage. What matters to the public's interest in receiving the AM station of choice is not what is estimated by FCC rules but what is experienced by listening to the AM band.

For these reasons, NAB strongly urges the Commission to establish AM interference standards and calculation methods that more precisely characterize AM coverage and interference. We are providing two comprehensive studies in the record of this proceeding. These studies will enable the industry and the Commission to assess the current state of the AM band and to recommend specific strategies for technical improvement. The first study, included as Appendix A, is entitled "AM Technical Assignment Criteria: An Examination of Issues Raised in MM Docket No. 87-267," conducted by Harrison Klein of the consulting engineering firm of Hammett & Edison (hereinafter referred to as the "Klein Report"). The Klein Report's specific conclusions will be discussed later in these

comments as they are relevant to specific questions posed by the Notice. In brief, the Klein Report analyzed the relationship among factors such as atmospheric and man-made noise, minimum usable field strength, co-channel and adjacent channel protection ratios, and RSS methods for calculating interference at night. The Klein Report also develops computer programs for use by interested parties in designing AM allocation criteria.[4]

NAB's second study, included as Appendix B, is entitled "AM Radio Interference Study" prepared by B. Angell and Associates, Inc. (hereinafter referred to as the Angell Study). This study examined the tolerance of AM listeners to co-channel and first adjacent channel AM interference for both wide and narrow receiver bandwidths.[5] At Appendix C is a description of the sound samples played for those listeners who participated in the five-city study.[6]

The Commission, in several parts of the Notice, references the need for, and relevance of, subjective listening studies.[7] We funded the Angell Study to help the Commission and industry understand what the listening public expects of AM radio service quality. The scope of the Angell Study and its methodology were given public scrutiny by the Commission's Advisory Committee on Radio

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[4]With these Comments NAB has provided the Commission with copies of the entire Klein Report. While NAB has no plans to file the computer programs in the record of this proceeding, copies of the program diskettes and the complete Klein Report are available from NAB Station Services, (202) 429-5373 for $75.00 (NAB members) and $100.00 (non members).

[5]Respondents listened to an audio bandwidth of 9 kHz for the "wide" bandwidth receiver and 6 kHz for the "narrow" bandwidth. While these bandwidths generally are wider than many receivers now in the marketplace, our experience with participating receiver manufacturers in the National Radio Systems Committee (NRSC) leads us to believe that these bandwidths are likely to become much more prevalent in the future.

[6]NAB is providing to the Commission's file in this docket a set of audio cassettes which contain these sound samples.

[7]See Notice, supra note 2, at questions 15-A, 19-A and B.

Broadcasting[8] and its two subgroups, the Allocations Policy Subgroup and the Technical Subgroup. Only after such scrutiny did Angell actually conduct its study. Accordingly, we believe that the Angell Study's results and conclusions should be well-accepted by both the industry and the Commission.

In these comments we outline the basic principles which should guide the FCC as it reviews its AM allocations policies. Among other things, we emphasize the need to reduce the interference present on the AM band, rather than to take allocations steps that only would increase interference levels. Concerning the issues raised in Section I of the Notice, focusing on "technical assignment principles," the Klein Report and the Angell Study clearly point to the need for revised technical standards. In Reply Comments we intend to provide additional guidance on how such standards should be altered. Also, in these comments NAB recommends new FCC rules and policies on "noise zones," minimum field strength protection and protection ratios for co-channel and adjacent channel interference. We also point to the improvements that can be achieved through revised AM antenna designs and urge a revision to the agency's RSS exclusion rule.

B. PRINCIPLES WHICH SHOULD GOVERN THE COMMISSION'S REVIEW OF AM ALLOCATIONS POLICIES

Before specifically addressing the many issues in the Notice, and to aid the Commission's staff in understanding NAB's position, it is appropriate to examine certain basic principles that, in NAB's view, should underlie the Commission's AM allocations policies.

First and foremost, the public interest is best served when the

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[8]The Advisory Committee was created by Memorandum Opinion and Order, FCC 80-537, adopted September 10, 1980. It was established under the principles of the Federal Advisory Committee Act (5 U.S.C. App. 2 Sections 1-15).

Commission's technical standards accurately predict coverage and interference. The consequences of inaccurate standards are many. Applicants for new stations or for major changes in existing stations, using FCC rules to calculate coverage and interference levels, file technical information with the Commission that misrepresents the actual interference levels that would be experienced once the application is granted. Many judgments, by the industry, business community and the Commission, rely on the Commission's technical standards to provide an accurate assessment of coverage and interference. Indeed, the major premise of technical standards presumably is to control and prevent interference. That purpose is necessarily frustrated by improperly devised technical standards. Moreover, certain of the existing FCC technical assignment principles appear to have been designed not to protect AM service responsibly, but to foster the addition of new stations, without giving any regard for the interference impact of those stations on existing and overall AM service. As a result, AM service areas supposedly protected from interference by the Commission's technical standards are not so protected, and service inaugurated in the past has deteriorated significantly over time. Indeed, the Commission's standards have allowed the agency continually to add new stations and grant major change applications while ignoring the interference price that is paid by existing AM stations and AM listeners. Poorly crafted technical standards penalize existing service and deny any means for affected stations to challenge the agency's decisions on technical grounds.

Second, we believe that the Commission's technical standards should be rooted in the subjective expectations of AM service quality held by the listening public. In determining the public interest, the Commission should be compelled to consider whether the service estimated by the agency's rules comports with the

service actually perceived and desired by the listening public. As we show below, there is a vast difference between what the Commission believes the AM service provides and what the public believes AM stations should be able to provide.[9]

Third, we strongly believe the Commission should move expeditiously in conducting appropriate rule makings designed to establish a consistent set of improved calculation methods and technical standards. We can think of no more urgent technical activity for the Commission to undertake. Beyond their relevance to existing AM service, the outcomes of these proceedings must be applied to the future AM allocations and technical assignments on the expanded AM band, 1605-1705 kHz.[10] An improved set of technical standards would permit AM service to be inaugurated on the expanded band in a fashion that truly meets the technical needs and expectations of the listening public. NAB will provide additional suggestions on these and other aspects of AM band expansion in comments to be filed in response to the Commission's Fourth Notice of Inquiry in Docket No. 84-467, supra.

Finally, whatever AM technical standards are adopted, there will come a time -- in the short term wherein the existing AM band is concerned -- when the AM spectrum becomes completely exhausted. While new AM stations can be added in the expanded band (perhaps in conjunction with a reduction of congestion on the existing band),[11] we strongly object to endless "shoehorning-in" of additional

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[9]The Commission should also consider that the terms "service quality" and "service" do not solely refer to audio quality; they include the relative importance and availability of a particular radio program to particular AM listeners.

[10]See, e.g., Fourth Notice of Inquiry in General Docket No. 84-467, FCC 88-72, released June 3, 1988.

[11]For some time NAB has supported the concept of daytime-only AM stations "homesteading" at least a portion of the station allotments in the expanded AM band and, after a period of years (when these expanded band stations become financially viable) ceasing operation of the daytime-only facilities, perhaps in

stations and causing new interference to existing stations where there is essentially no more room on the AM band.

C. ISSUES RAISED IN SECTION I -- TECHNICAL ASSIGNMENT PRINCIPLES

In Section I of the Notice, the Commission addresses a number of very fundamental issues relating to the allocation and assignment of AM broadcast stations. These issues include the appropriate values of normally-protected contours, the nature of receiver characteristics and subjective listener satisfaction levels to use in the determination of minimum signal strength values, the role and impact of natural and man-made noise levels, and the appropriate values for co-channel and adjacent channel RF protection ratios. Below are NAB's responses to specific questions raised in this section.

1. Section A: Protected Contours.

Question 15-A of the Notice asks whether, taking into account today's listener habits, the field strength values of the normally-protected contours currently in the FCC rules are still appropriate. Based on only an initial analysis of the Klein Report and the Angell Study, there appears to be ample evidence of the need to change many of the Commission's AM technical standards. However, we do not, at this time, recommend that the agency alter the applicable protected contours. The public interest goal of providing AM service is much more dependent on the protection ratios used to protect a given contour. NAB takes no specific position at this time on how these ratios should be altered, pending further assessment of the two reports and a review of other parties' initial

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conjunction with the issuance of federal tax benefits for doing so. See e.g., NAB Comments in General Docket 84-467, filed February 6, 1988 at 5-7.

filings.[12]

Question 15-C asks for an assessment of the benefits and costs to the broadcasting industry and to the public that would result from changing or not changing the field strength values of the protected contours. In NAB's view, the broadcasting industry is not so much looking for "benefits" or "costs" associated with particular protected contour signal strengths; rather, what is desired by the industry as a whole is a protected contour that is accurate and that is, in fact, protected from interference. We do not necessarily believe that protected contours should be changed simply for the sake of change. Protected contours only define the limit of AM service or non-interference and must be rationally considered together with co-channel and adjacent channel interference criteria. What is most important, from NAB's view, is that a protected contour provide some reasonable guarantee that future additions of new or modified AM stations will not degrade existing AM service.

2. Section B: Minimum Usable Field Strength.

In Section B of the Notice the Commission asks for comment on the many factors that affect the determination of minimum usable field strength ("E_{min}"). These include subjective listener measurements necessary to determine listener satisfaction and the various technical factors necessary to calculate E_{min}.

At pages 3-5 of the Klein Report, the issues and calculations of E_{min} are thoroughly discussed. With respect to E_{min}, the principal conclusion of the Klein Report is that:

> Minimum usable field strength can vary widely depending on atmospheric and man-made noise environment and/or required system performance. No single protected contour is appropriate for

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[12]Question 15-B, therefore, is not addressed by NAB at the present time.

all circumstances. Differing requirements should be accommodated by the Commission's allocation scheme.[13]

If the Commission desires to increase the accuracy of its service/interference calculations, it will be necessary to accommodate better the geographic variations of atmospheric noise.[14] However, it does not seem appropriate to consider values of noise-limited E_{min} where the AM service is presently limited by interference. Question 19-A asks whether additional subjective listener measurements are necessary to determine listener satisfaction. We believe the answer to this question is yes,[15] and in response to the Notice we provide in the Angell Study a comprehensive study of listener reactions to AM interference. In brief, listeners were asked to grade constantly deteriorating signal-to-interference ratios for both co-channel and adjacent channel interference.

One of the principal conclusions of the Angell Study is:

> The minimum acceptable D/U (desirable/undesirable) ratio for co-channel interference with musical program material was 26 dB. For talk programming with either music or talk interference, 40 dB was the minimum acceptable co-channel D/U ratio. For adjacent channel interference, the corresponding ratios were 16 dB for music, 16 dB for talk with talk interference and 20 dB for talk with music interference.[16]

This conclusion and the supporting tabulations clearly show that the Commission's first adjacent channel protection ratio of 0 dB falls seriously short of protecting the pubic from AM interference. The current co-channel protection ratio of 26 dB may still be appropriate. We discuss these matters below.

Question 19-C asks what receiver characteristics should be employed for

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[13]Klein Report at 1.

[14]See the discussion of atmospheric noise, infra.

[15]Thus, Question 19-B is not in point.

[16]Angell Study at 2.

determination of E_{min}. As noted in the Klein Report, receiver characteristics are an essential component of the E_{min} determination. Our tentative view is that the Commission should use NRSC-1 audio deemphasis and a narrow bandwidth configuration to determine E_{min}. The Standard was created after nearly two years of work and has now become widely accepted.[17] The NRSC-1 standard brings uniformity to the equalization of AM receivers and provides a benchmark from which AM station engineers can tailor the sound of their stations. For allocation planning purposes, it seems appropriate to use narrow bandwidth as a planning factor. If wide bandwidths were used as a planning factor, the resulting allocation system would essentially ignore the millions of narrow bandwidth receivers now on the market and the fact that many wide bandwidth receivers also have narrow bandwidth positions. We also recognize the importance of preserving AM service in weak signal areas, regardless of whatever protection ratios the Commission adopts.

For purposes of the expanded AM band, NAB also urges the Commission to determine technical standards based on a narrow bandwidth. Even though, at present, there are few, if any, receivers capable of receiving the frequencies 1605-1705 kHz, future receiver designs, in all likelihood, will continue to have narrow bandwidth capabilities. In essentially vacant spectrum, using narrow bandwidth as a planning factor will create an allocations system at 1605-1705 kHz that produces a high quality AM radio service. Accordingly, our initial view is to use narrow bandwidth as a criterion for the existing AM band and also for the expanded AM band.

Question 19-D asks what reference level of listener satisfaction should be

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[17]On November 6, 1987, NAB filed a Petition for Rule Making asking for FCC adoption, in its Rules, of the transmission portions of the NRSC-1 Standard for AM broadcasting.

used for determining E_{min}. While further analysis is warranted, NAB would support a 90% satisfaction level for use in the expanded AM band.

3. Section C: Atmospheric and Man-Made Noise

In Section C the Notice addresses the proper allocations considerations for man-made and atmospheric noise.[18] Noise is a technical factor that is considered in the calculation of E_{min}.[19] The Notice raises the possibility of creating "noise zones" for U.S. AM broadcasting as a means to more accurately predict service contours.

NAB supports the concept of establishing noise zones in the U.S. As indicated in the Klein Report, atmospheric noise may vary by as much as 60 dB.[20] A technical factor with such a potentially large variation simply must be accommodated in the Commission's allocation scheme. It should be possible to establish two or more noise zones with minimal administrative difficulty.

With respect to man-made noise, however, it may not be appropriate to establish noise zones. At Section 73.182(e) of the Rules, the Commission suggests using a signal strength of 2 mV/m or greater to serve communities with populations larger than 2,500. Based on CCIR Report 258-4,[21] it should be possible to modify Section 73.182(e) to provide further guidance on signal coverage requirements in the presence of man-made noise. Nearly all relevant technical references agree that the extent of the man-made noise is proportional to the populations of communities.[22]

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[18] Notice, supra note 2 at paras. 20-25.

[19] See Klein Report at 2.

[20] Id.

[21] Id. at 2 and Klein Report Appendix B.

[22] Klein Report at 2.

Question 25-A concerns the source of data that should be used in determining atmospheric noise levels in the United States. NAB has no objection to use of CCIR Report 322-3, attached as Appendix A to the Klein Report and submitted with these comments. In the course of preparing the Klein Report, NAB and Hammett & Edison were unable to uncover any other satisfactory study of U.S. atmospheric noise. Whatever the possible error in the noise map calculations of CCIR Report 322-3, given a 60 dB variation of atmospheric noise in the U.S., any use or accommodation of atmospheric noise in Commission allocation decisions must be considered to be a significant improvement in technical accuracy.

Question 25-B asks whether the U.S. should be divided into noise zones and whether the noise values should be averaged during the year. As discussed above, our initial view is that some division of the U.S. into two or more noise zones is appropriate. NAB may offer more specific guidance in Reply Comments.

Question 25-C concerns the appropriate basis for drawing the boundaries of noise zones. NAB leaves this issue for the Commission to determine via further rule making, if necessary. The Commission previously has successfully undertaken the establishment of zones for allocation purposes in Sections 73.205 and 73.609 of the Commission's Rules.

4. Section D: Co-Channel and Adjacent Channel Protection Ratios

Section D of the Inquiry considers the crucial issues of adequate co-channel and adjacent channel protection ratios.[23] As the Commission notes, the task of determining protection ratios is complicated and depends on many factors, technical and non-technical. In the Klein Report and the Angell Study, NAB has attempted to provide the tools necessary for determining appropriate protection

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[23] Notice, supra note 2 at paras. 26-35.

ratios.

At the outset, we note that both NAB studies conclusively show that the Commission's first adjacent channel protection ratio is entirely inadequate to protect AM stations from interference.[24] It simply must be changed.[25] The Klein Report concludes:

> Existing protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers. New protection ratios can be calculated that will reflect present and future technical parameters such as the NRSC-1 audio standard.[26]

We urge the Commission to conduct rule making on this ratio as soon as possible, in order to prevent occurrence of additional interference. We note, however, that in paragraph 32 the Notice states that "a high level of protection can significantly restrict the number of stations permitted to use the spectrum in a given area." In essence, the Commission is stating that some "compromise" of technical standards is needed to accommodate a greater number of AM stations. However, as stated in NAB's initial comments in this proceeding,[27] such a course is the exact opposite of where the Commission should be going. Revised technical standards should be used to "clean up" the band, rather than clear the path for additional interference. Were the Commission to pursue this "more stations is always better" approach in the existing AM band, the listening public would be a major loser, not the "diversity winner" intended by the Commission.

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[24] See Klein Report at 5-8.

[25] Even assuming the use of worst-case receiver characteristics, and use of NRSC preemphasis and bandlimiting, to achieve a co-channel protection ratio of 26 dB the first adjacent protection ratio must be at least 14 dB. The current FCC standard is 0 dB.

[26] Klein Report at 1.

[27] See NAB Comments in MM Docket No. 87-267, filed February 1, 1988, at 3-12.

Nearly all the technical issues specified by the Commission in Questions 35-A through 35-H are addressed in the Klein Report and the Angell Study, or have already been discussed in these comments. With respect to second adjacent channel interference, the Klein Report shows how use of the NRSC-1 transmission standard makes a dramatic difference in the levels of second adjacent channel interference.[28] Without NRSC-1 transmission, a protection level of -8 dB is necessary at the second adjacent channel for 26 dB of co-channel protection at the 0.5 mV/m contour.[29] Using NRSC-1 transmission and current receivers, the Klein Report shows that 22 dB less protection is needed (-30 dB).[30] Therefore, and because the current allocation standard provides less than 30 dB of protection,[31] maintaining use of the Commission's current allocation standard (prohibited overlap of 2 mV/m and 25 mV/m contours) to supply protection for second adjacent channel stations must be considered to be a minimum level of protection. If anything, a slight increase in second adjacent channel protection is warranted.

Finally, for purposes of internal consistency and technical accuracy, we suggest that the Commission consider replacing the current overlap standard with a suitable protection ratio to be considered at the protected contour.

D. ISSUES RAISED IN SECTION IV -- ANTENNA SYSTEMS

In Section IV of the Notice the Commission discusses potential rule changes regarding the AM broadcast antenna. As the Commission notes, NAB

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[28] Klein Report at 7 and 8.

[29] Id. at Figure 2.

[30] Id.

[31] Id. at note 10.

plans to conduct experimental antenna tests at a location owned by Howard University in Beltsville, Maryland. The first series of tests is designed to achieve separate control over skywave and groundwave signals. If successful, use of such an antenna can be effective in reducing skywave interference on the AM bands. These tests have been well planned and should begin later this year.[32]

In the second series of tests, NAB plans to develop a standardized "low profile" antenna that may prove beneficial for low-powered AM stations desiring to better cover their communities. An AM daytimer on a regional channel, for example, having received a low post-sunset and/or fulltime power authorization, often is unable to adequately cover his or her community because of these low power levels and high received interference levels. Due to the presence of many other strong nighttime signals, the coverage areas of daytimers operating at night is quite limited, even when using what otherwise might be considered high power levels, such as 500 watts. As a technical matter, merely increasing power, even ten-fold, is not a realistic solution for daytimers and, without adequate protection ratios, is not in the best technical interests of the AM band as a whole. Increasing power at night generally will not achieve the coverage gains that are necessary to cover adequately a licensed community. Moreover, increased interference would occur on the band, thereby limiting the service areas of other nighttime stations.

A far more practical approach is to develop a way to serve communities better by low-powered AM stations using economical AM antennas. A daytimer operating at night needs to use every available watt of energy in the most efficient manner. If a daytimer is constrained to use lower power, then that

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[32]On May 27, 1988 NAB filed with the Commission an application (Form 442) for a new experimental radio station to be authorized under Part 5 of the Rules.

lower power should operate in the most central location of the desired community area. Technically, it is possible to design and operate a physically shorter AM broadcast antenna. Such an antenna is not now permitted by current FCC rules. A physically short antenna could be located at many more locations than a "full size" broadcast antenna, thus providing more flexibility for a daytimer desiring to serve the licensed community at night.

Whatever the outcome of the Commission's AM antenna deliberations, we consider it highly important that antennas used for broadcasting purposes be standard antennas. If there were no standards at all, almost any piece of metal -- vertical, horizontal, encased, indoors, outdoors, etc. -- could be fed AM energy and used as an antenna. It would be impossible to predict coverage, and, accordingly, impossible to prevent, or even calculate, increases in the levels of interference. NAB urges the Commission to approve just one useful and well-tested low profile antenna design. Of course all Commission technical standards that relate to protection of other stations must be applicable to any use of the AM band.

E. THE COMMISSION SHOULD BEGIN RULE MAKING TO CHANGE THE 50% RSS EXCLUSION RULE TO A 25% EXCLUSION RULE

As noted above, NAB's earlier comments in response to the Notice, filed February 1, 1988, dealt with issues contained in Sections II (Additional Assignment Criteria) and III (Related Technical Issues). In these sections, the Commission asks whether the current procedure using the so-called root-sum-square (RSS) 50% exclusion principle should be maintained.[33] The Commission suggests use of a 25%

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[33] Notice, supra note 2 at paras. 74-80 and at question 81-A.

RSS exclusion.[34] NAB's initial comments urged a change in the current rule but declined to endorse a specific proposal, pending the outcome of several studies conducted within the Technical Subgroup of the Advisory Committee on Radio Broadcasting.[35] We also wished to consider this issue after completion of the Klein Report.

Based on our review of the Klein Report and various materials submitted to the Technical Subgroup, we now strongly urge the Commission to propose use of a 25% RSS exclusion principle in a rulemaking proceeding. After thoroughly analyzing the RSS technical principles, mathematics, and the effect of RSS calculations on AM allocations and nighttime AM service, the Klein Report concludes:

> The existing RSS calculation method using 50% exclusion results in unrealistic predictions of nighttime service and, over the years, has permitted widespread increases in interference. Use of a 25% exclusion method would more accurately portray nighttime service contours and would minimize future increases in interference.[36]

After considering the technical documents developed during the last six months, we have no hesitation in supporting use of a 25% RSS exclusion principle.

Finally, the Klein Report examined two issues that are also relevant to RSS calculation methods. First, the Klein Report examined the effect of 10%-of-the-time multiple interference calculations when the contributing 10% signals may

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[34] Id. at para. 79.

[35] See NAB Comments in MM Docket No. 87-267, supra note 3 at 17.

[36] Klein Report at 1 and 8-11.

not share the same duty cycle.[37] The Klein Report concludes that "[t]he existing RSS calculation method produces correct estimates of total 10%-time interference even though the 10%-time values of the interferers are individually specified prior to calculating the RSS."[38] Second, and as also discussed in NAB's initial comments,[39] the Klein Report concludes that the Commission should "include the effects of adjacent-channel skywave interference by weighing each RSS contributor by the appropriate protection ratio."[40]

F. CONCLUSION

For the reasons stated herein, NAB urges the Commission soon to begin rule making to adopt revised interference and allocations policies that will ensure reduced interference on the existing band and the interference-free introduction of new AM service on the expanded AM band. While giving the Commission substantial guidance in these initial comments, NAB intends to provide more detailed information following our examination of the comments of other parties and our further assessment of the Klein Report and Angell Study. Following the submission of reply comments, the Commission should initiate promptly a series of individual rule makings aimed at achieving many of the interference-reduction

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[37] That is, 10% signals arriving at a transmitter site from different parts of the country may not arrive at the same relative amplitude or phase, and the instantaneous differences in amplitude and phase may vary considerably as the ionosphere varies geographically. For a comprehensive analysis of the physics involved, see H. Anderson, "Signal-to-Interference Radio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers," Appendix F to the Klein Report.

[38] Klein Report at 1.

[39] See NAB Comments in MM Docket No. 87-267, supra note 3 at 18-21.

[40] Klein Report at 1.

goals specified in the Notice.

Respectfully submitted,

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June 17, 1988

APPENDIX A

MM Docket No. 87-267

NAB June 17,1988

NOTE: A copy of the complete "AM Technical Assignment Criteria" study, including Appendicies A, B, D and the computer programs is available from NAB SERVICES at (800) 368-5644.

AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87-267

An AM Improvement Report
from the
National Association of Broadcasters

June 17, 1988

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NAB BROADCASTERS

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AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87-267

HARRISON J. KLEIN, P.E.

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AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87-267

HARRISON J. KLEIN, P.E.[1]

I. EXECUTIVE SUMMARY

This technical report addresses four issues in the FCC's Notice of Inquiry in MM Docket No. 87-267:

1. Atmospheric and man-made noise
2. Minimum usable field strength
3. Adjacent-channel protection ratios
4. RSS (root-sum-square) calculations and adjacent-channel skywave interference.

Here are the principal conclusions of this report:

1. Minimum usable field strength can vary widely depending on atmospheric and man-made noise environment and on required system performance. No single protected contour is appropriate for all circumstances. Differing requirements should be accommodated by the Commission's allocation scheme.
2. Existing protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers. New protection ratios can be calculated that will reflect present and future technical parameters such as the National Radio Systems Committee (NRSC) audio standard.
3. The existing RSS calculation method using 50% exclusion results in unrealistic predictions of nighttime service and, over the years, has permitted widespread increases in interference. Use of a 25% exclusion method would more accurately portray nighttime service contours and would minimize future increases in interference.
4. The existing RSS calculation method produces correct estimates of total 10%-time interference even though the 10%-time values of the interferers are individually specified prior to calculating the RSS.
5. RSS calculations should include the effects of adjacent-channel skywave interference by weighting each RSS contributor by the appropriate protection ratio.

Finally, and most importantly, this report contains PC-compatible computer programs that permit an AM engineer to calculate the values of appropriate technical assignment criteria using user-supplied input parameters. Sample calculations are provided.

II. INTRODUCTION

This report, which was prepared on behalf of the National Association of Broadcasters (NAB), contains the results of a broad examination of AM technical assignment criteria. NAB's efforts were prompted by the August 17, 1987, release by the Federal Communications Commission of a Notice of Inquiry in MM Docket No. 87-267 ("Notice"). The Notice initiated a review of the many technical assignment criteria that collectively represent the technical framework for the AM broadcast service. Among the issues raised by the Commission are whether existing protected contours and protection ratios for the various classes of AM stations are appropriate in light of past and potential changes in transmission technology, AM receiver design, and listener habits. Related issues include the effects of atmospheric and man-made noise, and whether current FCC calculation methods adequately describe AM groundwave and skywave propagation and the effects of multiple interfering signals.

This report collects and analyzes available technical information and provides computer tools useful in developing recommendations for FCC action. The report considers the geographical dependence of atmospheric and man-made noise, and provides sources that contain estimates for their values. It analyzes each component required to determine the minimum usable field strength, E_{min}. It describes the factors that affect radio frequency protection ratios and describes the methods that have been developed to calculate protection ratios. The matters of RSS calculations and adjacent-channel skywave interference are thoroughly discussed; in particular, the report describes the proper method for calculating the effects of multiple interfering skywave signals.

Computer programs are provided for calculating E_{min}, adjacent-channel protection ratios, and signal-to-interference ratios for multiple skywave signals. The algorithms are explained in some detail and are available for the Commission and others to use in their deliberations.

A specific set of technical standards is not proposed by this report. Rather, interested parties are encouraged to use the information contained in this report to formulate suitable technical criteria they believe to be appropriate for the present and future AM broadcasting environment. This study was conducted because NAB wished to ensure that the Commission's technical standards are as accurate and objective as possible.

---

[1] Mr. Klein is with Hammett & Edison, Inc., Consulting Engineers, Box 280068, San Francisco, CA 94128-0068, (415) 342-5200.

III. Atmospheric and Man-Made Noise

The ambient noise level is a determining factor in the minimum usable field strength, E_{min}, which in turn is the basis for defining protected contours. A knowledge of the ambient atmospheric and man-made noise throughout the United States is essential to the development of more appropriate technical standards for the AM band. Stations must have an appropriate RF signal-to-noise ratio (SNR) in order to provide listeners with the quality of sound they demand.

A. Atmospheric Noise

Knowledge about atmospheric noise levels has improved significantly in the years since the present FCC allocation standards were developed. Extensive research has been conducted into the distribution of atmospheric noise throughout the world. The results are summarized in reports of the International Radio Consultative Committee (CCIR); the most recent is CCIR Report 322–3, "Characteristics and Applications of Atmospheric Radio Noise Data," which is dated 1986 and is included with this report as Appendix A. Report 322–3 is based principally on research performed by Spaulding and Washburn of the U.S. National Telecommunications and Information Administration [1].

Report 322–3 presents atmospheric noise data in the form of maps and graphs. Each map and its two associated graphs cover a specified season (winter, spring, summer, autumn) and four-hour time period (e.g., 0000–0400 local time). The map shows the expected value of atmospheric radio noise throughout the world, for a frequency of 1 MHz. Consistent with conventional technical discussions of noise, this report defines noise in terms of an effective antenna noise figure, F_a, and describes how F_a can be converted to an equivalent noise field strength in millivolts per meter. In the United States, F_{am}[2] ranges from a low of approximately 30 dB (Pacific Northwest, winter, 0800–1200) to a high of approximately 90 dB (Midwest, summer, 2000–2400).

One of the graphs associated with each map shows the variation of radio noise with frequency. Noise levels are highest at low frequencies and generally decrease with increasing frequency at the rate of approximately 30–70 dB per decade. Above about 30 MHz, atmospheric noise levels are beneath the level of galactic noise.

The other graph associated with each map shows, as a function of frequency, the remaining parameters necessary for a complete statistical description of the noise. V_d is the ratio, in dB, of the rms noise envelope voltage to the mean noise envelope voltage.[3] The higher the value of V_d, the more impulsive or "spiky" the noise. D_l and D_u are the lower and upper deciles, respectively, of the average noise power. The lower decile is the value exceeded for 90% of the hours within a time block; the upper decile is the value exceeded for 10% of the hours. D_l and D_u are measures of the deviation of F_a from its median value. The graph also shows the standard deviations of the various statistical quantities.

B. Man-made Noise

Man-made noise has become a much more serious allocation consideration as its level has increased due to the proliferation of power lines, industrial machinery, and noise-generating appliances, but less data is available on this topic than on atmospheric noise. CCIR Report 258–4, "Man-made Radio Noise," which is included with this report as Appendix B, includes a discussion of man-made noise based on work published in 1974 by Spaulding and Disney [2], but opinions differ on whether these levels are still valid.

Man-made noise is described using the same statistical quantities, such as F_{am}, as is atmospheric noise. Five "environmental categories" are defined in Report 258–4 corresponding to different values for F_{am}: galactic (as defined in Report 322–3), quiet rural, rural, residential, and business. Figure 1 of Report 258–4 shows that F_{am} for each category of noise varies linearly with the logarithm of the noise frequency.

To describe an environment that may better correspond to the increasing noise levels that have occurred over the last 15 years, this report defines a new environmental category called "intense," which is even noisier than the "business" category. "Intense" noise is equivalent to the noise level measured in the vicinity of power lines, which was reported in [2].

The next section of this report describes how the above statistical parameters of atmospheric or man-made noise, together with other transmission system parameters, are used to calculate E_{min}.

IV. Minimum Usable Field Strength

The minimum usable field strength, E_{min}, is defined as the field strength necessary to permit a desired reception quality, under specified receiving conditions, in the presence of natural and man-made noise.[4] If noise were constant, one could define reception quality simply as a certain signal-to-noise ratio, then add that value to the noise level to obtain E_{min} directly. But because the noise level is always changing, a technically accurate E_{min} must instead be evaluated statistically.

The report now describes how the concept of system performance is used to develop a method for calculating E_{min}. The statistical terms that define system performance are necessarily abstract. Readers without a theoretical background in probability and statistics should not expect to gain a thorough understanding of the concept of system performance from this report, but should become familiar with the basic terminology.

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2 F_{am} is the median of the hourly values of F_a within a time block.

3 The graph shows V_{dm}, which is the median of V_d for the specified time-block.

4 A more complete definition can be found in [3].

A. The Components of System Performance

For the purposes of this report, E_{min} is the field strength necessary to achieve a desired system performance, where system performance is defined in Report 322-3 in terms of three independent component parts: grade of service, time availability, and service probability. The concept of system performance used here is consistent with that for other communications systems. Each component of system performance must be specified before E_{min} can be calculated.

1. Grade of service

"Grade of service" represents the short-term reception quality of the system. The purpose of defining grades of service, which are common in many communication systems, is to develop subjective descriptions of quality that correspond to particular objective technical specifications. For example, common grades of service for commercial telephony systems are "just usable," "marginally commercial," and "good commercial." Example II in Section 6.5 of Report 322-3 defines the "marginally commercial" grade of service for a double-sideband telephony system to be a median signal-to-noise ratio of 64 dB in a 1 Hz bandwidth.

"Marginally commercial" provides a better subjective description of reception quality than does the technical specification "a median signal-to-noise ratio of 64 dB in a 1 Hz bandwidth." Knowing, for example, that a 5 mV/m field strength is required to obtain a SNR of 64 dB in a 1 Hz bandwidth is of little practical benefit without also knowing the relationship between the technical specification and the subjective description.

The terms used to specify grade of service depend on the particular communication system, but all grades of service for statistical systems must include a measure of time in addition to one of signal quality. The above example did not explicitly include a reference to time, but use of the term "median signal-to-noise ratio" implies a time percentage of 50%. Example I in Section 6.4 of Report 322-3 describes a frequency shift keying system in which grade of service is specified by the probability of bit error which, for a given transmission rate, corresponds to a certain number of errors per unit time.

In a telephony system such as AM, the grade of service is specified by an instantaneous signal-to-noise ratio and the percentage of time that the SNR is achieved. Note that the specification refers to the instantaneous SNR. Even for noise with a constant rms level, the instantaneous noise envelope voltage is constantly changing. Grade of service refers to the percentage of time that the signal is above the instantaneous level of the constantly changing noise, for a certain rms noise level.

At this time there are no generally accepted definitions in the United States for AM broadcasting grades of service. An instantaneous signal-to-noise ratio and percentage of time must be specified before E_{min} can be calculated, but there has been no relationship developed in which a certain combination of SNR and time percentage corresponds to Grade A or best quality service, a lower SNR to a Grade B or lesser quality service, and so forth. With further research, a relationship could be developed analogous to the TASO grades for television pictures. In the absence of defined grades of service, values that appear reasonable must be chosen for instantaneous SNR and time percentage, but those values cannot now be related to known levels of listener satisfaction.

2. Time availability

In the above discussion concerning grade of service, the time specification refers to the percentage of time the signal is above the instantaneous noise envelope voltage, for noise of constant rms level. But the rms noise level itself also changes from hour to hour within each four-hour seasonal time period (e.g., summer, 2000-2400 local time) shown in Report 322-3. "Time availability" is the percentage of time throughout the specified time period that a given grade of service or better will be achieved.

3. Service probability

Each parameter that describes the statistical nature of the noise has an uncertainty, which is described by its standard deviation. "Service probability" is the statistical confidence factor, required for any statistical description, that combines these various uncertainties. It is the probability that a specified grade of service or better will be achieved for a specified time availability.

To aid in understanding the concept of service probability, consider an E_{min} calculation made using the data in Report 322-3 for a particular season and time period, grade of service, and time availability, and for a service probability of 50%. For a given path from transmitter to receiver, 50% service probability means that there is a 50% chance that this value of E_{min} will be sufficient to achieve the specified grade of service and time availability.

B. Calculation of E_{min} by Computer

To provide information that will be useful to anyone wishing to develop specific recommendations for E_{min}, a PC-compatible computer program was written that allows the user to specify any desired set of input conditions, which consist of atmospheric or man-made noise parameters, system performance requirements, frequency, bandwidth, and standard deviation of the expected received signal strength.[5] Appendix C contains further information about the algorithm and instructions for program operation.

Sample E_{min} calculations have been made and are shown in Figure 1. The figure is arranged in order of worsening noise. Each example is for an instantaneous signal-to-noise ratio of 26 dB. Although the time percentage for grade of service can be specified differently from the percentage of time availability, in the examples the two percentages are specified identically; the columns labeled 50%-time, 90%-time, and

[5] See Appendix C for a discussion of standard deviation of the expected received signal strength.

Figure 1

CALCULATED MINIMUM USABLE FIELD STRENGTH, E_{min}

Signal-to-noise ratio = 26 dB Frequency = 1 MHz Service probability = 50%

Noise Type	Location or Category	Season and Local Time	Calculated E_{min} (mV/m) 50%-time	90%-time	99%-time
Atmospheric	Pacific Northwest	Winter, 0800–1200	<0.005	<0.005	0.03
Man-made	Rural		0.04	0.35	2.02
Man-made	Residential		0.07	0.67	4.69
Man-made	Business		0.11	1.04	7.52
Atmospheric	Midwest	Summer, 2000–2400	0.18	2.12	24.9
Man-made	Intense		0.56	5.89	46.7

99%-time refer to both grade of service and time availability. Each example is for a service probability of 50%. The examples show the values of field strength that would be needed for the instantaneous signal-to-noise ratio to be at least 26 dB, for the indicated percentage of time and for the indicated percentage of hours within the CCIR seasonal time period, with a confidence factor of 50%.

The bandwidth was specified as 10,666 Hz for all calculations. 10,666 Hz is the effective RF bandwidth of a receiver meeting the NRSC deemphasis standard, assuming infinite attenuation outside the ±10,000 Hz receiver passband.[6] The standard deviation of the expected received signal strength was specified as 2 dB and the frequency was specified as 1 MHz for all calculations.

The specific program input parameters for the two atmospheric noise examples were determined from Report 322-3 as follows:

Pacific Northwest, Winter, 0800–1200

F_{am}: 30 dB Standard deviation: 4.5 dB
V_{dm}: 4.1 dB Standard deviation: 2.2 dB
D_u: 9.2 dB Standard deviation: 5.2 dB

Midwest, Summer, 2000–2400

F_{am}: 90 dB Standard deviation: 4.8 dB
V_{dm}: 5.7 dB Standard deviation: 1.5 dB
D_u: 8.2 dB Standard deviation: 2.8 dB.

For the four man-made noise environments, F_{am}, V_{dm}, and D_u were taken from [2], if available, and are built into the program. The user is not required to specify these parameters.

Two general observations can be drawn from the data in Figure 1. First, under some circumstances noise levels can be extremely low. During winter in the Pacific Northwest, the 50%-time and 90%-time values for E_{min} are less than 5 microvolts per meter. Even in a business noise environment, a field strength of 0.1 mV/m is sufficient to provide a 26 dB signal-to-noise ratio approximately 50% of the time. This indicates that reception of a quality some may consider acceptable can occur even in areas of relatively low signal strength, such as the fringe areas of the 0.1 mV/m protected contour of a Class I station. If such a signal is the only kind available, as it may be in rural areas with no local radio station, it may provide listeners with perfectly usable service.

On the other hand, Figure 1 shows that it takes a strong signal to yield high time availabilities, especially in urban areas. A field strength of 1 mV/m is needed in a business noise environment merely to get a 90%-time signal-to-noise ratio of 26 dB. For a better SNR, the field strength would have to be correspondingly higher. To obtain 99%-time reliability, even with a signal-to-noise ratio of only 26 dB, in most locations AM signals must have field strengths in the 2-25 mV/m range.

This section has demonstrated that the calculated values of minimum usable field strength can vary widely depending on atmospheric and man-made noise environment and on required system performance. Thus no single protected contour is appropriate for all circumstances. Differing requirements should be accommodated by the Commission's allocation scheme.

6 Effective bandwidth is the bandwidth of a hypothetical white noise signal (constant power density) that has the same total noise power as noise that has been weighted by the deemphasis characteristic. The effective audio bandwidth was obtained by numerically integrating the NRSC deemphasis curve from 0 Hz to 10,000 Hz, using Simpson's rule with a step size of 50 Hz. The effective RF bandwidth is twice the effective audio bandwidth.

V. ADJACENT-CHANNEL PROTECTION RATIOS

The development of more realistic co-channel and adjacent-channel protection ratios is probably the most important technical issue in the AM improvement proceeding. The protection ratios that underlie existing allocation standards are largely responsible for the interference situation on the AM band. This section describes the factors that affect the protection ratio and discusses how protection ratios can be calculated that will reflect present and future technical parameters.

A. Factors Affecting Protection Ratio

The RF protection ratio is defined[7] as the RF desired-to-undesired (D/U) ratio at the receiver input[8] that will provide the required audio signal-to-interference ratio at the receiver output. The RF protection ratio depends on diverse parameters such as channel spacing, modulation characteristics, transmitter and receiver characteristics, human hearing characteristics, and subjective listening preferences. In particular, it depends on a number of technical parameters that have changed since the present allocation system was implemented, or that the broadcast industry hopes will change in the future:

1. The bandwidths of the transmitter and receiver and the preemphasis and deemphasis characteristics of the system. The NRSC standards and wider-bandwidth receivers should form the basis for new protection ratios.
2. The spectral energy distribution of the modulation signal. The spectral content of modern programming differs greatly from that found decades ago.
3. The amount of compression and limiting. The effects of heavy processing should be taken into account.
4. The amplitude and frequency response of the human ear. As listeners have become accustomed to improved quality sound reproduction from other media, their subjective preferences may have changed, which would affect their perception of interference.

[7] A more rigorous definition of both audio and RF protection ratios can be found in [3].

[8] The term "at the receiver input" can mean different things depending on context. In FCC allocation standards the term refers to the ratio of field strengths at the receiving antenna, but in the context of measurement practice it refers to RF voltages at the receiver's antenna terminals. In allocation standards based on protection ratios determined by conventional measurement techniques, receiving antenna directivity is assumed to be negligible; this is a reasonable assumption given the random orientation of the antenna and the random spatial relationship between the desired and undesired stations.

B. Determination of Protection Ratios

Protection ratios can be determined in several ways [4]. The most accurate method, and the only method for co-channel ratios, is through subjective listening tests, wherein listeners evaluate reception quality under specified conditions of desired and undesired signals and receiver characteristics. The protection ratio is chosen based on an agreed-upon listener satisfaction level. The subjective method is extremely time-consuming because it involves many variables and many people.

It is possible to determine adjacent-channel protection ratios through subjective listening tests. However, if listening tests are first used to determine the co-channel protection ratio, then various objective methods can be used to derive the adjacent-channel protection ratio relative to that co-channel ratio [5]. This relative adjacent-channel protection ratio, A_{rel}, is defined in [4].

A_{rel} is a construct — it does not represent an actual D/U ratio at any frequency — but it is useful because it can be calculated objectively and then used to derive the actual adjacent-channel protection ratio, A. The following equivalent equations relate A_{rel} to A and to the co-channel protection ratio, A_O:

$$A_{rel} = A - A_O$$
$$A = A_O + A_{rel}.$$

For example, the existing AM allocation system is based on a co-channel protection ratio at the protected contour of 20:1, or 26 dB, which means that the desired signal must be 26 dB greater than the undesired signal. The adjacent-channel protection ratio at the protected contour is 1:1, or 0 dB. Therefore, for the first adjacent channel,

$$A_{rel} = A - A_O$$
$$= 0 - 26$$
$$= -26 \text{ dB}.$$

All of the objective methods for obtaining relative protection ratios involve defining the technical parameters that make up the transmitter and receiver response. "Transmitter response" refers to the overall transmitted energy spectrum. "Receiver response" refers to the overall receiving system, which includes human hearing characteristics. In principle, if all of these technical parameters that affect A_{rel} are properly defined, the objective methods should yield the same protection ratios as would be obtained subjectively.

NAB has retained B. Angell & Associates, Inc., of Chicago to conduct the subjective tests needed to determine the required co-channel protection ratio, A_O. This companion report is intended to provide the background and tools necessary for interested parties to calculate the relative adjacent-channel protection ratio, A_{rel}, for any desired transmission and reception parameters. From A_O and A_{rel}, recommended values for the actual adjacent-channel protection ratio, A, can be derived.

C. Objective Methods for Determining Protection Ratios

Of the several objective methods described in [5] for determining A_{rel}, the most accurate is the "objective measurement method," which uses RF generators as the desired and undesired signals, modulates them with noise that simulates program material of the desired level and character, detects them with a receiver of the proper characteristics, and measures the signal-to-noise ratio with a properly weighted noise meter. While the objective measurement method is accurate, and serves as a reference for the other methods that do not involve measurement, it is time-consuming and requires specialized test equipment. The test equipment must be modified if the transmission or reception parameters are changed, which makes it difficult to use the objective measurement method with hypothetical transmission systems.

Another of the objective methods in [5] for determining A_{rel} is called the "numerical method," which involves a computer calculation that takes into account each of the objective parameters that affect the adjacent-channel protection ratio. It permits immediate determination of A_{rel} for any transmitting and receiving system, existing or projected. The numerical method is especially useful in the development of allocation standards because it can take into account the characteristics of the NRSC system, including future NRSC receivers.

D. Calculation of Protection Ratios by Computer

The CCIR numerical method is based on work done in Germany by Gröschel. His paper, "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems," which discusses the numerical method in detail, is included with this report as Appendix D. The paper describes a computer program that determines A_{rel} by means of numerical integration.[9] A copy of this program was obtained from the author. It was re-written to translate the German expressions, to make it PC-compatible, to permit specification of technical parameters such as the NRSC standards that are appropriate to domestic AM broadcasting, and to make it convenient for users to modify the program to specify different hypothetical parameters. Appendix E contains instructions for program operation.

The computer program permits interested users to evaluate relative adjacent-channel protection ratios under varying conditions and to make appropriate recommendations to the FCC. Sample calculations have been made and are shown in Figure 2. For ease of interpretation, the values of A_{rel} calculated by the computer have been converted to actual protection ratios using the existing FCC co-channel protection ratio, A_0, of 26 dB. Note that if A_0 were some higher value such as 40 dB, the adjacent-channel protection ratios shown in Figure 2 would have to be increased by 14 dB. Thus the protection ratios shown in Figure 2 can be considered minimal. For comparison, Figure 2 also shows the protection ratios implicit in existing allocation standards.[10]

The following parameters were used for all sample protection ratio calculations:

Transmission mode:	DSB/ISB
Modulation spectrum:	USASI noise
Modulation factor:	1.00
Transmitter noise:	100.0 dB below carrier
Intermodulation attenuation:	40.0 dB
Psophometric curve:	CCIR–468
Out-of-band selectivity:	100.0 dB
Notch filter:	None.

The remaining parameters were varied according to the desired transmission and reception mode. The transmission mode "Pre-NRSC" refers to transmission conditions prior to the adoption by stations of the NRSC audio standard,[11] in which an audio processor is used that has a simple 50-microsecond preemphasis curve and does not have the NRSC low-pass filter. "NRSC" refers to transmission with the preemphasis curve and low-pass filter of the NRSC audio standard; the NRSC RF mask limits were used as the out-of-band radiation model only in Sections B and C of Figure 2. The "5400 Hz bandwidth" mode refers to transmission with a sharp-cutoff 5400 Hz audio low-pass filter and no preemphasis.

The reception mode "Current Radios" refers to typical AM radios that begin to roll off about 2000 Hz, are down 20 dB at 5 kHz, and are down 40 dB at 10 kHz. "Ideal NRSC" refers to a radio using NRSC deemphasis and the same "brick wall" filter characteristics as an NRSC transmitter. Since a filter this sharp is unlikely in commercial AM radio receivers, a "Realistic NRSC" receiver was defined having a less selective band-limiting filter with a 60 dB per octave slope beyond 10 kHz; even this filter characteristic may be overly optimistic.

The specific program setup conditions for the various transmission and reception modes were as follows:

Pre-NRSC

Band limiting:	Low-pass
Attenuation:	40 dB/kHz
Bandwidth:	14000 Hz
Preemphasis:	50 μs
Out-of-band radiation:	CCIR

9 Gröschel's original program was written in BASIC for Hewlett-Packard desktop computers.

10 FCC Rules do not specify a second-adjacent-channel protection ratio. A ratio of –29.5 dB is specified internationally in [6]. The contour overlap table in Section 73.37(a) of the FCC Rules, which prohibits overlap of the 2 mV/m and 25 mV/m field strength contours of stations with a frequency separation of 20 kHz, does not provide a 30 dB protection ratio at the 0.5 mV/m protected contour.

11 The term "NRSC audio standard" refers to NRSC Standard No. NRSC–1, EIA Interim Standard EIA/IS–40, "NRSC AM Preemphasis/Deemphasis and Broadcast Audio Transmission Bandwidth Specifications."

Figure 2

REQUIRED ADJACENT-CHANNEL PROTECTION RATIOS
for Co-channel Protection Ratio of 26 dB

Transmission Mode	Reception Mode	Adjacent-channel Protection Ratio (dB) First (10 kHz)	Second (20 kHz)
	A. Out-of-band radiation: CCIR model		
Pre-NRSC	Current radios	17	–8
NRSC	Current radios	14	–30
NRSC	"Ideal" NRSC	21	–28
NRSC	"Realistic" NRSC	24	–7
5400 Hz audio bandwidth	Current radios	0	–47
	B. Out-of-band radiation: NRSC RF mask test limits		
NRSC	Current radios	18	(+) 3
NRSC	"Ideal" NRSC	20	(+) 7
NRSC	"Realistic" NRSC	21	(+) 8
	C. Out-of-band radiation: NRSC RF mask maximum limits		
NRSC	Current radios	20	(+) 15
NRSC	"Ideal" NRSC	22	(+) 16
NRSC	"Realistic" NRSC	22	(+) 16
	EXISTING ALLOCATION STANDARDS	0	–30

NRSC
- Band limiting: NRSC
- Preemphasis: NRSC
- Out-of-band radiation: CCIR, NRSC TEST, or NRSC MAX as indicated

5400 Hz audio bandwidth
- Band limiting: Low-pass
- Attenuation: 20 dB/kHz
- Bandwidth: 5400 Hz
- Preemphasis: None
- Out-of-band radiation: CCIR

Current Radios
- Band limiting: Low-pass
- Attenuation: 8 dB/kHz
- Bandwidth: 2500 Hz
- Deemphasis: None

"Ideal" NRSC
- Band limiting: NRSC
- Deemphasis: NRSC

"Realistic" NRSC
- Band limiting: Low-pass
- Attenuation: 6 dB/kHz
- Bandwidth: 10000 Hz
- Deemphasis: NRSC.

To interpret Figure 2, note that a higher protection ratio requires a lower undesired signal to prevent interference. Said another way, a higher protection ratio implies that a given undesired signal level will cause more interference.

Consider first the data in Section A of Figure 2 for the CCIR out-of-band radiation model. For stations operating under pre-NRSC conditions, the data indicate that a 17 dB first-adjacent-channel protection ratio is required, even with existing narrowband radios. A 17 dB protection ratio means that, at a station's 0.5 mV/m protected contour, an undesired signal 10 kHz removed should be 17 dB below 0.5 mV/m.

However, under the existing 0 dB allocation standard, that undesired signal could be as strong as 0.5 mV/m — 17 dB greater than it should be to avoid interference.[12]

Implementation of the NRSC audio standard for transmission while using narrowband radios makes only a modest 3 dB improvement in the first-adjacent-channel protection ratio, from 17 dB to 14 dB. However, NRSC transmission makes a major 22 dB improvement at the second adjacent channel: from –8 dB to –30 dB. This is an indication of the benefits to second-adjacent-channel interference of the NRSC bandwidth specification.

As receivers begin to implement the NRSC audio standard, their wider bandwidths will require protection ratios to increase far above those in existence today if adjacent-channel interference is to be avoided. The combination of NRSC transmission and "realistic" NRSC reception requires a first-adjacent-channel protection ratio of 24 dB — only 2 dB less than the 26 dB co-channel ratio. One can conclude that even if the FCC were to immediately change its contour overlap rules for new facilities to reflect higher protection ratios, wider bandwidth receivers would continue to experience adjacent-channel interference at the 0.5 mV/m contour for many years unless vast numbers of stations ceased operation.

To highlight the protection limitations inherent in existing allocation standards, the program was used to determine the transmission bandwidth that would be required with current radios to yield a first-adjacent-channel protection ratio equal to the existing 0 dB. Even with narrowband receivers, AM stations would be required to transmit with 5400 Hz audio bandwidth to obtain 0 dB protection. This is a clear indication of the magnitude of AM's present difficulties.

Sections B and C of Figure 2 repeat the calculations of Section A for NRSC transmission, but reflect use of the NRSC RF mask test limits and maximum limits, respectively, instead of the CCIR model, as the out-of-band radiation subfunction. While the two NRSC RF mask curves result in modest changes in the required first-adjacent ratios, they result in dramatic increases of up to 45 dB in the second-adjacent ratios. A 15–16 dB protection ratio is required if the NRSC maximum limits are assumed, which is 45–46 dB greater than the –30 dB of existing allocation standards.

These gross protection ratio changes occur because the NRSC limits assume far greater energy in the 10–25 kHz frequency band than does the CCIR model. Gröschel's CCIR model, with an intermodulation attenuation of 40 dB, has energy in the 10–25 kHz frequency band ranging from -71.7 dB to –94.5 dB. The NRSC test limits in that band range from –25 dB to –43.4 dB, and the NRSC maximum limits range from –25 dB to –35 dB.

Both Gröschel's out-of-band radiation model and the NRSC RF mask are said to be based on measurements of actual high-power transmitters, yet they yield vastly different results. If the NRSC mask really does represent the spurious energy radiated from modern transmitters, these data raise serious second-adjacent-channel allocation concerns. However, it may be that the NRSC RF mask represents the worst-case envelope of measured or expected spurious components from any transmitter; each transmitter may not be expected to radiate spurious energy up to the RF mask limits at every frequency. If so, then use of the NRSC limits in the out-of-band radiation subfunction is overly pessimistic and the CCIR model may provide more realistic results. Further investigation is needed to determine which model is correct.

Regardless of which out-of-band radiation model is assumed, the protection ratios shown in Figure 2 demonstrate that, although the NRSC audio standard may make a dramatic improvement in AM frequency response, it will exacerbate adjacent-channel interference-problems in weaker signal areas where the desired-to-undesired signal is low. In those areas, NRSC receivers will be required to contain selectable bandwidth or variable bandwidth circuitry to avoid interference. Figure 2 indicates that existing protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers.

VI. RSS Calculations and Adjacent-Channel Skywave Interference

The existing methods specified in the FCC Rules for the calculation of nighttime skywave interference ignore many signals that may contribute substantially to the interference environment. Over the years, the number of these signals has multiplied, making the true interference environment much worse than it is calculated to be. This section examines the two most significant problems with present interference calculation methods: the exclusion method used when calculating the RSS, and the omission of adjacent-channel skywave signals from interference consideration.

A. The RSS and the 50% Exclusion Method

The RSS, or root-sum-square, is intended to characterize the nighttime interference level of a station by combining the effects of all interfering signals into one net number. Because the various interfering signals arrive with random phase and modulation, the proper way to add them is on a power basis rather than on a voltage basis. The field strength voltage of each interfering signal is squared to obtain power, the squares are added, and the square root is taken to return to voltage. This root-sum-square voltage is multiplied by 20 to obtain the quantity conventionally known as the "RSS." Thus the RSS is the field strength that a desired signal must have to be 20 times, or 26 dB above, the interference level on the channel. Since 26 dB is the protection ratio, a station with a field strength at or above the RSS will provide interference-free service as it is now defined. Therefore, the value of the RSS is the limit of interference-free service; the RSS is also commonly known as the "limit."

It is impossible to add a new station to a channel without creating some additional interference to all the other stations

12 "To avoid interference" means only to prevent the weighted signal-to-interference ratio from becoming worse than 26 dB.

on that channel, although the amount of interference added to many of the stations may be extremely small. So if the FCC Rules specified that the RSS was to be calculated by taking into account every interfering signal, and if the Rules also prohibited, as they now do, any increase in the RSS,[13] then it would be impossible to add any new stations at all. To make it easier to add new stations, the FCC adopted the fiction that a new station will not increase the existing RSS unless the new station's interference contribution is at least 50% of the existing RSS or more than the smallest interference contribution already in the RSS. This is known as the "50% exclusion method."

B. Understatement of Interference and Overstatement of Coverage

The 50% exclusion method makes it possible to legally add a significant amount of new interference to an existing station, as long as it is done without raising this artificial measure of interference, the 50%-exclusion RSS. This has indeed occurred. Interference conditions are worse than they are calculated to be, and much worse than was expected some 50 years ago when the 50% exclusion method was adopted. Computer studies of several hundred AM stations have been made and were reported in [7] and [8]. Even though these studies did not take all interference contributions into account (only the ten greatest contributors were included), they showed that the 50% exclusion method understates the true interference level on a channel by more than 4 dB for some stations. The average understatement was approximately 2 dB.

In addition to allowing new interference to be created, the 50% exclusion method results in unrealistic predictions of nighttime service. As discussed above, the RSS is the limit of interference-free service. Nighttime service contours are defined as the field strength contour having the value of the calculated RSS. A station with a calculated RSS of, for example, 3.0 mV/m is considered to have interference-free service out to the 3.0 mV/m contour. If that station happens to be one for which the 50% exclusion method results in underestimation of interference by 4 dB, the station's true interference-free service would extend only to the smaller 4.8 mV/m contour. In a large metropolitan area, the population within those two contours could differ by many thousands of persons.

C. Alternative RSS Calculation Methods

Several ways have been suggested to produce a more realistic or otherwise "better" RSS. First, the exclusion concept could be retained but the calculation procedure changed. One alternative is the "n-highest contributor method," in which a certain number of stations, such as the four or eight greatest interference contributors, are included in the RSS and the rest excluded. Another alternative is to change the exclusion percentage to some smaller number such as 35%, 25%, or 15%. Both alternatives would tend to raise the calculated RSS closer to the actual interference level by including more stations. Both alternatives would reduce the amount of new interference that could be caused[14] but would retain some ability to add new stations or to improve existing ones.

Second, exclusion could be eliminated entirely, requiring all interference contributions to be included in the RSS calculation, but stations could be permitted to cause incremental increases in interference of 1 dB or perhaps some smaller amount. This option would retain some potential for new stations or facility improvements. The advantage of this option over an exclusion method is that it eliminates an inconsistency in the Rules. Under the 50% exclusion method, a new station can go on the air, or a station that is not now a contributor to another station's RSS can improve its facilities, and each is permitted to cause up to 1 dB of additional interference. However, a station that is already a contributor to another station's RSS is not permitted to raise that RSS at all, so it would be prevented from a facility improvement even if that improvement would also cause only a 1 dB interference increase. The second option would eliminate this inconsistency.

Third, exclusion could be eliminated while retaining the prohibition against increases in the RSS. As discussed above, this would prevent all further increases in interference, but would also prevent most new stations and most improvements in facilities.

D. Comparison of Alternatives

The ramifications of the first option, which is to modify the exclusion method, have been investigated in detail by Lahm and reported in [8]. He found that the n-highest contributor method was undesirable, even though it would more accurately represent the true interference levels on a channel, because of its inconsistent effects on the threshold of entry into the RSS from station to station and from channel to channel. The n-highest contributor method would yield substantial differences in the amount of new interference that a new or modified facility could cause, depending on the particular distribution of existing interference contributions on its channel.

Lahm found that a reduction in exclusion percentage provides better results. For 35% exclusion, the calculated RSS is increased by an average of 0.9 dB over that now calculated with 50% exclusion. For 25% exclusion and 15% exclusion the average increase is 1.5 dB and 1.8 dB, respectively; note that the magnitude of the increase decreases with decreasing exclusion levels. These increases in calculated RSS were found to be relatively consistent from station to

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[13] FCC Rules generally prohibit a new facility from increasing the RSS of another station if that RSS is above the normally protected value.

[14] A new RSS contribution of 50% will increase the actual interference level by up to 1 dB. Contributions of 35%, 25%, and 15% correspond to increased interference values of up to approximately 0.5 dB, 0.25 dB, and 0.1 dB, respectively.

station and channel to channel. Furthermore, the threshold of entry into the RSS was also consistent. A decrease in exclusion percentage from 50% to 25% has a substantial effect on the calculated RSS and on the amount of new interference that can be caused, while a further decrease to 15% has only a small marginal effect. Lahm concluded that an exclusion percentage of 25% was reasonable and in keeping with the desire to better define the interference-free coverage and to protect stations from interference.

The second option, which is to eliminate exclusion while permitting any station to increase interference by a specified amount, appears to offer no significant advantages over a 25% exclusion method; indeed, it appears to offer no significant benefits at all. The proposal to permit 1 dB or even 0.5 dB of additional interference to be caused is little different from the present undesirable situation that has permitted the creation of substantial increased interference. It would actually be worse, because in eliminating the FCC rule inconsistency mentioned above, all stations would be permitted to increase interference, not just new stations or stations that do not now contribute to the calculated RSS.

Even if the amount of permissible interference for the second option were to be defined as 0.25 dB, the problem of potential abuse through multiple applications for 0.25 dB interference increases would still need to be solved. Further, when comparing the first option using an exclusion percentage of 25%, with the second option using a corresponding increased interference amount of 0.25 dB, the FCC rule inconsistency becomes immaterial. It would be very unlikely for an existing station to be prevented from making a desired change only because it cannot cause a 0.25 dB RSS increase; the protection requirements could easily be met through the choice of power or antenna pattern.

In support of the third option, which is to completely eliminate exclusion, it has been suggested that the AM band is mature and that interference protection is more important than new stations or improved facilities. While this may be an accurate assessment, the third option does present severe practical problems without offsetting benefits. It would be very burdensome to include *all* stations in the calculated RSS. There may be 50 or more stations on one channel in the U.S. alone. Those stations, foreign stations, and possibly adjacent-channel stations[15] would all have to be included. The task of data gathering and computation, even with modern computer data bases, would become monumental. Yet even the long-term incremental interference-protection benefits of the third option over those of a reduced exclusion percentage are on the order of only 1 dB. The third option is not attractive.

The above comparison supports Lahm's conclusion that the existing RSS exclusion principle be retained but the exclusion percentage reduced to 25%. Such a change in the RSS calculation method would make the RSS a more accurate indicator of true interference levels on a channel. Predictions of coverage would be more accurate, causing the calculated interference-free contour level for some stations to change as much as several dB.

E. Future Interference Levels

One should not be overly optimistic about the effect that a change in RSS calculation method would have on interference levels in the AM band. Changing the exclusion method would not change the actual level of nighttime interference, it would change only the calculated level. No stations would be required to cause less interference if the exclusion method were changed. At best, an improved exclusion method can only prevent or reduce future increases in interference. Therefore, in evaluating the impact on interference of a new exclusion method, the important question is: how much does the actual interference level that could eventually exist differ from what now exists?

Consider a hypothetical Station A on a channel with 15 other nighttime signals. Station A's actual nighttime interference level, represented by its total RSS of 5.00 mV/m, is made up of contributions from all 15 of those signals. However, the present 50%-exclusion RSS of 3.50 mV/m understates that interference by about 3 dB. With 50% exclusion, a new interference contribution of 1.74 mV/m could be added, which would increase the total RSS to 5.29 mV/m, an increase of 0.49 dB. With 25% exclusion, a new interference contribution of 0.87 mV/m could be added, which would increase the total RSS to 5.08 mV/m, an increase of 0.14 dB. If exclusion were eliminated entirely, no increase would be possible, of course.

In this example, changing from 50% to 25% exclusion would make only a 0.35 dB difference in the amount of actual new interference that could be created by a new station. Eliminating exclusion entirely would make less than 0.5 dB difference. The small differences are a result of the maturity of the AM band, which has many stations per channel and significantly understated interference levels.

Although Station A was a hypothetical example, it is not unrepresentative. A computer study of many stations could be performed to better characterize the actual differences in effect between the various exclusion method alternatives. Even without such a study it is clear that, due to the maturity of the AM band, a change in RSS calculation method is unlikely to have a major impact on future interference. The effect on interference-free contour accuracy is much more significant.

F. The Effect of Multiple 10% Interferers

The existing RSS calculation method combines the 10%-time field strengths of all interfering signals to determine the total interference level. It might appear that the calculation procedure assumes "worst case" conditions; each interferer is assumed to be continuously present even though the 10%-time interference level is used in the calculation. Perhaps the present calculation method yields artificially high estimates of interference under multiple-interferer conditions. This section of the report demonstrates that the existing RSS calculation

15 See the discussion of adjacent-channel skywave interference in Section VI-G of this report.

method is indeed a proper procedure for combining multiple 10% interferers.

Section 73.182(l) of the FCC Rules defines interference to exist when the skywave field strength of an undesired station, or the RSS interference level of two or more stations, exceeds specified levels for 10% or more of the time. In other words, the total interference, as defined in theory, is considered to be the 10%-time value of the RSS combination of the individual interferers.

The definition differs from the following procedure which is used, in practice, to calculate the total interference:

1. The 10%-time field strength of each interfering signal is determined using the curves and formulas in Figures 1a, 1b, or 2, as appropriate, of Section 73.190
2. The individual 10%-time field strengths are combined in the RSS formula.

In other words, the total interference, as calculated in practice, is considered to be the RSS combination of the 10%-time values of the individual interferers.

Thus for the results of interference calculations to be correct, the 10%-time value of the RSS combination of the interferers must be equal to the RSS combination of the 10%-time values of the interferers. This equivalence is not intuitively obvious. However, its validity is demonstrated in the paper by Anderson, "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers," which is attached as Appendix F. Anderson's paper, prepared for inclusion in this report, directly addresses the issue of interference from multiple interferers. He has also provided a computer program, SKYIN, described in Appendix G, which permits interested users to perform their own calculations.

Anderson analyzes multiple interferers statistically, explicitly taking into account the continuous voltage variation of each one. In Section 7.0 of his paper he demonstrates that, regardless of the number or amplitude of the multiple interferers, the effect of the sum of the interferers on the signal-to-interference ratio is the same as the effect of a single interferer with equivalent power. Therefore, the existing RSS calculation method produces correct estimates of total 10%-time interference even though the 10%-time values of the interferers are individually specified prior to calculating the RSS.

G. Adjacent-channel Skywave Interference

It is apparent from Section V of this report that first-adjacent-channel signals can produce significant amounts of interference. Yet the FCC Rules provide no interference protection from nighttime adjacent-channel skywave interference. It is likely that much of the increased nighttime interference on the AM band over the last 40 years is due to adjacent-channel skywave signals.

Two approaches have been suggested for treating adjacent-channel skywave signals. In the Notice, the Commission suggests that one alternative would be to amend Section 73.182(n) of the Rules to require inclusion of skywave signals in the calculation of the adjacent-channel RSS.[16] While this alternative would result in accounting for adjacent-channel skywave interference in allocation studies, it would be a cumbersome method of achieving that desirable end. It would require additional time-consuming calculations, calculations that are not now normally required because, as described below, Section 73.182(n) is not pertinent to most nighttime allocation situations.

A station's protected daytime contour, which is generally the 0.5 mV/m contour, is usually more extensive than its protected nighttime contour. Therefore, the prohibition against daytime 0.5 mV/m contour overlap of adjacent-channel stations results in the two stations being so far apart that there is seldom any calculated adjacent-channel groundwave interference at night. If skywave signals were required to be included in the RSS calculations of nighttime adjacent-channel interference specified by Section 73.182(n), new RSS calculations would be required at numerous points along the protected contour.

The Commission's other suggested alternative, which is to include adjacent-channel skywave signals in conventional RSS calculations, would be a far better way to take account of adjacent-channel interference in allocation studies. A typical nighttime allocation study consists of RSS limit calculations for the pertinent stations on the proposed channel, with a showing that the proposed operation would not enter any RSS that is above the normally protected value. This showing is included in the application for construction permit.

Most RSS calculations are now done by computer. The co-channel stations to be included in the study are selected, the computer calculates the skywave field strengths of each station at each chosen site, and the RSS at each site is computed using the 50% exclusion rule. It would be a relatively simple task to include adjacent-channel stations in the study and to redefine the RSS formula to include adjacent-channel skywave signals weighted by the appropriate protection ratio. The application showings now required could be retained, but with the inclusion of adjacent-channel data. Substantial additional engineering time would not be required.

Inclusion of adjacent-channel skywave signals in the RSS would be in accordance with the CCIR methods in [9] and with procedures specified in the 1982 Region 2 Agreement [10]. Each specifies a formula for usable field strength which includes weighted adjacent-channel signals in an RSS calculation.

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In addition to the funding provided by the National Association of Broadcasters, Hammett & Edison provided

16 Section 73.182(n) now specifies the inclusion of only groundwave signals in the calculation of the RSS value of undesired adjacent-channel field strengths.

significant resources of its own toward the completion of this report. The author is grateful for the firm's generous support.

Several individuals made substantial contributions to this report. Robert P. Smith, Jr., of Hammett & Edison developed the user-friendly ADJACENT programs from Gröschel's original work. Robert Orban of Orban Associates, Inc., San Francisco, supplied the design of the NRSC filter used in the computer programs. Bronwen L. Jones, consultant, helped in the evaluation of alternative psophometric curves. Richard A. Kennedy and James T. Gotshall of Delco Electronics Corporation helped to interpret adjacent-channel protection ratio data and supplied information about future NRSC receiver parameters. Karl D. Lahm, P.E., of Karl D. Lahm & Associates, Inc., Fairfax, Virginia, provided helpful insight on RSS issues.

Special thanks go to Harry R. Anderson, P.E., of H. R. Anderson & Associates, Inc., Eugene, Oregon. Mr. Anderson wrote computer programs EMIN and SKYIN and the paper of Appendix F. He was also instrumental in the preparation of the text sections on atmospheric and man-made noise, minimum usable field strength, and the effects of multiple 10% interferers. His knowledge of communications engineering principles, and his patient answers to innumerable questions, were greatly appreciated.

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[10] "Final Acts ... ," *op.cit.*, Annex 2, Section 4.7.1.

Appendix A

"Characteristics and Applications of Atmospheric Radio Noise Data." CCIR Report 322-3, XVIth Plenary Assembly, Dubrovnik 1986.

Appendix B

"Man-made Radio Noise." CCIR Report 258–4, XVIth Plenary Assembly, Dubrovnik 1986, Vol. VI, pp. 207–214.

Appendix C
Instructions for Operation of Program "EMIN"

Introduction

These instructions describe the operation of a computer program for the calculation of minimum usable field strength, E_{min}.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. The master diskette contains the executable file EMIN.EXE. The source code file EMIN.FOR is available on a separate diskette from NAB upon request. The program may be copied, such as to a hard disk, but no additional disk space is necessary for program execution. The program was compiled with Microsoft FORTRAN v4.01 and is designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run more slowly. A coprocessor-equipped machine is recommended.

All output data appears on the screen. Neither a printer nor graphics capability is required.

Program description

The noise environment for AM broadcast reception is dominated by two noise types: atmospheric and man-made noise. Both are typically characterized as non-gaussian, white noise processes that are non-stationary; that is, their statistical properties change with time and bandwidth. To estimate E_{min} in the presence of this type of noise, the statistical properties of the noise must be evaluated in a specified bandwidth.

The program allows the user to specify any desired set of parameters to define the grade of service, average noise power, statistical variation of the noise, bandwidth, frequency, and the parameters needed to assess the time availability and service probability. Operation of the program is self-explanatory using the information displayed during the run.

Grade of service

The program first performs a grade of service analysis, finding the level of signal necessary to be above the noise level by the specified number of dB for the specified percentage of time. This is found by evaluating the amplitude probability distribution (APD) function for the noise. The APD function gives the instantaneous noise level exceeded a certain percentage of time relative to the rms noise level. The APD function used in the program is a computer model presented in [1], which approximates the empirical descriptions presented in CCIR Report 322-3. Based on the studies in [2], both atmospheric and man-made noise have similar statistical properties, so the same APD computer model can be used for both types.

The three parameters used to construct the APD are F_{am}, V_{dm}, and bandwidth. F_{am}, which represents the average noise power, moves the amplitude of the APD up or down but does not affect its shape. The shape of the APD is determined by V_{dm} and bandwidth. The value of V_{dm} given in the noise measurement data is for an effective noise bandwidth of 200 Hz. Its value is automatically adjusted by the program to the actual noise bandwidth, using the equations found in [3]. For atmospheric noise, the program user obtains the value for V_{dm} from the graphs in Report 322-3. For man-made noise, the values for V_{dm} were derived from [2] and are built into the program.

Time availability

The result of the grade of service analysis is a signal level, R (dB), which is the level of the required received signal above the average noise level. This indicates that the specified grade of service will be available for 50 percent of the time since the calculation of R was based on the median value, F_{am}. If a higher time availability is required, the value of F_{am} is adjusted based on its statistical variation, as indicated by the upper decile, D_u. For example, for a time availability of 90 percent, the value of F_{am} is adjusted upward by adding the value of D_u, since the 90-percent point is exactly the upper decile value.

The value of F_{am}, as adjusted, is F_a. The program automatically adjusts F_{am} for a specified time availability. For atmospheric noise, this is done using the D_u supplied by the user. For man-made noise, the values for D_u were taken from [2], if available, and are built into the program.

With the value of F_a and R known, the program calculates the value of E_{min} using the equation

$$E_{min}\ (\text{dBmV/m}) = F_a + R + 10\log_{10}(\text{BW}) + 20\log_{10}f_{\text{MHz}} + 48.5$$

where E_{min} is the minimum usable field strength, in dB relative to 1 mV/m

BW is the effective noise bandwidth in Hz, and

f_{MHz} is the frequency in MHz.

Service probability

The value for E_{min} calculated using the above equation is only an estimate. Since median values for all parameters were used to determine this value for E_{min}, this estimate provides the specified grade of service for the specified time availability for only 50 percent of the paths or circuits. This is equivalent to a service probability of 50 percent.

To increase the service probability, or confidence level, above 50 percent, E_{min} must be increased to take into account the uncertainties in the estimates of the parameters used to determine E_{min}. The uncertainty or variability in any estimate is indicated by its standard deviation, or σ value. Each of the parameters that was used to formulate the variables in the equation for E_{min} (F_{am}, V_{dm}, D_u) has an associated standard deviation which is provided in Report 322-3. For man-made noise, these parameters are generally not available and will therefore appear in the output as zeros.

A fourth element of uncertainty is the accuracy with which a given value of field strength can be predicted. When calculating the signal required to produce a desired signal-to-noise ratio, the signal is assumed to be known and constant. In reality it, too, varies from its expected value. This uncertainty is represented by the standard deviation of the expected received signal strength. For AM broadcast groundwave signals, considerable differences may exist between the actual and the predicted field strength due to uncertainties in the ground conductivity, reflections from nearby metallic objects (wires, buildings, towers), or physical elements (hills and abrupt conductivity boundaries) along the propagation path. These uncertainties are not accounted for in the current FCC field strength prediction method. Based on a relatively small amount of data, one study [4] found that the standard deviation of actual field strengths compared to predicted field strengths was about 1.4 dB. For skywave or other types of propagation paths, another value may be more appropriate.

With all four standard deviations or uncertainty factors identified, the total uncertainty can be found as the root-sum-square of the four individual standard deviations. That is, the variance of the final estimate for E_{min} is equal to the sum of variances of each constituent part of E_{min}. This summing operation is performed by the computer program.

With the total standard deviation, σ_T, found for the estimated E_{min}, E_{min} can be adjusted for service probabilities other than 50 percent. Assuming the variation is normally distributed, E_{min} is increased by $\sigma_T t$, where t is the standard normal deviate. For a service probability of 50 percent, t equals 0. For a service probability of 90 percent, t equals about 1.28. The program automatically evaluates t to determine the final adjusted value of E_{min} that achieves the required service probability.

Program execution

The program is run by typing "EMIN<ret>". A title screen will appear, followed by an instruction screen. The user is then asked sequentially for the required input data as discussed above. When all data has been entered, the program will display "Working . . ." while E_{min} is being calculated.

When the calculation is complete, a results screen will be displayed which tabulates all of the input data and the calculated value of E_{min}. Results can be printed using the "PrtSc" keyboard command. The user can then select another run or exit from the program.

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Appendix D

Gröschel, G: "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems." EBU Review – Technical, No. 169, June 1978, pp. 122–136.

Appendix E
Instructions for Operation of Program "ADJACENT"

Introduction

These instructions describe the operation of a computer program for the calculation of relative adjacent-channel protection ratio, A_{rel}.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. Protection ratio calculations require two BASIC programs, ADJACENT and ADJPRO. ADJACENT is a user-friendly data entry program; ADJACENT chains to ADJPRO, which is the program that does the calculations. Execution of the two programs may also generate other files.

The master diskette contains executable files (ADJACENT.EXE, ADJPRO.EXE) for both programs and contains three other related files (ADJPRO.DAT, NRSC.FSR, NRSC.OUT). The source code files (ADJACENT.BAS, ADJPRO.BAS) are available on a separate diskette from NAB upon request. Additional disk space is needed for program execution so the master diskette programs should be copied to a hard disk or separate floppy prior to use. The programs were compiled with Microsoft QuickBASIC v3.0 with coprocessor support and are designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run extremely slowly (one run may take 30 minutes or more, compared to about 60 seconds with a coprocessor). A coprocessor-equipped machine is highly recommended.

A printer will provide a hard-copy of the output data, but the program will run without it (output data can be viewed on the screen). Plotting and graphics routines are not included as there is no standard plotting or graphics protocol for the PC.

Program setup

Users should familiarize themselves with the paper, "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems," by G. Gröschel, published in the E.B.U. Review – Technical, June 1978. The computer program is modeled directly on the techniques described in the paper. During program setup, the user defines the subfunctions corresponding to each technical parameter that contributes to the overall transmitter and receiver response. These consist of:

- F0: the carrier (can be suppressed for single-sideband transmission)
- F1: spectral power density of the modulation signal
- F2: transmitter band limiting
- F3: transmitter preemphasis
- F4: transmitter out-of-band radiation
- F5: transmitter noise
- F6: receiver band limitation
- F7: psophometric curve
- F8: receiver deemphasis
- F9: receiver notch filter
- F10: receiver out-of-band selectivity.

In addition, the user specifies a "modulation factor," discussed in the Gröschel paper and below, which takes into account the depth of modulation and the amount of compression.

The program is run by typing "ADJACENT<ret>." The setup screen then appears; the help screen (press <F1>) explains how to use the setup screen. Once all fields are showing the correct information, typing "X" (no return) executes ADJPRO. Typing <Esc> exits the program. Typing either "X" or <Esc> will save the current setup screen data in the file ADJPRO.DAT.[1]

Following is a description of the fields in the setup screen:

Transmission mode. Select DSB/ISB (double sideband/independent sideband) or SSB (single sideband). Selection of mode automatically modifies the various subfunctions, and changes the setup screen, to match the mode requirements. This is discussed in detail below.

Type of study. Select SINGLE or SWEEP, and enter the difference frequency (dF) or difference frequency range and step size to be used. To obtain first- and second-adjacent-channel protection ratios, select SWEEP, with dF=10000 Hz to 20000 Hz every 10000 Hz.

FS/FR functions. Select COMPUTED, FROM DISK, or FROM KEYBOARD. Normal mode is COMPUTED, in which FS (the composite transmitter response) and FR (the composite receiver response) are calculated at the time of program execution from the transmitter and receiver subfunctions (F0 through F10) specified below. FROM DISK indicates that previously stored FS and FR values, if any, will be retrieved from disk. (The file name of the stored values will be requested at time of program execution.) FROM KEYBOARD permits FS and FR, from -25,000 Hz to +25,000 Hz in 100 Hz steps, to be manually entered. Use of FROM KEYBOARD is expected to be rare.

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[1] As supplied on the master diskette, ADJPRO.DAT contains the settings for NRSC transmission and "Ideal" NRSC reception, as defined in Section V of the report.

Tabulate subfunctions. Select YES or NO. If YES, select frequency range from low to high. Selection of YES will print out FS, FR, and F0 through F10, at 100 Hz increments across the selected range.

Print FS/FR. Select YES or NO. Selection of YES will print out FS and FR from 0 Hz to ±25,000 Hz in 100 Hz increments.

Allow changes to FS/FR. Select YES or NO. Selection of YES will allow changes to FS and FR at any desired frequency to be manually entered from the keyboard. If FS/FR are COMPUTED, Print FS/FR is YES, and Allow changes to FS/FR is YES, then FS/FR will first be computed and printed for examination before the program asks for changes.

Save FS/FR to disk. Select YES or NO. Selection of YES will cause FS/FR values to be saved to a disk file for future use. At the time of execution, the program will ask for the filename to be used. FS/FR filenames will automatically be given the extension ".FSR".[2]

Modulation spectrum. Select USASI NOISE or CCIR NOISE. USASI noise has been recently used to characterize modern U.S. program material.

Modulation factor. Enter value from 0.01 to 2.00. An appropriate value for very highly compressed program material is 1.00. Modulation factor is related to "loudness." It affects the peak level of the sideband energy, A_m, but does not affect its shape, which is defined by F1, F2, and F3. While at first it might appear that the choice of modulation factor is critical, in fact it has a negligible effect on A_{rel}. Any overall change in sideband energy will indeed affect the adjacent-channel protection ratio, A, but its effect on the co-channel protection ratio, A_O, will be essentially equal. Since $A_{rel} = A - A_O$, A_{rel} will be affected little.[3]

TRANSMITTER DATA

Band limiting. Select LOW PASS, IDEAL, NRSC, or AK-5. If LOW PASS or IDEAL is selected, screen will also ask for filter parameters. Band limiting characteristic depends whether DSB/ISB or SSB transmission mode was selected. If SSB is selected, the screen will also prompt for carrier reduction and undesired sideband suppression. The filters have the following characteristics:

LOW PASS is an nth-order Butterworth filter of the selected attenuation rate and bandwidth. For DSB/ISB mode, the response is 3 dB down at ± the selected bandwidth, and attenuates at the specified rate above and below the passband. For SSB mode, the response has the same attenuation rate, but a lower 3 dB point of 0 Hz.

IDEAL is a filter with flat response within the selected bandwidth and, for DSB/ISB transmission, 100 dB attenuation at the ± cutoff frequencies and beyond. For SSB transmission, the filter is down by the selected amount of undesired sideband suppression from 0 Hz to the negative cutoff frequency, and is 100 dB down at that frequency and beyond.

NRSC is a 9th-order elliptic-function filter with a passband of ±9600 Hz (0.162 dB ripple) and a stopband of ±10,100 Hz (minimum attenuation 50 dB). NRSC is not available in SSB mode.

AK-5 is a 4500 Hz, 60 dB/octave filter characteristic used in Germany. It is not available in SSB mode.

Preemphasis. Select NONE, TC, or NRSC. If TC is selected, the screen will also prompt for time constant in microseconds.

Noise. Enter residual noise in dB below carrier. Typically assumed to be 100 dB down.

Out-of-band radiation. Select CCIR, NRSC MAX, or NRSC TEST. CCIR is the out-of-band radiation subfunction described in the Gröschel paper. If CCIR is selected, the screen will also prompt for intermodulation attenuation ("IM atten") in dB, which is typically assumed to be 30-40 dB. NRSC MAX and NRSC TEST are the maximum limits and test limits, respectively, of the emission limitation for AM broadcast transmission specified in NRSC Standard No. NRSC-2. This parameter has a significant effect on second-adjacent-channel protection ratios.

Carrier reduction. Only used with SSB transmission. Enter carrier reduction in dB below full carrier.

Undesired sideband suppression. Only used with SSB transmission. Used to specify undesired sideband suppression in ideal band limiting filter (see above).

RECEIVER DATA

Band limiting. Select LOW PASS, NRSC, or MBF. If LOW PASS is selected, the screen will also prompt for filter parameters. Band limiting characteristic depends whether DSB/ISB or SSB transmission mode was selected. The LOWPASS and NRSC filters are specified identically to those in the transmitter data. The MBF filter simulates an E.B.U. reference receiver. NRSC band limiting is not available in SSB mode.

Deemphasis. Select NONE, TC, or NRSC. If TC is selected, the screen will also prompt for time constant in microseconds.

Psophometric curve. Select CCIR-468 or CCITT-P53. CCIR-468 is most appropriate for medium-wave AM broadcasting. The psophometric curve represents the objectionability of sound as a function of frequency. It is needed in the calculations because, for adjacent-channel signals, the interfering frequencies are shifted by 10 kHz or 20 kHz

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2 As supplied on the master diskette, NRSC.FSR contains FS for NRSC transmission and FR for "Ideal" NRSC reception.

3 This is true in the usual case where the adjacent-channel interference is dominated by the sideband energy, not by the carrier energy. If the carrier energy were the dominant contributor to adjacent-channel interference, a change in sideband energy would affect A_O and A_{rel}, not A.

and the energy contribution at each frequency must be properly weighted to correspond to the sensitivity of the ear.[4]

Out-of-band selectivity. Enter response in dB. Typically assumed to be 100 dB down.

Notch filter. Select NONE, IDEAL, or LC. If IDEAL or LC selected, the screen will prompt for resonant frequency Fr. IDEAL puts a 200 dB notch at exactly the selected frequency. If LC is selected, the screen will prompt for other LC notch filter parameters as described in the Gröschel paper.

Program execution

When all setup screen fields are as desired, pressing X will exit ADJACENT and execute ADJPRO. If FS/FR are to be retrieved from disk, the program will display all .FSR files and prompt for a selection. If FS/FR are to be input from the keyboard or changed, the program will prompt for the data. FS/FR will be printed if so specified. If FS/FR are to be saved to disk, the program will ask for a filename (extension .FSR will always be assigned).

When FS/FR calculations have been completed, the screen will display the following: a summary of input data; the three calculated Gröschel parameters of equivalent bandwidth Be, maximum power density Am, and out-of-band radiation factor Kr (if CCIR is selected); and a scrolling table of calculated protection ratios. If only a few frequency separations are being calculated, all input and output data will be simultaneously visible.

The program will ask whether output is to be printed, and then whether it is to be saved. Output can be saved in a user-specified filename and reviewed later at DOS level, using a TYPE command or other available file-examination utility.[5] After the two questions have been answered, the program returns to the ADJACENT setup screen for another run. If no other run is desired, type <Esc> to exit.

Output data

The program displays the relative adjacent-channel protection ratio Arel, and the contribution to Arel of the carrier (Atr) and the sidebands (Asb) of the adjacent-channel signal. Arel is a power summation of Atr and Asb. Users are encouraged to read the discussions in the Gröschel paper on interpretation of data and limitations of the numerical method. In particular, note that the relative adjacent-channel protection ratios calculated by the program are based on a determination of power. The numerical method does not take into account the additional 3 dB of co-channel noise suppression that results from coherent detection of the desired signal in the receiver. Therefore, values of A_{rel} calculated by the computer program must be corrected by –3 dB.

Program modification

Users with access to a QuickBASIC compiler are encouraged to modify the programs to meet their individual requirements, such as to include alternative subfunctions. Note that the program contains mathematical expressions that must be compiled on a coprocessor-equipped machine, using QuickBASIC with coprocessor support.

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4 The psophometric curve is defined in equal 100 Hz increments, as are the other subfunctions. The program does not differentiate between a single tone and an equal-energy 100 Hz band of noise, even though the tone would be psychoacoustically more objectionable. Therefore, even though a protection ratio calculation may indicate that the interfering carrier does not contribute significant adjacent-channel interference, implying that a 10 kHz notch filter would make no audible improvement, a psychoacoustic test might show a notch filter to be effective.

5 As supplied on the master diskette, NRSC.OUT contains the output for calculations of A_{rel} at 10 kHz and 20 kHz under conditions of NRSC transmission and "Ideal" NRSC reception.

Appendix F

Anderson, H.R.: "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers."

SIGNAL-TO-INTERFERENCE RATIO STATISTICS FOR AM BROADCAST GROUNDWAVE AND SKYWAVE SIGNALS IN THE PRESENCE OF MULTIPLE SKYWAVE INTERFERERS

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Abstract - **The development of a statistical description of the signal-to-interference ratio (SIR) for AM broadcast groundwave and skywave signals in the presence of multiple skywave interference signals is presented. The analysis assumes that the interfering signal envelope amplitudes are Rayleigh-distributed random variables with a lognormal distribution used to describe the long-term variations of the sum envelope amplitude. The resulting statistical description is used to evaluate the SIR degradation for a number of "interference exclusion" formulas under consideration for frequency allocation purposes.**

1.0 INTRODUCTION

Describing the statistics of the signal-to-interference ratio (SIR) of AM broadcast groundwave signals in the presence of multiple skywave interfering signals is important to understanding the reception and coverage possibilities of an AM broadcast station. Previously, the SIR has been calculated assuming the skywave fields were static; that is, not varying with time. With a constant desired groundwave signal amplitude, the resulting SIR was also a constant quantity.

It is the intent of this paper to consider the statistical variations of the combined skywave signals and to develop a statistical description of the SIR. This description is in the form of a probability density function (pdf) and associated cumulative distribution function (cdf). The cdf can be directly used to determine the percent time for which a given SIR is exceeded.

Following the analysis for a constant amplitude desired groundwave signal, the method will be extended for the case when the desired signal is a time-varying skywave signal.

2.0 SKYWAVE SIGNAL AMPLITUDE STATISTICS

AM broadcast skywave signals propagate primarily during nighttime hours by means of electromagnetic energy radiated from the transmitting antenna reflecting off the ionosphere and returning to earth at some distance from the transmitting antenna. AM broadcast signals reflect off both the E layer of the ionosphere at about 100 km above the earth and from the F layer at about 220 km above the earth. In North America, the dominant skywave propagation mechanism is via the E layer with an average altitude taken to be 100 km [1].

The amplitude of a skywave signal as received on earth varies primarily due to two mechanisms - the changing altitude and charged particle density in the reflecting layer and the fact that the skywave signal as received is actually the composite sum of several signals reflecting from different parts of the reflecting layer. The amplitude of each constituent part of the signal varies in amplitude and phase due to the changing layer characteristics. It can be shown [2] that with as few as six such reflecting signals, the amplitude variation of the sum is a gaussian-distributed random variable while the phase (relative to some arbitrary fixed reference) is a uniformly-distributed random variable.

For a signal with a gaussian-distributed total amplitude, the probability distribution of the envelope of that signal is Rayleigh-distributed. As the signal amplitude varies, the received signal appears to "fade" in and out, being louder and less noisy at times and weaker and more noisy at other times. Since the amplitude variation is Rayleigh-distributed, the term "Rayleigh-fading" has been used to describe this effect. The nature of the amplitude distribution of the skywave signal has been confirmed by measurements [3].

The pdf for the random variable v with a Rayleigh distribution is given by

$$p_V(v) = \frac{v}{\sigma^2} \exp\left[\frac{-v^2}{2\sigma^2}\right] \qquad (1)$$

The corresponding cdf is given by

$$P_V(v) = 1 - \exp\left[\frac{-v^2}{2\sigma^2}\right] \qquad (2)$$

The voltage amplitude which is exceeded 50 percent of the time (median) can be readily found by integrating the pdf as follows:

$$0.5 = \int_v^\infty p_V(v)\,dv = \exp\left[\frac{-v^2}{2\sigma^2}\right] \tag{3}$$

which yields a median value of 1.177σ. Similarly, the voltage exceeded 10 percent of the time is:

$$0.1 = \int_v^\infty p_V(v)\,dv \tag{4}$$

This gives a 10 percent time voltage of 2.146σ.

From this it is apparent that the voltage exceeded 10 percent of the time for a Rayleigh distribution is always about 5.2 dB higher than the median voltage. If the 10 percent time voltage is known or calculated using propagation curves, it can be used to find σ and thereby fully describe the distribution.

While measurements show that the short term (within an hour) variations in the signal envelope amplitude are Rayleigh-distributed, measurements taken over a longer period of time (from days to months) show a statistical variation in the median received field strength which is more closely described by a lognormal distribution [3,4].

The lognormal pdf is given by

$$p_V(v) = \frac{1}{v\sqrt{2\pi\sigma^2}} \exp\left[\frac{-(\ln v - a)^2}{2\sigma^2}\right] \tag{5}$$

where a is the mean value. The lognormal cdf is given by

$$P_V(v) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{(\ln v - a)}{\sigma\sqrt{2}}\right)\right] \tag{6}$$

where erf is the error function.

As shown above, the 10 percent time voltage for the Rayleigh distribution is only 5.2 dB above the median value. However, it is common in currently employed skywave field strength prediction methods to set the 10 percent time value at 8 dB [5] or 10 dB [1] above the median value, indicating that the lognormal distribution is the appropriate choice to describe the long term variations in the skywave signal strength.

3.0 COMPUTATION OF THE COMPOSITE INTERFERENCE PDF

In most situations, the total skywave interference at a given point in a station's coverage area is the sum of several co-channel interfering signals arriving from different stations with different power levels and transmitting antenna characteristics. Typically, the interfering signal from each is computed using the 10 percent time amplitude FCC propagation curves, and taking into account the interfering station's radiated power and antenna radiation characteristics at the appropriate vertical departure angle which results in an ionospheric reflection at the given point in the desired station's coverage area.

The total power in the composite interfering signal is the sum of the power of the contributing interfering signals. This power is given by the envelope voltage squared divided by the receiver input impedance. As shown above, for each interferer the 10 percent voltage can be used to find σ^2 which is then an indication of the power contributed by that interferer.

The problem of adding up the interfering signals can be easily solved by recognizing that each interfering envelope voltage can be resolved into quadrature voltage components, each of which is a gaussian random variable (r.v.). The gaussian quadrature components of all the interferers can then be added to yield a composite gaussian r.v. with σ^2 of the sum equal to the sum of the constituent σ^2 from each interferer and with a mean value equal to the sum of the mean values. If $N(a,\sigma^2)$ is used to indicate a normal or gaussian-distributed r.v., then the distribution of the sum of any M gaussian r.v.'s is given by:

$$N\left[\sum_{m=1}^{M} a_m\,,\ \sum_{m=1}^{M} \sigma_m^2\right] \tag{7}$$

Since all of the skywave signals have zero mean values (i.e., no d.c. component), the sum of the mean values a_m in (7) is zero.

Each of the individual σ_m^2 can be found from the predicted 10 percent time voltage as described above. By summing the σ^2 for both quadrature components, the quadrature components can then be used to find the Rayleigh distribution of the composite envelope voltage with

$$\sigma_T^2 = \sum_{m=1}^{M} \sigma_m^2 \tag{8}$$

This composite σ_T^2 can now be used to find the median value of the Rayleigh distribution which describes the total interference; that is, median $= 1.177\sigma_T$. This median value is then used for a in the lognormal distribution pdf equation given in (5). The standard deviation of the lognormal distribution as indicated by σ in (5) can be set to correspond to 8 or 10 dB as found in [5] or [1]. For FCC purposes, the upper decile value is 8 dB above the median, which corresponds to $\sigma = .72$ in equation (5).

The value of σ in the lognormal distribution given above produces the appropriate distribution when the voltage levels are around 1 mV/m or less. At higher voltage levels, the distribution is somewhat skewed.

It is recognized that this transition from the Rayleigh distribution to the lognormal distribution is a simplified, ad hoc approach. This ad hoc approach is not incorrect,

however, because the empirical data on skywave amplitudes generally falls between a Rayleigh distribution and a lognormal distribution. In other words, the distribution of amplitudes cannot be strictly characterized as Rayleigh or lognormal using some statistical-physical model of the ionospheric reflection mechanism. The distributions are approximate, empirical models which represent a reasonable match to the data. However, a more refined analysis of the interdependence of the two distributions can be done. This analysis is presented in the next section.

4.0 CONDITIONAL DISTRIBUTION OF RAYLEIGH SKYWAVE SIGNAL AMPLITUDES

In [4], the skywave amplitude is described as being Rayleigh-distributed over short periods (hours) with the median hourly value of this Rayleigh distribution itself a random variable (over long periods) with a lognormal distribution. The envelope voltage at any time, then, is a conditional Rayleigh probability density function which depends on lognormally-distributed median values.

If $p_V(v)$ represents the pdf over all time, then $p_V(v|s)$ represents the conditional pdf with median value s where s is a lognormally-distributed r.v. For a Rayleigh-distributed r.v., the median is proportional to the standard deviation ($s = 1.177\sigma$), so that one can write

$$p_V(v|s) = \frac{v}{(s/1.177)^2} \exp\left[\frac{-v^2}{2(s/1.177)^2}\right] \qquad (9)$$

Our objective is the unconditional pdf $p_V(v)$ which is given by

$$p_V(v) = \int_0^\infty p_V(v|s)\, p_S(s)\, ds \qquad (10)$$

where $p_S(s)$ is a lognormal pdf. Substituting the appropriate pdf's into (10) yields

$$p_V(v) = \int_0^\infty \frac{v}{(s/1.177)^2} \exp\left[\frac{-v^2}{2(s/1.177)^2}\right] \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[\frac{-(\ln s - a)^2}{2\sigma^2}\right] ds \qquad (11)$$

Rearranging terms results in

$$p_V(v) = \int_0^\infty \frac{1.385v^2}{s^3\sqrt{2\pi\sigma^2}} \exp\left[\frac{-v^2}{2(s/1.177)^2} + \frac{-(\ln s - a)^2}{2\sigma^2}\right] ds \qquad (12)$$

This somewhat cumbersome integral can be solved numerically to find the unconditional pdf for v over all time. The mean value of the lognormal distribution given by a in (12) would be found from the average of the hourly median values over a long period of time. As before, the value of σ can be chosen so that the voltage exceeded 10 percent of the time approximately matches the data.

5.0 COMPUTATION OF THE PDF FOR THE SIGNAL-TO-INTERFERENCE RATIO

The pdf for the SIR can be found by first converting the lognormal pdf from (5) in volts to a pdf in dBmW and doing the corresponding process for the desired signal amplitude in volts. The pdf of the SIR in dB is then found by subtracting the interference pdf in dBmW from the signal pdf in dBmW.

The signal amplitude in dBmW and the interference amplitude in dBmW are both random variables so that the SIR is also a random variable. The pdf of the sum (or difference) of two r.v.'s is given by the convolution of the pdf's, as follows:

$$p_Z(z) = p_X(z) * p_Y(-y) \qquad (13)$$

For this case, z represents the SIR, x represents the desired signal level in dBmW, and y represents the interference level in dBmW.

The process of converting the envelope voltage pdf in volts (or mV/m) to dBmW across 1 ohm starts with the relationship:

$$S = 20\log(\text{mV}) - 30 \qquad \text{dBmW} \qquad (14)$$

where S is power and mV is the voltage in millivolts. If the relationship between two quantities is known, the pdf for one can be found in terms of the pdf for the other using the following relationship:

$$p_S(s) = p_V(v)\left|\frac{dv}{ds}\right| \qquad (15)$$

Starting with (14) and performing the operations indicated by (15), the resulting pdf for the power s in dBmW is

$$p_S(s) = p_V\left(10^{((s+30)/10)}\right) 10^{((s+30)/10)} \frac{\ln 10}{20} \qquad (16)$$

The pdf for $p_V(v)$ is given by (5). To find $p_S(s)$, it is a matter of substituting the argument

$$10^{((s+30)/10)}$$

into equation (5) for v, and multiplying in the other components of (16), to arrive at the final equation for the pdf of s in dBmW.

The convolution in (13) can now be performed. Since this analysis was implemented on a computer, the convolution was done by a numerical method which is somewhat more efficient than the straight multiplication and summation approach. The technique goes as follows:

1. Take the Fast Fourier Transform (FFT) of each pdf
2. Multiply the two FFT's together
3. Take the inverse FFT of the result from step 2.

Since FFT's can be done very rapidly, this approach to a convolution is much faster than the straight multiplying method.

The convolution in (13) was performed using a constant desired signal amplitude of 1.0 mV/m (-30 dBmW across 1 ohm) and several different combinations of interfering signal amplitudes corresponding to various interference "exclusion" principles currently under consideration for frequency allocation purposes. Note that the pdf of the constant amplitude desired signal is simply a delta function at the signal level -30 dBmW.

Tables 1 through 5 show tabulations of various percent-time points for which the SIR is exceeded for the cases which were studied. The results show that for the addition of one interferer at the 50% exclusion level (that is; it would not be permitted if its amplitude were greater than 50% of the first interferer), that the SIR at the 50% time point is degraded by about 1 dB. This is found by comparing the 50% percent time points in Tables 1 and 2. For the 25% exclusion case, the degradation in SIR is about 0.27 dB (compare Tables 1 and 3). Similarly, for the four additional interferers and 50% exclusion, the SIR is degraded about 3 dB from the 1 interferer case. For 25% exclusion, the SIR is degraded by about 1 dB.

6.0 COMPUTATION OF THE PDF FOR THE SIR FOR A TIME-VARYING DESIRED SIGNAL

If the constant amplitude desired groundwave signal represented by z in (13) is replaced with a time-varying skywave signal (such as the 50% time secondary skywave service of Class I-A stations in the United States) the analysis in the last section can be repeated and a new set of SIR statistics produced for such skywave coverage areas. The lognormal pdf for the desired signal is established using the 50% time (median) value and the same σ value used before to set the upper decile point at 8 dB above the median. Convolving the resulting desired signal pdf in dBmW with the combined interference pdf in dBmW yields the SIR pdf.

The results of this process are shown in Tables 6 through 10. The tables show that the 50% time degradation in SIR is about what it was for the constant amplitude case. However, the standard deviation of the SIR is much greater owing to the spread in the desired signal amplitude. The 90% time point for the single interferer case (Table 6) is about 11 dB below the median value. The relative differences in the SIR statistics between the 50% exclusion and 25% exclusion cases are the same as for the constant amplitude desired signal case discussed in Section 5.0.

7.0 IMPACT ON SIR OF MULTIPLE INTERFERERS VERSUS A SINGLE INTERFERER

For frequency allocation purposes in the United States, it is common to use the root of the sum of the squares (RSS) of the amplitudes of multiple interferers to arrive at an indication of the signal-to-interference ratio. Currently, this RSS calculation is done using the 10 percent time signal amplitudes for each of the interferers as given by the appropriate propagation curve. This procedure suggests to some that a "worst case" assumption has been made that the 10 percent time signal level from each interferer is continuously present rather than present or exceeded only 10 percent of the time.

It is easy to show that the probability of multiple independent interferers all exceeding their 10 percent levels simultaneously at any given time is much smaller than 10 percent. However, only considering whether or not a 10 percent threshold is exceeded provides a very incomplete description of the sum voltage of multiple interferers since the contributing voltages involved are continuous, rather than discrete, random variables. To find the complete statistical description of the sum voltage, an approach like that taken in Section 3.0 of this paper must be used where the continuous statistical voltage variation of the constituent interferers is explicitly taken into account.

Consider the case of N interferers where the rms voltage of the ith interferer is given by $\sqrt{2}\sigma_i$. From Section 2.0, for a Rayleigh distribution the 10 percent time voltage is $2.146\sigma_i$. The RSS of the 10 percent time voltages of this set of N interferers is then

$$\text{RSS} = \sqrt{\sum_{i=1}^{N}(2.146\sigma_i)^2} \tag{17}$$

$$\text{RSS} = \sqrt{4.605\sum_{i=1}^{N}\sigma_i^2} \tag{18}$$

Now consider a single interferer with an rms voltage $\sqrt{2}\sigma_0$ and with a power level equal to the sum of the powers of the N individual interferers. The total power for the sum of the N interferers is the sum of the individual powers. The individual power for each (across 1 ohm) is given by the rms voltage squared, or $2\sigma_i^2$. The sum of these powers is then

$$\text{Total power} = P_T = \sum_{i=1}^{N} 2\sigma_i^2 \tag{19}$$

The equivalent single interferer will have a power equal to P_T. The power of this single interferer across 1 ohm is also equal to its rms voltage squared, or $2\sigma_0^2$.

TABLE 1

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	26.11 dB
80	28.86
70	30.84
60	32.54
50	34.12
40	35.70
30	37.40
20	39.38
10	42.13

TABLE 2

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.09 dB
80	27.85
70	29.83
60	31.52
50	33.11
40	34.69
30	36.39
20	38.37
10	41.12

TABLE 3

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.83 dB
80	28.58
70	30.57
60	32.26
50	33.85
40	35.43
30	37.12
20	39.11
10	41.86

TABLE 4

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m
10% time amplitude of interferer 3: 0.0250 mV/m
10% time amplitude of interferer 4: 0.0250 mV/m
10% time amplitude of interferer 5: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.96 dB
80	25.71
70	27.69
60	29.39
50	30.97
40	32.55
30	34.25
20	36.23
10	38.98

TABLE 5

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m
10% time amplitude of interferer 3: 0.0125 mV/m
10% time amplitude of interferer 4: 0.0125 mV/m
10% time amplitude of interferer 5: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.09 dB
80	27.85
70	29.83
60	31.52
50	33.11
40	34.69
30	36.39
20	38.37
10	41.12

TABLE 6

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.79 dB
80	26.68
70	29.49
60	31.88
50	34.12
40	36.36
30	38.76
20	41.56
10	45.45

TABLE 7

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	21.78 dB
80	25.67
70	28.47
60	30.87
50	33.11
40	35.35
30	37.74
20	40.55
10	44.44

TABLE 8

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.52 dB
80	26.41
70	29.21
60	31.61
50	33.85
40	36.09
30	38.48
20	41.29
10	45.17

TABLE 9

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m
10% time amplitude of interferer 3: 0.0250 mV/m
10% time amplitude of interferer 4: 0.0250 mV/m
10% time amplitude of interferer 5: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	19.64 dB
80	23.53
70	26.33
60	28.73
50	30.97
40	33.21
30	35.61
20	38.41
10	42.30

TABLE 10

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m
10% time amplitude of interferer 3: 0.0125 mV/m
10% time amplitude of interferer 4: 0.0125 mV/m
10% time amplitude of interferer 5: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	21.78 dB
80	25.67
70	28.47
60	30.87
50	33.11
40	35.35
30	37.74
20	40.55
10	44.44

$$2\sigma_0^2 = \sum_{i=1}^{N} 2\sigma_i^2 \qquad (20)$$

The 2's cancel so

$$\sigma_0 = \sqrt{\sum_{i=1}^{N} \sigma_i^2} \qquad (21)$$

The 10 percent time voltage for this single interferer is $2.146\sigma_0$ or

$$\text{10 percent time voltage} = 2.146 \sqrt{\sum_{i=1}^{N} \sigma_i^2} \qquad (22)$$

The RSS of the 10 percent time voltage of this single interferer is just

$$\text{RSS} = \sqrt{\sum_{k=1}^{1} \left(2.146 \sqrt{\sum_{i=1}^{N} \sigma_i^2} \right)^2} \qquad (23)$$

$$\text{RSS} = \sqrt{4.605 \sum_{i=1}^{N} \sigma_i^2} \qquad (24)$$

Since the RSS value for the single interferer equals the RSS value for the sum (equation (18)), the variances are also the same and the Rayleigh distribution of the single interferer is the same as the Rayleigh distribution of the sum of the multiple interferers. It is clear, then, that regardless of the number or amplitude of the multiple interferers, the effect of the sum of interferers on the SIR is the same as the effect of a single interferer with equivalent power.

It should be noted that this analysis applies only to the ratio of the desired signal power to the total undesired signal power. It does not deal with the psychoacoustical effects, or listenability, of a single interferer versus multiple interferers. One might intuitively argue that a single interferer will more drastically degrade listenability than multiple interferers (though the SIR is the same), because the single loud interferer will cause more distraction from the desired program than will a "babble" of lower level interferers. Listenability tests of various interference circumstances will ultimately be needed to resolve this issue.

Since a Rayleigh distribution with $\sigma = \sigma_0$ provides a complete description of the statistical characteristics of the sum of N interferers, it is now possible to return to the earlier question of the probability that the sum voltage will be equal to or above some combination of 10 percent time voltage levels from the individual interferers. For example, assume that $N = 8$ and that each of the eight interferers has a 10 percent time amplitude of 2.146σ. The probability that the sum voltage will be, for instance, four times the 10 percent time voltage of one interferer is

$$\text{Probability} = \int_{4\times 2.146\sigma}^{\infty} \frac{v}{\sigma_0} \exp\left[\frac{-v^2}{2\sigma_0^2}\right] dv \qquad (25)$$

From equation (21), and with $N = 8$, we have

$$\sigma_0 = \sqrt{\sum_{i=1}^{N} \sigma_i^2} = 2.828\sigma \qquad (26)$$

Putting this value of σ_0 into (25) and performing the integration (from (3))

$$\text{Probability} = \exp\left[\frac{-(8.584\sigma)^2}{2(2.828\sigma)^2}\right] \qquad (27)$$

This results in a probability of 0.009998 that the sum voltage will exceed 4 times the 10 percent time voltage of a single interferer.

For this case, the ratio of the 10 percent time voltage of the sum to the 10 percent time voltage of one of the eight constituent interferers (with all the σ_i's the same) is

$$\frac{2.146\sqrt{\sum_{i=1}^{N} \sigma_i^2}}{2.146\sigma_i} = \sqrt{N} = 2.828 \qquad (28)$$

8.0 CONCLUSIONS

The foregoing analysis used statistical descriptions for the amplitude of a desired AM broadcast groundwave signal and multiple interfering skywave signals to develop a statistical description of the desired signal-to-interference ratio. The resulting probability density function was used to evaluate the percentage of time SIR's are exceeded with a variety of interfering signal combinations. The results show that adding four equal interferers, each at a level equal to 50% of a first interferer, degrades the 50% time SIR by a little more than 3 dB. If the four added interferers are all set at a level equal to 25% of the first interferer, the 50% time SIR is degraded by only 1 dB.

A similar analysis was conducted using a time-varying desired signal with a lognormal amplitude distribution. The results show that the spread of the SIR distribution increases so that the 90% time point is about 11 dB below the 50% time point. However, the relative changes in the SIR statistics between the various combinations of interference cases is the same as for the study with a constant amplitude desired signal.

A comparison of the impact on the SIR of multiple interferers with the impact on the SIR of a single interferer of equivalent power shows that the effect was the same in both cases.

9.0 REFERENCES

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[3] op. cit., M. Schwartz et al. pp. 381-382.

[4] CCIR, Dubrovnik (1986). Report 322-3 (draft), "Characteristics and Applications of Atmospheric Radio Noise Data."

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Appendix G
Instructions for Operation of Program "SKYIN"

Introduction

These instructions describe the operation of a computer program to calculate signal-to-interference ratio statistics for AM broadcast groundwave and skywave signals in the presence of multiple skywave interferers.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. The master diskette contains the executable file SKYIN.EXE. The source code file SKYIN.FOR is available on a separate diskette from NAB upon request. The program may be copied, such as to a hard disk, but no additional disk space is necessary for program execution. The program was compiled with Microsoft FORTRAN v4.01 and is designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run more slowly. A coprocessor-equipped machine is recommended.

All output data appears on the screen. Neither a printer nor graphics capability is required.

Program description

Users should familiarize themselves with the paper, "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers," by H. Anderson, which is Appendix F of this report. The paper describes the calculations made by the program and gives several examples.

Program execution

The program is run by typing "SKYIN<ret>". After a title screen appears, the user is asked to select a constant amplitude or lognormal-fading desired signal and to enter its amplitude. If a lognormal-fading signal is selected, there will be a delay while the computer calculates its probability density function (pdf).

The user is then asked for the number of interferers (up to 10) and their amplitudes, and the computer begins its calculations. When the calculation is complete, a results screen will be displayed which tabulates all of the input data and the signal-to-interference ratio exceeded from 10% to 90% of the time in steps of 10%. Results can be printed using the "PrtSc" keyboard command. The user can then select another run or exit from the program.

Appendix C - Tape Index, B. Angell AM Radio Interference Study
NAB Comments to MM Docket 87-267, June 17, 1988

(All cuts are 20 seconds, except those marked "full" are full length)

I. Index to Co-channel Interference Tapes

Tape: "C1 Chicago" Format: AOR/Black-Urban/CHR

Cut #	Desired Program	Undesired Program	D/U Ratio	(W)ide/(N)arrow
1	"Smokin Gun"	n/a	FM	n/a
2	"Smokin Gun"	n/a	FM	n/a
3	"Smokin Gun"	"Everlasting"	40 dB	W
4	"Smokin Gun"	"Everlasting"	34 dB	W
5	"Smokin Gun"	"Everlasting"	30 dB	W
6	"Smokin Gun"	"Everlasting"	28 dB	N
7	"Smokin Gun"	"Everlasting"	28 dB	W
8	"Smokin Gun"	"Everlasting"	26 dB	N
9	"Smokin Gun"	"Everlasting"	26 dB	W
10	"Smokin Gun"	"Everlasting"	22 dB	N
11	"Smokin Gun"	"Everlasting"	22 dB	W
12	"Smokin Gun"-full	"Everlasting"	26 dB	W

Tape: "C2 Chicago" Format: Beautiful Music/Easy Listening

1	"Ebb Tide"	n/a	FM	n/a
2	"Ebb Tide"	n/a	FM	n/a
3	"Ebb Tide"	"Everlasting"	40 dB	W
4	"Ebb Tide"	"Everlasting"	34 dB	W
5	"Ebb Tide"	"Everlasting"	30 dB	W
6	"Ebb Tide"	"Everlasting"	28 dB	N
7	"Ebb Tide"	"Everlasting"	28 dB	W
8	"Ebb Tide"	"Everlasting"	26 dB	N
9	"Ebb Tide"	"Everlasting"	26 dB	W
10	"Ebb Tide"	"Everlasting"	22 dB	N
11	"Ebb Tide"	"Everlasting"	22 dB	W
12	"Ebb Tide"-full	"Everlasting"	26 dB	W

Tape: "C3 Chicago" Format: Adult Contemporary

1	"Margaritaville"	n/a	FM	n/a
2	"Margaritaville"	n/a	FM	n/a
3	"Margaritaville"	"Everlasting"	40 dB	W
4	"Margaritaville"	"Everlasting"	34 dB	W
5	"Margaritaville"	"Everlasting"	30 dB	W
6	"Margaritaville"	"Everlasting"	28 dB	N
7	"Margaritaville"	"Everlasting"	28 dB	W
8	"Margaritaville"	"Everlasting"	26 dB	N
9	"Margaritaville"	"Everlasting"	26 dB	W
10	"Margaritaville"	"Everlasting"	22 dB	N
11	"Margaritaville"	"Everlasting"	22 dB	W
12	"Margaritaville" -full	"Everlasting"	26 dB	W

Tape: "C4 Chicago" Format: News/Talk

Cut #	Desired Program	Undesired Program	D/U Ratio	(W)ide/(N)arrow
1	"News/Talk"	n/a	FM	n/a
2	"News/Talk"	n/a	FM	n/a
3	"News/Talk"	"Everlasting"	40 dB	W
4	"News/Talk"	"Everlasting"	34 dB	W
5	"News/Talk"	"Everlasting"	30 dB	W
6	"News/Talk"	"Everlasting"	28 dB	N
7	"News/Talk"	"Everlasting"	28 dB	W
8	"News/Talk"	"Everlasting"	26 dB	N
9	"News/Talk"	"Everlasting"	26 dB	W
10	"News/Talk"	"Everlasting"	22 dB	N
11	"News/Talk"	"Everlasting"	22 dB	W
12	"News/Talk"	n/a	FM	n/a
13	"News/Talk"	"News"	40 dB	W
14	"News/Talk"	"News"	34 dB	W
15	"News/Talk"	"News"	30 dB	W
16	"News/Talk"	"News"	28 dB	N
17	"News/Talk"	"News"	28 dB	W
18	"News/Talk"	"News"	26 dB	N
19	"News/Talk"	"News"	26 dB	W
20	"News/Talk"	"News"	22 dB	N
21	"News/Talk"	"News"	22 dB	W
22	"News/Talk"-4 min.	"Everlasting"	26 dB	W

(adjacent channel interference index list begins on next page)

II. Index to Adjacent Channel Interference Tapes

Tape: "A1 Chicago" Format: AOR/Black-Urban/CHR

Cut #	Desired Program	Undesired Program	D/U Ratio	(W)ide/(N)arrow
1	"Smokin Gun"	n/a	FM	n/a
2	"Smokin Gun"	n/a	FM	n/a
3	"Smokin Gun"	"Everlasting"	+20 dB	W
4	"Smokin Gun"	"Everlasting"	+16 dB	W
5	"Smokin Gun"	"Everlasting"	+6 dB	N
6	"Smokin Gun"	"Everlasting"	+12 dB	W
7	"Smokin Gun"	"Everlasting"	0 dB	N
8	"Smokin Gun"	"Everlasting"	+6 dB	W
9	"Smokin Gun"	"Everlasting"	-4 dB	N
10	"Smokin Gun"	"Everlasting"	0 dB	W
11	"Smokin Gun"	"Everlasting"	-4 dB	W
12	"Smokin Gun"-full	"Everlasting"	0 dB	W

Tape: "A2 Chicago" Format: Beautiful Music/Easy Listening

1	"Ebb Tide"	n/a	FM	n/a
2	"Ebb Tide"	n/a	FM	n/a
3	"Ebb Tide"	"Everlasting"	+20 dB	W
4	"Ebb Tide"	"Everlasting"	+16 dB	W
5	"Ebb Tide"	"Everlasting"	+6 dB	N
6	"Ebb Tide"	"Everlasting"	+12 dB	W
7	"Ebb Tide"	"Everlasting"	0 dB	N
8	"Ebb Tide"	"Everlasting"	+6 dB	W
9	"Ebb Tide"	"Everlasting"	-4 dB	N
10	"Ebb Tide"	"Everlasting"	0 dB	W
11	"Ebb Tide"	"Everlasting"	-4 dB	W
12	"Ebb Tide"-full	"Everlasting"	0 dB	W

Tape: "A3 Chicago" Format: Adult Contemporary

1	"Margaritaville"	n/a	FM	n/a
2	"Margaritaville"	n/a	FM	n/a
3	"Margaritaville"	"Everlasting"	+20 dB	W
4	"Margaritaville"	"Everlasting"	+16 dB	W
5	"Margaritaville"	"Everlasting"	+6 dB	N
6	"Margaritaville"	"Everlasting"	+12 dB	W
7	"Margaritaville"	"Everlasting"	0 dB	N
8	"Margaritaville"	"Everlasting"	+6 dB	W
9	"Margaritaville"	"Everlasting"	-4 dB	N
10	"Margaritaville"	"Everlasting"	0 dB	W
11	"Margaritaville"	"Everlasting"	-4 dB	W
12	"Margaritaville" -full	"Everlasting"	0 dB	W

Tape: "A4 Chicago" Format: News/Talk

Cut #	Desired Program	Undesired Program	D/U Ratio	(W)ide/(N)arrow
1	"News/Talk"	n/a	FM	n/a
2	"News/Talk"	n/a	FM	n/a
3	"News/Talk"	"Everlasting"	+20 dB	W
4	"News/Talk"	"Everlasting"	+16 dB	W
5	"News/Talk"	"Everlasting"	+6 dB	N
6	"News/Talk"	"Everlasting"	+12 dB	W
7	"News/Talk"	"Everlasting"	0 dB	N
8	"News/Talk"	"Everlasting"	+6 dB	W
9	"News/Talk"	"Everlasting"	-4 dB	N
10	"News/Talk"	"Everlasting"	0 dB	W
11	"News/Talk"	"Everlasting"	-4 dB	W
12	"News/Talk"	n/a	FM	n/a
13	"News/Talk"	"News"	+20 dB	W
14	"News/Talk"	"News"	+16 dB	W
15	"News/Talk"	"News"	+6 dB	N
16	"News/Talk"	"News"	+12 dB	W
17	"News/Talk"	"News"	0 dB	N
18	"News/Talk"	"News"	+6 dB	W
19	"News/Talk"	"News"	-4 dB	N
20	"News/Talk"	"News"	0 dB	W
21	"News/Talk"	"News"	-4 dB	W
22	"News/Talk"-4 min.	"Everlasting"	0 dB	W

AM RADIO INTERFERENCE STUDY

Final Report

NAB BROADCASTERS

National Association of Broadcasters • 1771 N Street, N.W. • Washington, D.C. 20036-2898

AM Radio Interference Study
Final Report
June 1988

B. Angell & Associates, Chicago, IL

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Overview

The technical assignment criteria for the AM radio service are based on engineering, and other policy inputs. The last time the FCC considered the results of a consumer acceptance study of interference in the AM band was over 40 years ago. To update and expand upon these historical data, the NAB commissioned B. Angell & Associates to conduct a new study of listener acceptance of different types and levels of AM interference. In this study, co-channel and first adjacent channel interference at varying dB levels (bracketing current FCC standards) for a series of music and talk programming selections were studied. Overall, it was found that 1988 listener acceptability of AM interference is lower than was found in earlier studies. To satisfy at least 50% of AM listeners, current AM technical assignment criteria need to be adjusted.

B. Angell & Associates, Inc.

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AM RADIO INTERFERENCE STUDY

Final Report

MM Docket No. 87-267

Prepared for: NATIONAL ASSOCIATION OF BROADCASTERS
Washington, D.C.
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I. EXECUTIVE SUMMARY

BACKGROUND AND OBJECTIVES

The National Association of Broadcasters commissioned a study to determine the level of transmitter interference at which AM reception is unacceptable to the listening public. This is in response to the Federal Communications Commission's Notice of Inquiry (MM Docket No. 87-267), "Review of Technical Assignment Criteria for the AM Broadcast Industry."

The Technical Assignment Criteria for the four classes of AM stations are based on a system of "protected contours" for which specific field strength values have been determined. The reference data, on which these technical guideline values for new or modified AM service are based, were reported in 1946. Since then 1940s, the number and quality of audio sources available to the public have changed dramatically.

Both co-channel and first adjacent channel interference were tested. Each type of interference was heard in three formats:

- Music over music
- Music over news/talk, and
- Talk over news/talk

The music tapes used also had three formats, based on the usual music format listened to by each respondent:

- AOR/Black-Urban/CHR (Contemporary Hit Radio)
- Easy Listening/Beautiful Music
- Country/AC (Adult Contemporary)

A complete description of the methodology of the study and qualification of the respondents can be found in the background, objectives and methodology sections of this report.

SUMMARY OF FINDINGS

The primary results of the study are as follows:

- The minimum acceptable D/U (desirable/ undesirable) ratio (i.e., mean greater than 3.5 on a 6-point acceptance scale) for co-channel interference with musical program material was 26dB. For talk programming with either music or talk interference, 40dB was the minimum acceptable co-channel D/U ratio. For adjacent channel interference, the corresponding ratios were 16dB for music, 16dB for talk with talk interference and 20dB for talk with music interference.

- For both co-channel and adjacent channel interference, respondents accepted much less interference on talk segments than they did on music segments.

- For musical formats, co-channel interference yielded high acceptance ratings at 26dB Wide and

above. Some variation of acceptability occurred in various musical formats.

- Adjacent channel interference for musical formats yielded high acceptance ratings at 16dB Wide and above. Again, there were variations of acceptability among different musical formats.

RADIO INTERFERENCE TOLERANCE LEVELS
(Desired/Undesired dB levels)

	ADJACENT		CO CHANNEL	
	DESIRED	UNDESIRED	DESIRED	UNDESIRED
All Music	16dB Wide +*	12dB Wide - 6dB Narrow -	26dB Wide +	22dB Wide - 28dB Narrow -
AOR/Black	16dB Wide +	12dB Wide - 6dB Narrow -	22dB Wide +	28dB Narrow -
Beautiful Music	6dB Narrow + 12dB Wide +	0dB Narrow - 6dB Wide -	30dB Wide +	28dB Wide - 28dB Narrow -
Country/AC	16dB Wide +	12dB Wide - 6dB Narrow -	26dB Wide + 26dB Narrow +	22dB Wide - 22dB Narrow -
News/Talk (Music Interference)	20dB Wide +	16dB Wide - 6dB Narrow -	40dB Wide +	34dB Wide - 28dB Narrow -
News/Talk (Voice Interference)	16dB Wide +	12dB Wide - 6dB Narrow -	40dB Wide +	34dB Wide - 28dB Narrow -

* In linear terms, the 26dB Wide acceptable co-channel figure can be stated as the interfering signal level being 5 percent of the desired signal level (in mathematical terms, the inverse logarithm of -1.3, which is -26dB first divided by 20, which is .05). For the acceptable adjacent channel figure of 16dB Wide, the interfering signal level is 16 percent of the desired signal. Using the same terms, the 12dB Wide unacceptable adjacent channel level represents an interfering signal level 25 percent of the desired signal level.

- Almost all of the respondents reported some experience with radio interference in their everyday listening situation. The problems mentioned most frequently included: station fading in and out; static/crackling; station over station; and blocked signal. Interference problems occur more often in cars than in buildings.

- When they hear it, respondents indicated that they deal with radio interference problems in a variety of ways, ranging from waiting to see if it improves, attempting to adjust the set, changing stations, or turning the radio off.

- Most of those studied felt the tapes that they had listened to were similar to "normal" radio interference they have experienced in the past. A few thought it was different, but they were divided about whether the interference on the tapes was worse or not as bad as usual interference.

- AM sound quality was reported to fall short of FM sound quality for the following reasons:

  - Interference, especially weather related interference, increased hiss and background noise, and increased static

  - Sound quality, which appears to be both an image problem and an actual problem, including lack of stereo sound; less clarity of sound; and lack of clear/crisp musical sound

- Reception, especially weaker signal and inconsistent signal (producing fading in and out)

In summary, the study findings suggest that the acceptance standards for AM broadcast quality, as perceived by these respondents, are quite high. Although the 1946 study used a different methodology, it found that listeners in 1946, as compared to our 1988 data, would accept greater amounts of interference. For example, in 1946, 50% of the respondents accepted a D/U ratio of 28.6dB for talk with talk co-channel interference. In this study, the figure was 40dB. The overall co-channel interference ratio that satisfied 50% of the 1946 listeners was 23.5dB. Although no overall ratio is offered here, the music ratio was 26dB and both talk ratios were 40dB. Since adjacent channel interference was not tested with listeners in the 1946 study, no direct comparisons are made against the current findings.

II. BACKGROUND AND OBJECTIVES

The National Association of Broadcasters (NAB) is interested in contributing to the Federal Communications Commission's Notice of Inquiry in MM Docket No. 87-267, "Review of Technical Assignment Criteria for the AM Broadcast Industry."

The Technical Assignment Criteria for the four classes of AM stations are based on a system of "protected contours" for which specific field strength values have been determined. Those values are calculated for both "nominal usable field strength" (Enom), and the "minimum usable field strength" (Emin) needed to satisfy Enom.

The FCC has developed technical guidelines as parameters regarding new or modified AM service. The reference data on which these values are based were reported in 1946, when the AM band was the primary broadcast medium. Since the 1940s, the number and quality of audio sources available to the public have changed dramatically. The primary concern at this time is interference. The three main sources of interference are:

- Station Transmitter Interference
  - Co-channel
  - Adjacent channel
- Man-made Interference
- Atmospheric Interference

Transmitter interference data will be used to investigate frequency allocation and frequency protection policies with the intent of initiating an AM spectrum

reevaluation. Transmitter interference, particularly co-channel interference, is the priority for this investigation. Therefore, man-made, atmospheric and skywave-groundwave interference conditions were not addressed in this study.

The objective of the study is to evaluate the degree to which different types and levels of transmitter interference affect the acceptability of various types of AM signals by the listening public.

III. METHODOLOGY

Limitations

As with any study, certain limitations must be kept in mind. In this study, a non-random sample was used, thus limiting the projectibility to a population. Additionally, respondents self-selected the formats they listened to based on their reported favorite stations. The choice of musical formats was reduced to three for reasons of logistics. While potential respondents were screened for "normal" hearing ability, this was based on self-report and a potential for bias exists.

Procedures

A total of 500 interviews were conducted with individuals 18 years and older in five geographically dispersed markets. The cities used for interviewing were Burlington, VT; Jacksonville, FL; Chicago, IL; Wichita, KS; and Los Angeles, CA. While not meant to suggest statistical projectability, these markets were selected as representative of a national cross section of radio listeners. One hundred interviews were completed in each market.

Respondents were screened to meet the following qualifications:

- Own at least one radio
- Report TSL (time spent listening) of:
  - At least 1 hour/day (5 hours/week)
  - and - No more than 10 hours/day (60 hours/week)

- At least 25% of sample AM listeners
- Fall within one of ten representative format preferences
- (Within the above) Age, sex and race distributions

In each of the markets, potential respondents were intercepted randomly at shopping centers/malls. Those who qualified were asked to participate in the study. In two of the markets (Burlington, VT and Wichita, KS.), respondents were paid a cooperation incentive of $15 to $25. In the remaining locations, such incentives were not necessary.

Such interviewing procedures are commonly used in a wide variety of consumer studies to ascertain prevailing attitudes, opinions, preferences and for the determination of acceptance thresholds. In our professional opinion as consumer researchers, we are confident that this methodological choice is appropriate and reliable, given the study objectives.

Interference Tested

Two types of station transmitter interference were tested: first adjacent channel and co-channel. Half of the respondents listened to tapes containing adjacent channel interference, while half listened to co-channel interference. Each respondent listened to ten musical selections on tape. The type of music was determined by their favorite or usual choice of music, i.e., respondents

were assigned to formats based on their self reported listening preferences. Adjacent and co-channel interference were tested in all three music formats:

- AOR/Black-Urban/CHR (Contemporary Hit Radio)
- Easy Listening/Beautiful Music
- Country/AC (Adult Contemporary)

Each respondent also heard tapes with talk. One set of these tapes had music interference over the talking, while the other set had voice interference.

Both desired and undesired interfering transmissions originated off either CD versions of music selections or professional reel to reel recordings of news/talk programming. The audio selections were:

Desired Signal	Format
Smokin' Gun - Robert Cray Band	AOR/Black-Urban/CHR
Margaritaville - Jimmy Buffett	Country/AC
Ebb Tide - 101 Strings	Easy Listening/Beautiful
Live talk segment - WGN radio	News/Talk

Undesired Signal	Type of Interference
Everlasting - Natalie Cole	Music
Live newscast - WGN radio	Voice

The "Desired Signal" selections were chosen for the broadest appeal across designated formats. The "Undesired music Signal" selection was used since, as a Pop production, the audio level was quite consistent due to processing in the original recording. The "Undesired voice Signal" was typical of current newscast formats.

The interference tested, listed from no interference (the FM benchmark) to the most interference, is as follows:

Adjacent Channel	Co-Channel
FM	FM
20dB Wide*	40dB Wide
16dB Wide	34dB Wide
6dB Narrow	30dB Wide
12dB Wide	28dB Narrow
0dB Narrow	28dB Wide
6dB Wide	26dB Narrow
-4dB Narrow	26dB Wide
0dB Wide	22dB Narrow
-4dB Wide	22dB Wide

* For example, "20dB Wide" for adjacent channel interference indicates the interfering station transmitted signal was set at a level 20dB below the level of on-channel signal, and the recording was made with the test receiver set to its "wide" bandwidth mode (respondents listened to an audio bandwidth of approximately 9 kHz in the "wide" mode and 6 kHz in the "narrow" mode). "FM" refers to a strong signal, with "wide" bandwidth and without an interfering signal.

Technical Notes Regarding Preparation of Tapes

The tapes used in the study were prepared by NAB. The details of how these tapes were produced have been provided by NAB, and this technical information follows.

As noted, the audio tapes used in this study contain recordings of AM transmissions with varying amounts of added interference. To create these recordings, an AM transmission and reception system was constructed in the electronics laboratory of the National Association of Broadcasters.

Those interference cuts were recorded by the NAB onto a digital audio tape (DAT).

A DAT player was used to reproduce first generation cuts onto a professional cassette machine. Back-up tapes were produced simultaneously on a second machine and were also, therefore, first generation. The cassette tape used was Maxell UDXL11.

All recordings were monophonic with the same information to both channels of the cassettes using a "Y" connector. Signal levels were set for 0dB peaks. No equalization or noise reduction was used. The NAB felt that the most accurate cassette reproduction of the original audio signal would be achieved without any noise reduction. After some experimenting with and without noise reduction, the project director was in agreement with the NAB.

Equipment Used for Listening Tests

The audio playback equipment that was used for the consumer listening tests was identical in each market. The audio equipment consisted of:

- A Tascam 122 Mk 11 cassette deck
- An Electro-Voice 1/3 Octave EQ
- 2 Electro-Voice Sentry 100 Self-Powered Speakers

In order to ensure identical audio information on both speakers, the audio output was fed from the left channel only of the cassette deck into the EQ. From the EQ, a splitter was used to send identical signals to each speaker.

Technical Preparation for Listening Rooms

Each room was equalized for flat response up to 10KHz using a pink noise source and spectrum analyzer with calibrated microphone. Pre-recorded pink noise cassette tapes were used so that the room could be EQed for the specific head alignment of the individual cassette deck.

The microphone was placed in various orientations and at different elevations so as to test response within the range of movement for a seated listener. All frequencies were set to compensate for seating positions.

In some locations, the room required hanging sound dispersion material on the wall in order to obtain a flat acoustic response. All other rooms were equalized without the need for additional sound absorbtion/dispersion.

Transmission System

Two program chains were developed, one for the desired signal and one for the undesired, interfering signal. The program source material originated on two consumer-type compact disc players, a Magnavox CDB-560 and a Magnavox FD1051. The "talk" material, however, originated on a high-quality reel to reel professional tape machine, an Otari MX55. The output of each compact disc player then passed through state-of-the-art audio processing equipment, adjusted for typical and average station operation. Audio processing conformed to the NRSC-1 audio standard. The output of each audio processor then fed a laboratory-quality signal generator (HP 3314A and Boonton 103D) in order to produce an AM modulated RF carrier. The modulation of each generator was carefully adjusted to produce high average modulation without carrier-clipping. Modulation characteristics were observed on a Tektronix 7A18 Oscilloscope. The magnitude of the RF carriers and the occupied bandwidth of the AM transmissions were observed using a Tektronix 7L14 Spectrum Analyzer. The output of each signal generator was combined and fed to the receiving and recording system.

Receiving System

The RF output of the transmission system was coupled to an automobile-type AM receiver. A matching network was used to avoid an impedance mismatch between the coaxial cable from the transmission system and the antenna inputs of the receiver. The receiver and one signal generator were tuned to 1000 kHz. This receiver was specially designed for the National Association of Broadcasters. It included NRSC deemphasis and as a wide a bandwidth as deemed

technically feasible for the receiver manufacturer. The receiver was equipped with both "wide" and "narrow" bandwidth positions. Tone controls were kept neutral. The other signal generator, representing the undesired signal, was tuned to either 1000 kHz or 1010 kHz, depending on whether co-channel or adjacent channel interference was being recorded. Since all transmissions were in monophonic, then each audio output of the AM receiver were combined and fed the right channel of a digital audio tape (DAT) recorder. Cue instructions, via microphone and preamp, were fed to the DAT left channel.

Recording and Test Procedure

A variety of desired-to-undesired (D/U) RF ratios were tested using the above-described transmission/reception system. The desired RF signals were kept constant. The magnitude of the undesired signals were controlled at the Boonton 103D signal generator. In each instance of recording, the D/U ratios were verified on the Tektronix spectrum analyzer. Recording gain was constant throughout the test. Audio processing was kept constant throughout the test, except that, for the FM "benchmark," two changes were made to the audio processing: (1) a wider audio bandwidth was used (approximately 12.5 kHz instead of 10 kHz), and (2) the processor's asymmetry control was turned to minimum (i.e., equal positive and negative peaks).

Set up of all test equipment was performed by competent engineering personnel, with much experience in conducting tests of this kind. Block diagram, lists of equipment, etc. are available at the offices of NAB Science & Technology, (202) 429-5346.

IV. DETAILED FINDINGS

The results of the respondents' opinions about the levels of interference they listened to on the test tapes are expressed as average, or mean ratings. The respondents rated 10 interference segments on each tape utilizing a 6-point acceptance scale, where a rating of 6 denoted "completely acceptable," and a rating of 1 denoted "completely unacceptable" levels of interference. With a midpoint value of this range at 3.5, any rating below 3.5 is considered "unacceptable."

A. Co-Channel Interference

1. Interference Over Music

The acceptability ratings for respondents who heard "Easy Listening/Beautiful Music" tapes and "Country/AC" tapes were more consistent than the ratings of those who listened to "AOR/Black-Urban/CHR." The mean ratings for the first two types of Music almost perfectly followed the levels of interference. That is, the acceptability of the sound decreased as the level of interference increased.

Furthermore, based on these ratings, it was evident that higher interference levels were more acceptable for "Country/AC" music and for "Easy Listening/Beautiful music" than for "AOR/Black-Urban/CHR" music. In particular, those who listened to "AOR/Black-Urban/CHR" rated the narrow bandwidths at 28dB and 26dB much lower than the wide bandwidths at 28dB and

26dB. For all three types of music, 22dB Wide was rated higher than 22dB Narrow, although all were below the 3.5 threshold of acceptability.

Overall, the most acceptable ratings for co-channel interference were above 30dB Wide, of 4.12 or higher. The 28dB and 26dB levels were marginally acceptable, at 3.61 and 3.52, respectively.

In the following table, the acceptable levels based on a 6-point acceptance scale (1=Completely Unacceptable and 6=Completely Acceptable) are highlighted.

CO-CHANNEL MUSIC INTERFERENCE

6-point acceptance scale 1=Completely Unacceptable 6=Completely Acceptable	EASY LISTEN	COUNTRY/ AC	AOR/ BLACK	TOTAL MUSIC
FM	5.14*	5.29*	4.92*	5.06*
40dB Wide	5.11*	4.67*	4.25*	4.49*
34dB Wide	4.86*	4.32*	3.80*	4.10*
30dB Wide	4.43*	4.06*	4.08*	4.12*
28dB Narrow	3.97*	3.75*	2.84	3.26
28dB Wide	3.49	3.68*	3.61*	3.61*
26dB Narrow	3.49*	3.54*	2.70	3.05
26dB Wide	2.83	3.54	3.68*	3.52*
22dB Narrow	2.66	3.10	2.29	2.57
22dB Wide	2.66	2.81	3.43*	3.15
(Base)	(35)	(72)	(145)	(252)

* Acceptable to 50% or more of the respondents.

2. Interference Over Talk

The respondents' tolerance for interference caused by music over talk, or talk over talk, was much lower overall than was the music over music interference. As seen in the following table, only at the FM standards level, or at the 40dB Wide, was the interference perceived to be acceptable to the participants.

INTERFERENCE OVER TALK--CO-CHANNEL

6-point acceptance scale 1=Completely Unacceptable 6=Completely Acceptable	MUSIC/ TALK	TALK/ TALK
FM	4.49*	4.15*
40dB Wide	3.85*	3.84*
34dB Wide	3.09	3.39
30dB Wide	2.46	2.65
28dB Narrow	2.20	2.26
28dB Wide	2.00	1.96
26dB Narrow	1.95	1.83
26dB Wide	1.76	1.61
22dB Narrow	1.56	1.47
22dB Wide	1.47	1.40
(Base)	(252)	(252)

* Acceptable to 50% or more of the respondents.

3. Co-Channel Summary

In summary then, co-channel interference was acceptable to the participants at FM and 40dB Wide levels for interference over talk. In turn, interference over music was tolerable to a much broader range, down to as low as 26dB Wide.

4. Additional Statistical Procedures--Co-Channel

A special statistical test, called an analysis of variance (ANOVA), was performed on the ratings for total music over music, total music over news/talk and for talk over news/talk. The purpose of this analysis was to determine the strength of the levels of difference among the means.

This analytical procedure was done to assure that any differences observed among the means were real differences, and not due to chance. ANOVA does this by comparing the variation of observations within each mean to the variation across all means. When "within" variation is large, it is more likely that differences are due to chance. When the ANOVA was significant (at the 95% confidence level) further comparisons were carried out to determine which means were significantly different.

For co-channel interference, the significant differences among the means are as follows:

(1) Total Music over Music
- FM is significantly more acceptable than 40dB Wide and below
- 40dB Wide is significantly more acceptable than 34dB Wide and below
- 30dB Wide and 34dB Wide are statistically comparable, and more acceptable than 28dB Narrow and below
- 28dB Wide and 26dB Wide are statistically comparable, and more acceptable than 28dB Narrow, 26dB Narrow and below

(2) Total Music over News/Talk
- FM is significantly more acceptable than 40dB Wide and below
- 40dB Wide is significantly more acceptable than 34dB Wide and below

(3) Total Talk over News/Talk
- FM is significantly more acceptable than 40dB Wide and below
- 40dB Wide is significantly more acceptable than 34dB Wide and below

The remaining significant differences all involved levels where the interference was consistently unacceptable to the respondents--at 3.5 and below.

B. Adjacent Channel Interference

1. Interference Over Music

Respondents who listened to "Easy Listening/ Beautiful Music" appeared to be more tolerant of interference than those who were exposed to "Country/AC" or the "AOR/Black-Urban/CHR" music. The pattern of ratings as interference increased held for "Easy Listening/Beautiful Music" and "Country/AC." As for the co-channel test, the acceptability ratings were again less consistent for "AOR/Black-Urban/CHR." As with co-channel ratings, the wide bandwidths were rated higher than the narrow bands.

ADJACENT CHANNEL MUSIC INTERFERENCE

6-point acceptance scale 1=Completely Unacceptable 6=Completely Acceptable	EASY LISTEN	COUNTRY/ AC	AOR/ BLACK	TOTAL MUSIC
FM	5.46*	5.24*	5.19*	5.24*
20dB Wide	5.36*	4.47*	4.53*	4.60*
16dB Wide	4.93*	4.15*	4.33*	4.34*
6dB Narrow	3.54*	2.71	2.87	2.89
12dB Wide	3.64*	2.84	3.33	3.19
0dB Narrow	2.46	1.98	1.80	1.94
6dB Wide	2.54	1.90	2.19	2.13
-4dB Narrow	1.82	1.45	1.45	1.49
0dB Wide	1.82	1.43	1.49	1.51
-4dB Narrow	1.46	1.35	1.39	1.38
(Base)	(28)	(86)	(134)	(248)

* Acceptable to 50% or more of the respondents.

2. Interference Over Talk

For adjacent channel interference, the respondents again demonstrated a lower level of tolerance for interference caused by either music or talk over talk than by music over music. For voice interference, acceptability was once again at the highest two levels: FM or at 20dB Wide. Interference related by talk over talk was slightly more acceptable than for music over talk. It was acceptable at the 16dB Wide level or above, with a mean of 3.58.

INTERFERENCE OVER TALK--ADJACENT CHANNEL

6-point acceptable scale 1=Completely Unacceptable 6=Completely Acceptable	MUSIC/ TALK	TALK/ TALK
FM	4.92*	4.42*
20dB Wide	3.66*	4.12*
16dB Wide	2.95	3.58*
6dB Narrow	2.17	2.90
12dB Wide	2.06	2.67
0dB Narrow	1.65	2.03
6dB Wide	1.53	1.80
-4dB Narrow	1.36	1.56
0dB Wide	1.34	1.49
-4dB Narrow	1.29	1.39
(Base)	(248)	(248)

* Acceptable to 50% or more of the respondents.

3. Additional Statistical Procedures--Adjacent Channel

Analysis of variance was also performed for the adjacent channel interference on the ratings for total music over music, total music over news/talk and for talk over news/talk. For adjacent interference, the significant differences between the means are as follows:

(1) Total Music over Music
- FM is significantly more acceptable than 20dB Wide and below
- 20dB Wide is significantly more acceptable than 16dB Wide and below
- 16dB Wide is significantly more acceptable than 12dB Wide and below

(2) Total Music over News/Talk
- FM is significantly more acceptable than 20dB Wide and below
- 20dB Wide is significantly more acceptable than 16dB Wide and below

(3) Total Talk over News/Talk
- FM is significantly more acceptable than 20dB Wide and below
- 20dB Wide is significantly more acceptable than 16dB Wide and below
- 16dB Wide is significantly more acceptable than 6dB Narrow and below

As before, the remaining significant differences involved levels where the interference was unacceptable to the respondents -- at 3.5 and below.

C. Comparative Co-Channel Versus Adjacent Channel Interference Acceptance Ratings

As a further indication of the degree of acceptability of interference, between those respondents who are exposed to the co-channel tapes versus their adjacent channel counterparts, the findings within each of the two were combined, bringing together the acceptance resulting from all of the evaluations within each of the two segments.

For the accumulated co-channel segment, the ratings of 3.5 and above were restricted to interference at 34dB Wide or higher. All other interferences, from 30dB Wide on down, were judged unacceptable.

The combined adjacent channel ratings indicated that at 16dB Wide or above, the interference was judged acceptable. From 6dB Narrow and from 12dB Wide on down, the interference was judged unacceptable.

D. Experience with Radio Interference

At the beginning of the interview, the respondents were asked a series of questions about the extent of their experience with radio interference: what kinds of interference they had experienced; frequency of experiencing radio interference; where they heard radio interference (home, car, at work); how much radio interference bothered them; and what they usually did about interference. This section of the report provides a brief synopsis of their responses to this series of questions.

1. Type of Interference Experienced

Virtually all the respondents reported some experience with radio interference. In fact, only 4% said they had not experienced interference. The types of interference reported most frequently were:

Fading in and out	69%
Static/crackling	67
Station cutting in over station	45
Blocked Signal (building/hill)	37
Whistle/whine	20
Splashy/splattering sound	20

2. Frequency of Interference Experience

A very small proportion reported any of the above interference problems occurring "frequently." The incidence of reporting specific problems all or most of the time were: "static," 13%; "fading," 8%; "station over station," 7%; and "blocked signal," 6%.

3. Interference By Location

The most common location related reception problem was reported to be in the car. Regardless of location, "fading" and "static" remain the most frequently mentioned problems. "Blocking of the signal" reportedly occurs most often in the car. A summary of problem by location appears below.

	CAR	HOME	WORK
Fading in and out	40%	29%	6%
Static/crackling	41	26	8
Station cutting in over station	24	19	4
Blocked Signal (building/hill)	26	7	3
Whistle/whine	11	5	1
Splashy/splattering sound	10	6	2
None reported	32	50	84

4. Reaction to Interference

Half (50%) of those respondents who reported reception related problems said that "fading" and "static" bothered them "very much" or "somewhat." One-third (31%) said that "station over station" interference bothered them "very much" or "somewhat," while one-fourth (26%) felt that way about "blocked signals."

When interference problems are experienced, nearly two-thirds (63%) of these radio listeners reported that they "listen for a while" before

they decide it to be unacceptable enough to "do something about it." One in five (19%) decide to do something when they first turn the radio on, and 12% reported that they take action only when something else comes on the radio. The most common solution was said to be "change stations," reported by 57%. In addition, 30% turn the radio off, while 28% attempt to adjust the radio, and 12% wait to see if it will clear up. These answers total more than 100%, as listeners were allowed to give more than one response. For example, a person might have said they try to adjust the station and if that doesn't work, they turn off the radio.

5. Location of Interference

Respondents were asked if radio reception was generally worse when listening inside a building or in a car. Consistent with their previous answers, about two-thirds (64%) said interference was worse in a car, while 33% said interference was worse in a building. Those who believe interference is worse in a car feel it is worse for the following ways and reasons:

Interference in Car

Inconsistent signal (includes fading)	18%
Bad reception/interference in car	17
Static/noise	14
Interference from structures/buildings	12
Changes in distance from station	11
Electrical interference	10
Quality of car radio/sound in car	7

Those who believe interference is worse in a building feel it is worse for the following reasons:

Interference in Building

General interference (includes static)	12%
Weaker signal/bad reception	10
Inconsistent signal (includes fading)	7
Buildings interrupt signal	7
Electrical interference	5

6. Impact of Interference on Listener Behavior

Some respondents (14%) reported that they stopped listening to any radio stations because of too much interference. For those who have stopped listening to a station, 3% stopped listening to an AM station, 8% stopped listening to an FM station and 3% did not specify the kind of station to which they had stopped listening.

7. Perceptions of Test Interference

The study participants were asked if the interference they had listened to on the tapes was similar or different from the kinds of interference that they have heard on the radio. Three-fourths (78%) felt the tapes were similar to radio interference they have experienced in the past.

Those who felt it was the same noted these major similarities:

Station over station	57%
General interference (includes static/crackle/whine)	33
Inconsistent signal (includes fading)	16

Those who felt what they listened to was not the same noted these major differences:

This interference was worse	13%
This interference was not as bad	5
Station over station	9
General interference (includes static/crackle/whine)	5
Inconsistent signal (includes fading)	3
Hiss/background noise	3

8. Reactions to Overall Quality of Test Tape

Toward the end of the interview, the respondents listened to a full length NRSC wide band cut of their respective musical selection at the current FCC standards -- 26dB for co-channel or 0dB for adjacent channel. They were asked to rate the sound quality of the tape on a 4-point scale: excellent, good, fair or poor.

Those who had listened to the co-channel tape rated its sound quality at a mean of 2.66 out of 4.00 -- 65% rated it "excellent" or "good." The sound quality of the adjacent channel tape, in turn, was rated significantly lower at a mean of 1.94 -- 33% rated it "excellent" or "good."

	CO-CHANNEL	ADJACENT CHANNEL
FCC Standard	26dB	0dB
Sound Quality Rating		
Excellent	10%	4%
Good	55	29
Fair	26	26
Poor	9	42
Mean	2.66	1.94
(Base)	(252)	(248)

After the sound quality of the test tape had been rated, respondents were asked if they would expect to hear this kind of broadcast quality on an FM or AM station. They were nearly divided on this issue: 55% said it was AM, while 51% said it was FM. Since some of the participants stated that they would have expected this kind of broadcast quality for either AM or FM, these total over 100%.

The reasons given for these answers fell into four major categories, as follows:

	AM	FM
Sound quality (includes clarity/ frequency response/stereo/not stereo/overall quality)	31%	30%
Interference (includes more interference/static/hiss/noise/ station over station interference/ modulation)	23	14
Reception (includes strength of of signal/not as strong/ stronger/inconsistent/fading)	13	11
Image (includes view that FM is better/AM is worse/what I listen to/don't listen to, etc.)	9	7

9. Perception of AM Sound Quality

The study participants were next asked to describe the difference between the sound quality of the AM radio signal and the FM radio signal, thinking about other qualities, as well as interference. The differences they noted were similar to the answers given to the previous question. The sound quality of AM radio was described as follows:

Sound Quality Image (Net)	58%
No stereo sound	18
Less/no clarity of sound	14
Music not as clear/crisp	8
Poorer quality	6
Interference (Net)	24%
More interference/static	18
Hiss/background noise	4
Reception (Net)	23%
Weaker signal/distant	12
Fades out	4
No Difference	2%

10. Perceptions of AM Radio Sound Quality Problems

In closing, the respondents were asked to define the major problems with the sound quality of the AM radio signal. Again, these answers were quite similar to the earlier questions, although one new complaint with AM interference did emerge. This was the problem presented by weather interference, mentioned by 69% of those interviewed.

Interference (Net)	85%
Weather interference	69
Hiss/background noise	37
Static	19
More interference (not specified)	8
Station crowding	7
Reception (Net)	33%
Weak signal	20
Inconsistent/fading	9
Sound Quality Image (Net)	32%
Frequency response (includes music not crisp/flat/ tinny/shallow)	13
AM image	6
Don't Know	15%

B. Angell & Associates, Inc.

STUDY #88-123/14240
FOR OFFICE USE ONLY:
RESPONDENT # ___ ___ ___ ___ (1-4)

One East Superior Street • Chicago Illinois 60611 • 312/943-4400

ADJ-CHANNEL
("A") CASSETTES (6)

NAB RADIO INTERFERENCE
(Screening Questionnaire)

Male -1
Female - 2

-1 Burlington
-2 Jacksonville
(-3) Chicago
-4 Wichita
-5 Los Angeles (5)

FAVORITE STATION (Q.N): _____
CASS. USED: ( ) (7)

AM LISTENER -1 Yes
-2 No
(8)

Hello, I'm _____ from B. Angell Research, an independent consumer research company. We are conducting a survey of public opinion in several cities throughout the country and would like to ask you a few questions.

A. In the past four months, have you participated in a marketing research study?

IF YES → TERMINATE AND TALLY → [ ] (9-10)

B. (SHOW CARD "A") Which one letter on this card best describes your age?

A. -1 Under 18 → TERMINATE AND TALLY → [ ] (11-12)
B. -2 18-24
C. -3 25-34
D. -4 35-44 → OBTAIN A GOOD SPREAD
E. -5 45-54
F. -6 55+ (13)

C. What is your occupation? _____

_____ (PROBE FOR SPECIFIC FIELD) (14)

IF RADIO, MUSIC, BROADCAST-RELATED, TERMINATE AND TALLY → [ ] (15-16)

D. This survey specifically deals with listening to a variety of audio and sound sources. Since we will be talking about a wide range of sounds we would like to know: Do you have any hearing disorders?

Yes → TERMINATE AND TALLY → [ ] (17-18)
No → CONTINUE

E. Do you live in the (INSERT MARKET) metro/suburban area?

-1 Yes → CONTINUE

-2 No → BURLINGTON ONLY:

(19) Are you a U. S. resident?

-1 Yes → CONTINUE

(20) -2 No → TERMINATE AND TALLY

F. How many radios, receivers, or tuners do you own that pick-up either FM and/or AM broadcast stations? (DO NOT READ)

-1 None → TERMINATE AND TALLY → [ ] (21-22)

-2 One
-3 Two
-4 Three or more
→ CONTINUE

(23)

(DO NOT MENTION) -- IF ASKED, DOES INCLUDE CAR RADIO

G. On a typical day, including all day long and all night, how much time do you spend listening to the radio -- would you say: (READ LIST) (CHECK ONE)

-1 Less than 1 hour per day TERMINATE AND TALLY → [ ] (24-25)

-2 1-2 hours per day
-3 3-4 hours per day
-4 5-8 hours per day
-5 9-10 hours per day
→ CONTINUE

(26)

-6 More than 10 hours per day ASK: How many days per week do you usually listen to the radio? (DO NOT READ)

-1 1-5 days per week → CONTINUE

(27)

-2 6-7 days per week → TERMINATE AND TALLY [ ] (28-29)

(SHOW CARD "B")

H. Which letter on this card best describes your radio listening:

A. -1 Only AM Stations

B. -2 Mostly AM but some FM Stations (at least 5 minutes per week)

C. -3 AM & FM Stations equally

D. -4 Mostly FM but some AM Stations (at least 5 minutes per week)

E. -5 Only FM Stations (CHECK QUOTA)

(30)

RECORD ALL ANSWERS ON NEXT PAGE

I. What radio stations do you listen to at least 5 minutes a week? (DO NOT READ) (CIRCLE ALL THAT APPLY)

(IF RESPONDENT DOES NOT KNOW CALL-LETTERS, HAVE THEM GIVE FREQUENCY/DIAL POSITION, SLOGAN, CITY/STATE, SPECIFIC PROGRAMS, OR ANY OTHER WAY OF IDENTIFYING STATION -- USE STATION PAGE FOR REFERENCE)

FOR ALL STATIONS CIRCLED IN Q.I
ASK Qs. J - M AND RECORD ON NEXT PAGE:

J. Is... (INSERT STATION FROM Q.I) which you listen to AM or FM?

K. (SHOW CARD "C") Using this card, please tell me at what time of day do you usually listen to...
(INSERT STATION FROM Q.I) (CIRCLE ALL THAT APPLY)

L. In what location are you when you are usually listening to... (INSERT STATION FROM Q.I) -- would that be: (1) At Home; (2) Away-from-Home -- In the Car; or (3) Away-from-Home -- Not in the Car (CIRCLE ALL THAT APPLY)

(ASK ONLY FOR CIRCLED AS "OTHER" IN Q.I)

M. What kind of programming or music do they have on (INSERT "OTHER" STATION FROM Q.I) ? (BE AS SPECIFIC AS POSSIBLE) (CIRCLE ALL THAT APPLY) (RECORD ON NEXT PAGE)

(BM/E-Z = "Beautiful Music")

N. Which is your favorite station? (ACCEPT ONLY ONE) (VERIFY IF STATION IS "AM" OR "FM" IF IT CAN BE EITHER)

* IF Q.N = ANY NEWS/TALK OR NON-MUSIC STATION -- ASK:
And what is your favorite music station? (CIRCLE ONE MORE ON NEXT PAGE)

(31) STATION/FREQ	(BAND) AM	FM	(WHEN LISTEN) 6-10	10-3	3-7	7-Md	Md-6	(WHERE LISTEN) HOME	CAR	OTHER	(KIND OF PROGRAM) BM/ E-Z	TOP40 CNTRY	ALBUM BLACK	NEWS/ TALK	OTH	Q.N FAVRIT STATN
-1 WAUR/107.9	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (36)						-1 (13)
-2 WBBMa/780	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-2*
-3 WBBMf/96.3	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-3
-4 WBEE/1570	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-4
-5 WBMXa/1490	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-5
-6 WBMXf/102.7	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (41)						-6
-7 WBEZ/91.5	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-7
-8 WCKG/105.9	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-8
-9 WCLR/101.9	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-9
-0 WCZE/820	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-0
-X WFMT/98.7	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (46)						-X
-R WFYR/103.5	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-R
(32)																
-1 WGCIa/1390	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-1 (14)
-2 WGCIf/107.5	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-2
-3 WGN/720	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-3*
-4 WIND/560	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (51)						-4
-5 WJJD/1160	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-5
-6 WJMK/104.3	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-6
-7 WJOB/1230	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-7*
-8 WJPC/950	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-8
-9 WJZQ/95.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (56)						-9
-0 WKQX/101.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-0
-X WLAK/93.9	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-X
-R WLOO/100.3	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-R
(33)																
-1 WLS/890	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-1 (15)
-2 WLUPa/1000	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (61)						-2
-3 WLUPf/97.9	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-3
-4 WMAQ/670	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-4*
-5 WMBIa/1110	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-5
-6 WMBIf/90.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-6
-7 WNIB/97.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (66)						-7
-8 WNUA/95.5	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-8
-9 WOJO/1320	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-9
-0 WRXR/105.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-0
-X WTAQ/106.7	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-X
-R WUSN/99.5	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0 (71)						-R
(34)																
-1 WVON/1450	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-1 (16)
-2 WWCA/1270	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-2
-3 WXRT/93.1	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-3
-4 WYTZf/94.7	-1	-2	-3	-4	-5	-6	-7	-8	-9	-0						-4
(35)																CARD 2 (dup 1-8)
☐ (OTHER)	-1	-2	-1	-2	-3	-4	-5	-1	-2	-3 (76)	-1	-2	-3	-4	-5 (9)	☐ (17)
☐ (OTHER)	-1	-2	-1	-2	-3	-4	-5	-1	-2	-3	-1	-2	-3	-4	-5(10)	☐ (18)
☐ (OTHER)	-1	-2	-1	-2	-3	-4	-5	-1	-2	-3 (79-80)-1	-1	-2	-3	-4	-5(11) (12)	☐ (19)

NOTE: IF WIND, WOJO, WTAQ, OR OTHER SPANISH LANGUAGE STATIONS ARE ONLY STATIONS LISTENED TO TERMINATE AND SAVE SCREENER

O. Which of these do you use regularly: (READ LIST) (CIRCLE ALL THAT APPLY)

-1 Hi-Fi Stereo System (20)
-2 Compact Disc Player (CD)
-3 Record Turntable
-4 Cassette Deck
-5 Stereo TV
-6 Hi-Fi/Stereo VCR
-7 Graphic Equalizer

P. (SHOW CARD "D") Overall, which letter on this card best represents the value of the audio system you use most often?

A. -1 Less than $50 (21)
B. -2 $50-$99
C. -3 $100-$299
D. -4 $300-$499
E. -5 $500-$999
F. -6 $1,000-$1,999
G. -7 $2,000-$2,999
H. -8 $3,000 and over

Q. Generally speaking, how can you tell if you are hearing good audio quality? (PROBE) (BE SPECIFIC)

_____(22)

_____(23)

_____(24)

_____(25)
(26)
(27)
(28)
(29)
(30)

R. We would like to interview you as part of a survey on Audio and Radio listening. The rest of this interview will take about 15-20 minutes. If you will come with me, we would like to finish the rest of the questions at our offices (over here).

TAKE RESPONDENT TO INTERVIEWING LOCATION. ADMINISTER DETAILED QUESTIONNAIRE.

IF REFUSAL -- TERMINATE AND SAVE SCREENER (31-32)

CHECK FOR APPROPRIATE MUSIC AND RECORD BELOW:
(Chicago)

FAVORITE STATION (FROM Q.N)	TAPE
WAUR.....	2
*WBBMa.....	4
WBBMf.....	1
WBEE.....	1
WBMXa.....	1
WBMXf.....	1
WBEZ.....	4
WCKG.....	1
WCLR.....	3
WCZE.....	2
WFMT.....	2
WFYR.....	3
WGCIa.....	1
WGCIf.....	1

FAVORITE STATION (FROM Q.N)	TAPE
*WGN.....	4
WJJD.....	2
WJMK.....	3
*WJOB.....	4
WJPC.....	1
WJZQ.....	2
WKQX.....	3
WLAK.....	3
WLOO.....	2
WLS.....	3
WLUPa.....	1
WLUPf.....	1

FAVORITE STATION (FROM Q.N)	TAPE
*WMAQ.....	4
WMBIa.....	2
WMBIf.....	2
WNIB.....	2
WNUA.....	1
WRXR.....	3
WUSN.....	3
WVON.....	3
WWCA.....	2
WXRT.....	1
WYTZ.....	1
_____( ) Other (specify)	

(3

MUST INCLUDE MUSIC STATION -- THERE WILL BE TWO FAVORITES CIRCLED ONLY WHEN 1st FAVORITE IS NEWS/TALK!

(TAPES "1 - 3")

NOTE: THIS DATA MUST BE VERIFIED WITH A SUPERVISOR AND LOGGED ON THE MAIN QUESTIONNAIRE AND FRONT OF SCREENER

(34-38)

STUDY #88-123/1424Q

ADJ-CHANNEL
("A") CASSETTES

One East Superior Street • Chicago Illinois 60611 • 312/943-4400
B. Angell & Associates, Inc.

AM LISTENER -1 Yes
-2 No

NAB RADIO INTERFERENCE
(Main Questionnaire)

-1 Burlington
(-2) Jacksonville
-3 Chicago
-4 Wichita
-5 Los Angeles

FROM LAST PAGE OF SCREENER:
RECORD FAVORITE STATION
FROM Q.N _____
CASSETTE USED: ( )

TIME STARTED:
a.m.
_____ p.m.

NOTE: MAKE SURE ALL TAPES HAVE BEEN RE-WOUND AND THE CORRECT TAPE FOR THIS RESPONDENT HAS BEEN CHOSEN AND INSERTED IN CASSETTE MACHINE

MAKE SURE POWER BUTTON ON PLUG STRIP (ON FLOOR) IS ON

1. We would like to know how you feel toward interference on the radio. By interference, we mean any annoying or undesirable noise or other sounds that either partially or completely obscure the radio station you want to hear. Thinking about your normal radio listening, or if you try to tape off the radio, have you ever been bothered by interference on the radio?

-1 Yes (39)
-2 No

RECORD ALL ANSWERS ON NEXT PAGE

2. (SHOW CARD "E") Which of the situations listed on this card have you ever experienced while listening to the radio? (CIRCLE ALL THAT APPLY)

(1) The station you are listening to "fading in and out"

(2) A building or hill blocking your signal

(3) Another station cutting in over your station

(4) "Splashy" or "splattering" sound over your station

(5) Static/crackling

(6) Whistles, whines/tones

Other _____
(Please describe in detail)

FOR ALL SITUATIONS CIRCLED IN Q.2/"EXPERIENCED" -- ASK Qs. 3 - 6 AND RECORD ON NEXT PAGE.

(SHOW CARD "F")

3. How often do you experience... (INSERT ALL CIRCLED FROM Q.2):

IF Q.3 = -2 OR -1 SKIP TO Q.7a.

4. On which stations have you heard... (INSERT ALL CIRCLED FROM Q.2)?

(SHOW CARD "G")

5. When you hear ... (INSERT ALL CIRCLED FROM Q.2), in what location would you be listening to the radio?

(SHOW CARD "H")

6. How much does it bother you when you hear ... (INSERT ALL CIRCLED FROM Q.2) ?

RECORD ALL ANSWERS FOR Qs. 3-6 BELOW

Q.2	Q.3						Q.4		Q.5					Q.6				
EXP.	ALL TIME	MOST TIME	SOME TIME	HDLY EVER	NEVR		STATIONS (WRITE IN)		AT HOME	IN CAR	AT WORK	OTHR AWAY		VERY MUCH	SOME WHAT	SLIG HTLY	NOT ALL	
-1	-5	-4	-3	-2	-1	(45)	_____	_____	(58) -1	-2	-3	-4	(9)	-4	-3	-2	-1	(22)
-2	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	
-3	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	
-4	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	
-5	-5	-4	-3	-2	-1		_____	_____	(62) -1	-2	-3	-4		-4	-3	-2	-1	
-6	-5	-4	-3	-2	-1	(50)	_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	
_____ (Other)	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4	(15)	-4	-3	-2	-1	(28)
_____ (Other)	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	(29)
_____ (Other)	-5	-4	-3	-2	-1		_____	_____	-1	-2	-3	-4		-4	-3	-2	-1	(30)
(41)						(54)			(67)				(18)					

(42) (55) (68) (19) (31)

(43) (56) (69) (20) (32)

(44) (57) (70) (21) (33)

(71-78)
(79-80)-2
CARD 3 (1-10 dup)

7a. When you experience interference problems, at what point do you decide that the interference is unacceptable for the purpose of listening to the station? (READ) (CIRCLE ONE)

(34)

-1 When you first turn it on

-2 After you have listened a while

-3 Only after a different music selection and/or program comes on

-4 Some other time (Specify)_____(35)

_____(36)

(37)

(38)

7b. What do you do if the the interference is completely unacceptable? (DO NOT READ) (CIRCLE ALL THAT APPLY)

(39)

-1 Try to adjust radio

-2 Wait to see if it clears up

-3 Turn to another station

-4 Turn off the radio

-5 Turn down the volume

[ ] Other (Specify)_____(40)

_____(41)

(42)

(43)

8a. Do you generally find that radio interference is worse when listening inside a building or in the car?

(44)

-1 Building

-2 Car

8b. In what ways is it worse? (PLEASE DESCRIBE)

_____(45)

_____(46)

_____(47)

_____(48)

_____(49)

(50)

(51)

9. Are there any stations you no longer listen to because of problems with too much interference?

-1 Yes ⟶ Which stations? _____ _____(53)

-2 No (52) (54)

(55)

MAKE SURE TAPE (___) IS IN THE CASSETTE MACHINE
ALWAYS USE MUSIC TAPE FIRST

! START CASSETTE ! (ALL TAPES HAVE 20 SECONDS AT THE BEGINNING IN WHICH TO SET VOLUME)

TELL RESPONDENT: Please adjust the volume knob (HERE) for the level you like listening to the radio.

HAVE RESPONDENT SET VOLUME FOR GOOD LISTENING LEVEL. MAKE SURE LEVEL IS APPROPRIATE FOR ATTENTIVE, COMFORTABLE LISTENING (NOT TOO LOUD OR TOO SOFT) WHILE SETTING LEVEL ACCORDING TO PERSONAL PREFERENCE -- UNTIL TONE IS HEARD.

! STOP CASSETTE !

10. LOOK AT AND RECORD VOLUME SETTING THAT THE RESPONDENT HAS CHOSEN. (DO NOT ALLOW RESPONDENT TO SET VOLUME CONTROL AT 1:2 OR 9:10)

		-3	3:4	-5	5:6	-7	7:8	
-2	2:3	-4	4:5	-6	6:7	-8	8:9	(56)

INTRODUCTION: (HAND RESPONDENT DATA CARD THAT MATCHES TAPE SELECTION) Please be seated comfortably. I am going to play for you some short segments from radio station broadcasts. We are interested in getting your opinion on interference you may hear in this programming. Please tell us is if what you hear is Completely Acceptable, Completely Unacceptable, or somewhere in-between.

Using the card in front of you, read the rating on the left side of the row; then read the rating on the right side.

If you feel the rating on the right completely describes what you hear, put a check mark in the box closest to that rating. If you feel that the rating on the left completely describes what you hear, put a check mark closest to that rating.

You may, of course, put a check mark in any one box between the ratings depending on how closely that rating describes what you feel. The closer you place a mark to a rating, the more strongly you feel that rating describes what you hear.

AUDIO TEST

SECTION 1
(Music Interference Over Music)

Here is selection #1:

! START CASSETTE !

(1ST MUSIC SEGMENT)

! STOP CASSETTE !

Now, please check the box you feel is most appropriate. (MAKE SURE RESPONDENT CHECKS ONE BOX). OK, from now on, I will let the tape run. Please rate each one during the pause.

Next is selection #2 -- and we will continue for a total of 10 selections:

! START CASSETTE !

NOTE: WATCH TO MAKE SURE RESPONDENTS KEEP THEIR PLACE IN THE ORDER AND THAT THERE IS NO CONFUSION. (IF THERE IS ANY MAJOR PROBLEM, ISSUE A BRAND NEW DATA CARD AND START ALL OVER FROM "TEST" AT TOP).

WHEN TONE SOUNDS AT END OF SEGMENTS --

! STOP CASSETTE ! -- REMOVE TAPE (DO NOT REWIND YET!)

SECTION 2
(Music Interference Over Talk)

INSERT TAPE "4" (NEWS/TALK)

! START CASSETTE ! CHECK WITH RESPONDENT FOR VOLUME ACCEPTABILITY DURING 1ST 20 SECONDS

WHEN TONE SOUNDS --

! STOP CASSETTE !

ISSUE DATA CARD "4"

Here are some more segments for you to rate.

! START CASSETTE !

WHEN TONE SOUNDS --

ONLY STOP CASSETTE IF NECESSARY

(SAME TAPE CONTINUES)

SECTION 3
(Talk Interference Over Talk)

Here are some final segments for you to rate. Please continue rating these just as you have been doing.

! START CASSETTE !

WHEN TONE SOUNDS AT END OF SEGMENTS --

! STOP CASSETTE ! -- IF FAVORITE STATION IS MUSIC (Q.N), REMOVE TAPE -- INSERT MUSIC TAPE BACK INTO MACHINE. OTHERWISE, LEAVE TALK TAPE IN

==========

! START CASSETTE ! (SHOULD BE ON A FULL-LENGTH VERSION)

! LOWER VOLUME ! -- TO LET TAPE PLAY AUDIBLY WHILE CONTINUING WITH QUESTIONNAIRE.

11. Was the interference you just heard similar or different from the kinds of interference you have heard on the radio in the past? (CIRCLE ALL THAT APPLY)

-1 Similar → In what ways was it similar? _____(58)

_____(59)

(57) _____(60)

_____(61)

(62)

-2 Different → In what ways was it different? _____(63)

_____(64)

_____(65)

_____(66)

(67)

12. What do you feel about the sound quality of this tape we are listening to now, which is from a radio transmission -- (TURN-UP MUSIC IF NEEDED) would you say it is: (READ LIST) (ACCEPT ONE ONLY)

-4 Excellent (68)

-3 Good

-2 Fair

-1 Poor

13. Would you expect to hear this kind of broadcast quality on an FM station or on an AM station? (CIRCLE ALL THAT APPLY)

-1 FM → Why is that? _____(70)

(69) _____(71)

_____(72)

-2 AM → Why is that? _____(73)

_____(74)

_____(75)

(76)

(77)

(78)

(79-80)-3

14. Thinking about <u>other</u> qualities as well as interference, what is there about the sound quality of the AM radio signal that is different from the way the FM signal sounds?_____ (9)

_____(10)

_____(11)

(12)

(13)

(14)

15. What do you feel are the major problems with the sound quality of the AM radio signal? (PROBE) (BE SPECIFIC)

_____(15)

_____(16)

_____(17)

_____(18)

(19)

(20)

CLASSIFICATION SECTION

Now, I have a few questions that will allow us to combine your answers with others who take part in this nationwide survey.

S. In total, how many people, including yourself, are there living in your household? (ACTUAL NUMBER)

_____People (21-22)

T. Of these, how many are... (READ) (RECORD NUMBER FOR EACH)

___ Under 12 (23)

___ 12-17 (24)

___ 18 or older (25)

U. How would you best describe your background -- would it be: (READ)

-1 White

-2 Black

-3 Hispanic

-4 Asian

☐ Other (Specify)_____ (26)

V. (HAND RESPONDENT CARD "I")
Please tell me which letter on this card best represents your household's total annual income:

A. -1 Under $20,000 (27)

B. -2 $20,000 - 34,999

C. -3 $35,000 - 49,999

D. -4 $50,000 and over

W. (DO NOT ASK)

RECORD SEX: (28)

-1 Male

-2 Female

NOTE -- NOTE: REWIND ALL TAPES AND ORGANIZE FOR NEXT INTERVIEW.

My supervisor may be calling to verify my work. May I have your:

NAME:_____PHONE:( )_____

ADDRESS:_____

CITY:_____STATE:_____ZIP:_____

INTERVIEWER:_____DATE:_____

CONFIRMED BY:_____CONFIRMED DATE:_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

TIME ENDED:
a.m.
_____ p.m.

(29-30)
(31-60) DATA CARDS
(61-78)

(79-80)-4

CASSETTE A-A RECORDING CARD REPONDENT NAME_____

CUT#

1.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
2.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
3.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
4.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
5.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
6.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
7.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
8.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
9.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
10.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
11.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
12.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
13.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
14.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
15.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
16.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
17.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
18.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
19.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE
20.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐ COMPLETELY UNACCEPTABLE

CASSETTE (A1) RECORDING CARD REPONDENT NAME_____

CUT#

1.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE (31)
2.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
3.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
4.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
5.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
6.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
7.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
8.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
9.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE
10.	COMPLETELY ACCEPTABLE	☐	☐	☐	☐	☐	☐	COMPLETELY UNACCEPTABLE (40)

(5-11-88 AM Radio Advisory Committee) 19.

DRAFT

FOR REVIEW AND COMMENT

5/17/88

AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87–267

An AM Improvement Report
from the
National Association of Broadcasters

June 17, 1988

Harrison J. Klein, P.E.
Hammett & Edison, Inc.
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AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87-267

HARRISON J. KLEIN, P.E.

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AM Technical Assignment Criteria

An Examination of Issues Raised in MM Docket No. 87–267

HARRISON J. KLEIN, P.E.[1]

I. EXECUTIVE SUMMARY

This technical report addresses four issues in the FCC's Notice of Inquiry in MM Docket No. 87–267:

1. Atmospheric and man-made noise
2. Minimum usable field strength
3. Adjacent-channel protection ratios
4. RSS calculations and adjacent-channel skywave interference.

Here are the principal conclusions of this report:

1. Minimum usable field strength can vary widely depending on atmospheric and man-made noise environment and on required system performance. No single protected contour is appropriate for all circumstances. Differing requirements should be accommodated by the Commission's allocation scheme.
2. Existing protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers. New protection ratios can be calculated that will reflect present and future technical parameters such as the NRSC audio standard.
3. The existing RSS calculation method using 50% exclusion results in unrealistic predictions of nighttime service and, over the years, has permitted widespread increases in interference. Use of a 25% exclusion method would more accurately portray nighttime service contours and would minimize future increases in interference.
4. The existing RSS calculation method produces correct estimates of total 10%-time interference even though the 10%-time values of the interferers are individually specified prior to calculating the RSS.
5. RSS calculations should include the effects of adjacent-channel skywave interference by weighting each RSS contributor by the appropriate protection ratio.

Finally, and most importantly, this report contains PC-compatible computer programs that permit an AM engineer to calculate the values of appropriate technical assignment criteria using user-supplied input parameters. Sample calculations are provided.

II. INTRODUCTION

This report, which was prepared on behalf of the National Association of Broadcasters (NAB), contains the results of a broad examination of AM technical assignment criteria. NAB's efforts were prompted by the August 17, 1987, release by the Federal Communications Commission of a Notice of Inquiry in MM Docket No. 87–267 ("Notice"). The Notice initiated a review of the many technical assignment criteria that collectively represent the technical framework for the AM broadcast service. Among the issues raised by the Commission are whether existing protected contours and protection ratios for the various classes of AM stations are appropriate in light of past and potential changes in transmission technology, AM receiver design, and listener habits. Related issues include the effects of atmospheric and man-made noise, and whether current FCC calculation methods adequately describe AM groundwave and skywave propagation and the effects of multiple interfering signals.

This report collects and analyzes available technical information and provides computer tools useful in developing recommendations for FCC action. The report considers the geographical dependence of atmospheric and man-made noise, and provides sources that contain estimates for their values. It analyzes each component required to determine the minimum usable field strength, E_{min}. It describes the factors that affect radio frequency protection ratios and describes the methods that have been developed to calculate protection ratios. The matters of RSS calculations and adjacent-channel skywave interference are thoroughly discussed; in particular, the report describes the proper method for calculating the effects of multiple interfering skywave signals.

Computer programs are provided for calculating E_{min}, adjacent-channel protection ratios, and signal-to-interference ratios for multiple skywave signals. The algorithms are explained in some detail and are available for the Commission and others to use in their deliberations.

A specific set of technical standards is not proposed by this report. Rather, interested parties are encouraged to use the information contained in this report to formulate suitable technical criteria they believe to be appropriate for the present and future AM broadcasting environment. This study was conducted because NAB wished to ensure that the Commission's technical standards are as accurate and objective as possible.

---

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III. ATMOSPHERIC AND MAN-MADE NOISE

The ambient noise level is a determining factor in the minimum usable field strength, E_{min}, which in turn is the basis for defining protected contours. A knowledge of the ambient atmospheric and man-made noise throughout the United States is essential to the development of more appropriate technical standards for the AM band. Stations must have an appropriate RF signal-to-noise ratio (SNR) in order to provide listeners with the quality of sound they demand.

A. Atmospheric Noise

Knowledge about atmospheric noise levels has improved significantly in the years since the present FCC allocation standards were developed. Extensive research has been conducted into the distribution of atmospheric noise throughout the world. The results are summarized in reports of the International Radio Consultative Committee (CCIR); the most recent is CCIR Report 322–3, "Characteristics and Applications of Atmospheric Radio Noise Data," which is dated 1986 and is included with this report as Appendix A. Report 322–3 is based principally on research performed by Spaulding and Washburn of the U.S. National Telecommunications and Information Administration [1].

Report 322–3 presents atmospheric noise data in the form of maps and graphs. Each map and its two associated graphs cover a specified season (winter, spring, summer, autumn) and four-hour time period (e.g., 0000–0400 local time). The map shows the expected value of atmospheric radio noise throughout the world, for a frequency of 1 MHz. Consistent with conventional technical discussions of noise, this report defines noise in terms of an effective antenna noise figure, F_a, and describes how F_a can be converted to an equivalent noise field strength in millivolts per meter. In the United States, F_{am}[2] ranges from a low of approximately 30 dB (Pacific Northwest, winter, 0800–1200) to a high of approximately 90 dB (Midwest, summer, 2000–2400).

One of the graphs associated with each map shows the variation of radio noise with frequency. Noise levels are highest at low frequencies and generally decrease with increasing frequency at the rate of approximately 30–70 dB per decade. Above about 30 MHz, atmospheric noise levels are beneath the level of galactic noise.

The other graph associated with each map shows, as a function of frequency, the remaining parameters necessary for a complete statistical description of the noise. V_d is the ratio, in dB, of the rms noise envelope voltage to the mean noise envelope voltage.[3] The higher the value of V_d, the more impulsive or "spiky" the noise. D_l and D_u are the lower and upper deciles, respectively, of the average noise power. The lower decile is the value exceeded for 90% of the hours within a time block; the upper decile is the value exceeded for 10% of the hours. D_l and D_u are measures of the deviation of F_a from its median value. The graph also shows the standard deviations of the various statistical quantities.

B. Man-made Noise

Man-made noise has become a much more serious allocation consideration as its level has increased due to the proliferation of power lines, industrial machinery, and noise-generating appliances, but less data is available on this topic than on atmospheric noise. CCIR Report 258–4, "Man-made Radio Noise," which is included with this report as Appendix B, includes a discussion of man-made noise based on work published in 1974 by Spaulding and Disney [2], but opinions differ on whether these levels are still valid.

Man-made noise is described using the same statistical quantities, such as F_{am}, as is atmospheric noise. Five "environmental categories" are defined in Report 258–4 corresponding to different values for F_{am}: galactic (as defined in Report 322–3), quiet rural, rural, residential, and business. Figure 1 of Report 258–4 shows that F_{am} for each category of noise varies linearly with the logarithm of the noise frequency.

To describe an environment that may better correspond to the increasing noise levels that have occurred over the last 15 years, this report defines a new environmental category called "intense," which is even noisier than the "business" category. "Intense" noise is equivalent to the noise level measured in the vicinity of power lines, which was reported in [2].

The next section of this report describes how the above statistical parameters of atmospheric or man-made noise, together with other transmission system parameters, are used to calculate E_{min}.

IV. MINIMUM USABLE FIELD STRENGTH

The minimum usable field strength, E_{min}, is defined as the field strength necessary to permit a desired reception quality, under specified receiving conditions, in the presence of natural and man-made noise.[4] If noise were constant, one could define reception quality simply as a certain signal-to-noise ratio, then add that value to the noise level to obtain E_{min} directly. But because the noise level is always changing, a technically accurate E_{min} must instead be evaluated statistically.

The report now describes how the concept of system performance is used to develop a method for calculating E_{min}. The statistical terms that define system performance are necessarily abstract. Readers without a theoretical background in probability and statistics should not expect to gain a thorough understanding of the concept of system performance from this report, but should become familiar with the basic terminology.

---

2 F_{am} is the median of the hourly values of F_a within a time block.

3 The graph shows V_{dm}, which is the median of V_d for the specified time-block.

4 A more complete definition can be found in [3].

A. The Components of System Performance

For the purposes of this report, E_{min} is the field strength necessary to achieve a desired system performance, where system performance is defined in Report 322–3 in terms of three independent component parts: grade of service, time availability, and service probability. The concept of system performance used here is consistent with that for other communications systems. Each component of system performance must be specified before E_{min} can be calculated.

1. Grade of service

"Grade of service" represents the short-term reception quality of the system. The purpose of defining grades of service, which are common in many communication systems, is to develop subjective descriptions of quality that correspond to particular objective technical specifications. For example, common grades of service for commercial telephony systems are "just usable," "marginally commercial," and "good commercial." Example II in Section 6.5 of Report 322–3 defines the "marginally commercial" grade of service for a double-sideband telephony system to be a median signal-to-noise ratio of 64 dB in a 1 Hz bandwidth.

"Marginally commercial" provides a better subjective description of reception quality than does the technical specification "a median signal-to-noise ratio of 64 dB in a 1 Hz bandwidth." Knowing, for example, that a 5 mV/m field strength is required to obtain a SNR of 64 dB in a 1 Hz bandwidth is of little practical benefit without also knowing the relationship between the technical specification and the subjective description.

The terms used to specify grade of service depend on the particular communication system, but all grades of service for statistical systems must include a measure of time in addition to one of signal quality. The above example did not explicitly include a reference to time, but use of the term "median signal-to-noise ratio" implies a time percentage of 50%. Example I in Section 6.4 of Report 322–3 describes a frequency shift keying system in which grade of service is specified by the probability of bit error which, for a given transmission rate, corresponds to a certain number of errors per unit time.

In a telephony system such as AM, the grade of service is specified by an instantaneous signal-to-noise ratio and the percentage of time that the SNR is achieved. Note that the specification refers to the instantaneous SNR. Even for noise with a constant rms level, the instantaneous noise envelope voltage is constantly changing. Grade of service refers to the percentage of time that the signal is above the instantaneous level of the constantly changing noise, for a certain rms noise level.

At this time there are no generally accepted definitions in the United States for AM broadcasting grades of service. An instantaneous signal-to-noise ratio and percentage of time must be specified before E_{min} can be calculated, but there has been no relationship developed in which a certain combination of SNR and time percentage corresponds to Grade A or best quality service, a lower SNR to a Grade B or lesser quality service, and so forth. With further research, a relationship could be developed analogous to the TASO grades for television pictures. In the absence of defined grades of service, values that appear reasonable must be chosen for instantaneous SNR and time percentage, but those values cannot now be related to known levels of listener satisfaction.

2. Time availability

In the above discussion concerning grade of service, the time specification refers to the percentage of time the signal is above the instantaneous noise envelope voltage, for noise of constant rms level. But the rms noise level itself also changes from hour to hour within each four-hour seasonal time period (e.g., summer, 2000-2400 local time) shown in Report 322–3. "Time availability" is the percentage of time throughout the specified time period that a given grade of service or better will be achieved.

3. Service probability

Each parameter that describes the statistical nature of the noise has an uncertainty, which is described by its standard deviation. "Service probability" is the statistical confidence factor, required for any statistical description, that combines these various uncertainties. It is the probability that a specified grade of service or better will be achieved for a specified time availability.

To aid in understanding the concept of service probability, consider an E_{min} calculation made using the data in Report 322–3 for a particular season and time period, grade of service, and time availability, and for a service probability of 50%. For a given path from transmitter to receiver, 50% service probability means that there is a 50% chance that this value of E_{min} will be sufficient to achieve the specified grade of service and time availability.

B. Calculation of E_{min} by Computer

To provide information that will be useful to anyone wishing to develop specific recommendations for E_{min}, a PC-compatible computer program was written that allows the user to specify any desired set of input conditions, which consist of atmospheric or man-made noise parameters, system performance requirements, frequency, bandwidth, and standard deviation of the expected received signal strength.[5] Appendix C contains further information about the algorithm and instructions for program operation.

Sample E_{min} calculations have been made and are shown in Figure 1. The figure is arranged in order of worsening noise. Each example is for an instantaneous signal-to-noise ratio of 26 dB. Although the time percentage for grade of service can be specified differently from the percentage of time availability, in the examples the two percentages are specified identically; the columns labeled 50%-time, 90%-time, and

[5] See Appendix C for a discussion of standard deviation of the expected received signal strength.

DRAFT

Figure 1

CALCULATED MINIMUM USABLE FIELD STRENGTH, E_{min}

Signal-to-noise ratio = 26 dB Frequency = 1 MHz Service probability = 50%

Noise Type	Location or Category	Season and Local Time	Calculated E_{min} (mV/m) 50%-time	90%-time	99%-time
Atmospheric	Pacific Northwest	Winter, 0800–1200	<0.005	<0.005	0.03
Man-made	Rural		0.04	0.35	2.02
Man-made	Residential		0.07	0.67	4.69
Man-made	Business		0.11	1.04	7.52
Atmospheric	Midwest	Summer, 2000–2400	0.18	2.12	24.9
Man-made	Intense		0.56	5.89	46.7

99%-time refer to both grade of service and time availability. Each example is for a service probability of 50%. The examples show the values of field strength that would be needed for the instantaneous signal-to-noise ratio to be at least 26 dB, for the indicated percentage of time and for the indicated percentage of hours within the CCIR seasonal time period, with a confidence factor of 50%.

The bandwidth was specified as 10,666 Hz for all calculations. 10,666 Hz is the effective RF bandwidth of a receiver meeting the NRSC deemphasis standard, assuming infinite attenuation outside the ±10,000 Hz receiver passband.[6] The standard deviation of the expected received signal strength was specified as 2 dB and the frequency was specified as 1 MHz for all calculations.

The specific program input parameters for the two atmospheric noise examples were determined from Report 322-3 as follows:

Pacific Northwest, Winter, 0800–1200

F_{am}:	30 dB	Standard deviation:	4.5 dB
V_{dm}:	4.1 dB	Standard deviation:	2.2 dB
D_u:	9.2 dB	Standard deviation:	5.2 dB

Midwest, Summer, 2000–2400

F_{am}:	90 dB	Standard deviation:	4.8 dB
V_{dm}:	5.7 dB	Standard deviation:	1.5 dB
D_u:	8.2 dB	Standard deviation:	2.8 dB.

For the four man-made noise environments, F_{am}, V_{dm}, and D_u were taken from [2], if available, and are built into the program. The user is not required to specify these parameters.

Two general observations can be drawn from the data in Figure 1. First, under some circumstances noise levels can be extremely low. During winter in the Pacific Northwest, the 50%-time and 90%-time values for E_{min} are less than 5 microvolts per meter. Even in a business noise environment, a field strength of 0.1 mV/m is sufficient to provide a 26 dB signal-to-noise ratio approximately 50% of the time. This indicates that reception of a quality some may consider acceptable can occur even in areas of relatively low signal strength, such as the fringe areas of the 0.1 mV/m protected contour of a Class I station. If such a signal is the only kind available, as it may be in rural areas with no local radio station, it may provide listeners with perfectly usable service.

On the other hand, Figure 1 shows that it takes a strong signal to yield high time availabilities, especially in urban areas. A field strength of 1 mV/m is needed in a business noise environment merely to get a 90%-time signal-to-noise ratio of 26 dB. For a better SNR, the field strength would have to be correspondingly higher. To obtain 99%-time reliability, even with a signal-to-noise ratio of only 26 dB, in most locations AM signals must have field strengths in the 2-25 mV/m range.

This section has demonstrated that the calculated values of minimum usable field strength can vary widely depending on atmospheric and man-made noise environment and on required system performance. Thus no single protected contour is appropriate for all circumstances. Differing requirements should be accommodated by the Commission's allocation scheme.

6 Effective bandwidth is the bandwidth of a hypothetical white noise signal (constant power density) that has the same total noise power as noise that has been weighted by the deemphasis characteristic. The effective audio bandwidth was obtained by numerically integrating the NRSC deemphasis curve from 0 Hz to 10,000 Hz, using Simpson's rule with a step size of 50 Hz. The effective RF bandwidth is twice the effective audio bandwidth.

V. ADJACENT-CHANNEL PROTECTION RATIOS

The development of more realistic co-channel and adjacent-channel protection ratios is probably the most important technical issue in the AM improvement proceeding. The protection ratios that underlie existing allocation standards are largely responsible for the interference situation on the AM band. This section describes the factors that affect the protection ratio and discusses how protection ratios can be calculated that will reflect present and future technical parameters.

A. Factors Affecting Protection Ratio

The RF protection ratio is defined[7] as the RF desired-to-undesired (D/U) ratio at the receiver input[8] that will provide the required audio signal-to-interference ratio at the receiver output. The RF protection ratio depends on diverse parameters such as channel spacing, modulation characteristics, transmitter and receiver characteristics, human hearing characteristics, and subjective listening preferences. In particular, it depends on a number of technical parameters that have changed since the present allocation system was implemented, or that the broadcast industry hopes will change in the future:

1. The bandwidths of the transmitter and receiver and the preemphasis and deemphasis characteristics of the system. The NRSC standards and wider-bandwidth receivers should form the basis for new protection ratios.
2. The spectral energy distribution of the modulation signal. The spectral content of modern programming differs greatly from that found decades ago.
3. The amount of compression and limiting. The effects of heavy processing should be taken into account.
4. The amplitude and frequency response of the human ear. As listeners have become accustomed to improved quality sound reproduction from other media, their subjective preferences may have changed, which would affect their perception of interference.

7 A more rigorous definition of both audio and RF protection ratios can be found in [3].

8 The term "at the receiver input" can mean different things depending on context. In FCC allocation standards the term refers to the ratio of field strengths at the receiving antenna, but in the context of measurement practice it refers to RF voltages at the receiver's antenna terminals. In allocation standards based on protection ratios determined by conventional measurement techniques, receiving antenna directivity is assumed to be negligible; this is a reasonable assumption given the random orientation of the antenna and the random spatial relationship between the desired and undesired stations.

B. Determination of Protection Ratios

Protection ratios can be determined in several ways [4]. The most accurate method, and the only method for co-channel ratios, is through subjective listening tests, wherein listeners evaluate reception quality under specified conditions of desired and undesired signals and receiver characteristics. The protection ratio is chosen based on an agreed-upon listener satisfaction level. The subjective method is extremely time-consuming because it involves many variables and many people.

It is possible to determine adjacent-channel protection ratios through subjective listening tests. However, if listening tests are first used to determine the co-channel protection ratio, then various objective methods can be used to derive the adjacent-channel protection ratio relative to that co-channel ratio [5]. This relative adjacent-channel protection ratio, A_{rel}, is defined in [4].

A_{rel} is a construct — it does not represent an actual D/U ratio at any frequency — but it is useful because it can be calculated objectively and then used to derive the actual adjacent-channel protection ratio, A. The following equivalent equations relate A_{rel} to A and to the co-channel protection ratio, A_O:

$$A_{rel} = A - A_O$$
$$A = A_O + A_{rel}.$$

For example, the existing AM allocation system is based on a co-channel protection ratio at the protected contour of 20:1, or 26 dB, which means that the desired signal must be 26 dB greater than the undesired signal. The adjacent-channel protection ratio at the protected contour is 1:1, or 0 dB. Therefore, for the first adjacent channel,

$$A_{rel} = A - A_O$$
$$= 0 - 26$$
$$= -26 \text{ dB}.$$

All of the objective methods for obtaining relative protection ratios involve defining the technical parameters that make up the transmitter and receiver response. "Transmitter response" refers to the overall transmitted energy spectrum. "Receiver response" refers to the overall receiving system, which includes human hearing characteristics. In principle, if all of these technical parameters that affect A_{rel} are properly defined, the objective methods should yield the same protection ratios as would be obtained subjectively.

NAB has retained B. Angell & Associates, Inc., of Chicago to conduct the subjective tests needed to determine the required co-channel protection ratio, A_O. This companion report is intended to provide the background and tools necessary for interested parties to calculate the relative adjacent-channel protection ratio, A_{rel}, for any desired transmission and reception parameters. From A_O and A_{rel}, recommended values for the actual adjacent-channel protection ratio, A, can be derived.

C. Objective Methods for Determining Protection Ratios

Of the several objective methods described in [5] for determining A_{rel}, the most accurate is the "objective measurement method," which uses RF generators as the desired and undesired signals, modulates them with noise that simulates program material of the desired level and character, detects them with a receiver of the proper characteristics, and measures the signal-to-noise ratio with a properly weighted noise meter. While the objective measurement method is accurate, and serves as a reference for the other methods that do not involve measurement, it is time-consuming and requires specialized test equipment. The test equipment must be modified if the transmission or reception parameters are changed, which makes it difficult to use the objective measurement method with hypothetical transmission systems.

Another of the objective methods in [5] for determining A_{rel} is called the "numerical method," which involves a computer calculation that takes into account each of the objective parameters that affect the adjacent-channel protection ratio. It permits immediate determination of A_{rel} for any transmitting and receiving system, existing or projected. The numerical method is especially useful in the development of allocation standards because it can take into account the characteristics of the NRSC system, including future NRSC receivers.

D. Calculation of Protection Ratios by Computer

The CCIR numerical method is based on work done in Germany by Gröschel. His paper, "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems," which discusses the numerical method in detail, is included with this report as Appendix D. The paper describes a computer program that determines A_{rel} by means of numerical integration.[9] A copy of this program was obtained from the author. It was re-written to translate the German expressions, to make it PC-compatible, to permit specification of technical parameters such as the NRSC standards that are appropriate to domestic AM broadcasting, and to make it convenient for users to modify the program to specify different hypothetical parameters. Appendix E contains instructions for program operation.

The computer program permits interested users to evaluate relative adjacent-channel protection ratios under varying conditions and to make appropriate recommendations to the FCC. Sample calculations have been made and are shown in Figure 2. For ease of interpretation, the values of A_{rel} calculated by the computer have been converted to actual protection ratios using the existing FCC co-channel protection ratio, A_O, of 26 dB. Note that if A_O were some higher value such as 40 dB, the adjacent-channel protection ratios shown in Figure 2 would have to be increased by 14 dB. Thus the protection ratios shown in Figure 2 can be considered minimal. For comparison, Figure 2 also shows the protection ratios implicit in existing allocation standards.[10]

The following parameters were used for all sample protection ratio calculations:

Transmission mode:	DSB/ISB
Modulation spectrum:	USASI noise
Modulation factor:	1.00
Transmitter noise:	100.0 dB below carrier
Intermodulation attenuation:	40.0 dB
Psophometric curve:	CCIR–468
Out-of-band selectivity:	100.0 dB
Notch filter:	None.

The remaining parameters were varied according to the desired transmission and reception mode. The transmission mode "Pre-NRSC" refers to transmission conditions prior to the adoption by stations of the NRSC audio standard,[11] in which an audio processor is used that has a simple 50-microsecond preemphasis curve and does not have the NRSC low-pass filter. "NRSC" refers to transmission with the preemphasis curve and low-pass filter of the NRSC audio standard; the NRSC RF mask limits were used as the out-of-band radiation model only in Sections B and C of Figure 2. The "5400 Hz bandwidth" mode refers to transmission with a sharp-cutoff 5400 Hz audio low-pass filter and no preemphasis.

The reception mode "Current Radios" refers to typical AM radios that begin to roll off about 2000 Hz, are down 20 dB at 5 kHz, and are down 40 dB at 10 kHz. "Ideal NRSC" refers to a radio using NRSC deemphasis and the same "brick wall" filter characteristics as an NRSC transmitter. Since a filter this sharp is unlikely in commercial AM radio receivers, a "Realistic NRSC" receiver was defined having a less selective band-limiting filter with a 60 dB per octave slope beyond 10 kHz; even this filter characteristic may be overly optimistic.

The specific program setup conditions for the various transmission and reception modes were as follows:

Pre-NRSC

Band limiting:	Low-pass
Attenuation:	40 dB/kHz
Bandwidth:	14000 Hz
Preemphasis:	50 μs
Out-of-band radiation:	CCIR

9 Gröschel's original program was written in BASIC for Hewlett-Packard desktop computers.

10 FCC Rules do not specify a second-adjacent-channel protection ratio. A ratio of –29.5 dB is specified internationally in [6]. The contour overlap table in Section 73.37(a) of the FCC Rules, which prohibits overlap of the 2 mV/m and 25 mV/m field strength contours of stations with a frequency separation of 20 kHz, does not provide a 30 dB protection ratio at the 0.5 mV/m protected contour.

11 The term "NRSC audio standard" refers to NRSC Standard No. NRSC–1, EIA Interim Standard EIA/IS–40, "NRSC AM Preemphasis/Deemphasis and Broadcast Audio Transmission Bandwidth Specifications."

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Figure 2

REQUIRED ADJACENT-CHANNEL PROTECTION RATIOS

for Co-channel Protection Ratio of 26 dB

Transmission Mode	Reception Mode	Adjacent-channel Protection Ratio (dB) First (10 kHz)	Second (20 kHz)
	A. Out-of-band radiation: CCIR model		
Pre-NRSC	Current radios	17	–8
NRSC	Current radios	14	–30
NRSC	"Ideal" NRSC	21	–28
NRSC	"Realistic" NRSC	24	–7
5400 Hz audio bandwidth	Current radios	0	–47
	B. Out-of-band radiation: NRSC RF mask test limits		
NRSC	Current radios	18	(+) 3
NRSC	"Ideal" NRSC	20	(+) 7
NRSC	"Realistic" NRSC	21	(+) 8
	C. Out-of-band radiation: NRSC RF mask maximum limits		
NRSC	Current radios	20	(+) 15
NRSC	"Ideal" NRSC	22	(+) 16
NRSC	"Realistic" NRSC	22	(+) 16
	EXISTING ALLOCATION STANDARDS	0	–30

NRSC

Band limiting:	NRSC
Preemphasis:	NRSC
Out-of-band radiation:	CCIR, NRSC TEST, or NRSC MAX as indicated

5400 Hz audio bandwidth

Band limiting:	Low-pass
Attenuation:	20 dB/kHz
Bandwidth:	5400 Hz
Preemphasis:	None
Out-of-band radiation:	CCIR

Current Radios

Band limiting:	Low-pass
Attenuation:	8 dB/kHz
Bandwidth:	2500 Hz
Deemphasis:	None

"Ideal" NRSC

Band limiting:	NRSC
Deemphasis:	NRSC

"Realistic" NRSC

Band limiting:	Low-pass
Attenuation:	6 dB/kHz
Bandwidth:	10000 Hz
Deemphasis:	NRSC.

To interpret Figure 2, note that a higher protection ratio requires a lower undesired signal to prevent interference. Said another way, a higher protection ratio implies that a given undesired signal level will cause more interference.

Consider first the data in Section A of Figure 2 for the CCIR out-of-band radiation model. For stations operating under pre-NRSC conditions, the data indicate that a 17 dB first-adjacent-channel protection ratio is required, even with existing narrowband radios. A 17 dB protection ratio means that, at a station's 0.5 mV/m protected contour, an undesired signal 10 kHz removed should be 17 dB below 0.5 mV/m.

However, under the existing 0 dB allocation standard, that undesired signal could be as strong as 0.5 mV/m — 17 dB greater than it should be to avoid interference.[12]

Implementation of the NRSC audio standard for transmission while using narrowband radios makes only a modest 3 dB improvement in the first-adjacent-channel protection ratio, from 17 dB to 14 dB. However, NRSC transmission makes a major 22 dB improvement at the second adjacent channel: from –8 dB to –30 dB. This is an indication of the benefits to second-adjacent-channel interference of the NRSC bandwidth specification.

As receivers begin to implement the NRSC audio standard, their wider bandwidths will require protection ratios to increase far above those in existence today if adjacent-channel interference is to be avoided. The combination of NRSC transmission and "realistic" NRSC reception requires a first-adjacent-channel protection ratio of 24 dB — only 2 dB less than the 26 dB co-channel ratio. One can conclude that even if the FCC were to immediately change its contour overlap rules for new facilities to reflect higher protection ratios, wider bandwidth receivers would continue to experience adjacent-channel interference at the 0.5 mV/m contour for many years unless vast numbers of stations ceased operation.

To highlight the protection limitations inherent in existing allocation standards, the program was used to determine the transmission bandwidth that would be required with current radios to yield a first-adjacent-channel protection ratio equal to the existing 0 dB. Even with narrowband receivers, AM stations would be required to transmit with 5400 Hz audio bandwidth to obtain 0 dB protection. This is a clear indication of the magnitude of AM's present difficulties.

Sections B and C of Figure 2 repeat the calculations of Section A for NRSC transmission, but reflect use of the NRSC RF mask test limits and maximum limits, respectively, instead of the CCIR model, as the out-of-band radiation subfunction. While the two NRSC RF mask curves result in modest changes in the required first-adjacent ratios, they result in dramatic increases of up to 45 dB in the second-adjacent ratios. A 15–16 dB protection ratio is required if the NRSC maximum limits are assumed, which is 45–46 dB greater than the –30 dB of existing allocation standards.

These gross protection ratio changes occur because the NRSC limits assume far greater energy in the 10–25 kHz frequency band than does the CCIR model. Gröschel's CCIR model, with an intermodulation attenuation of 40 dB, has energy in the 10–25 kHz frequency band ranging from -71.7 dB to –94.5 dB. The NRSC test limits in that band range from –25 dB to –43.4 dB, and the NRSC maximum limits range from –25 dB to –35 dB.

Both Gröschel's out-of-band radiation model and the NRSC RF mask are said to be based on measurements of actual high-power transmitters, yet they yield vastly different results. If the NRSC mask really does represent the spurious energy radiated from modern transmitters, these data raise serious second-adjacent-channel allocation concerns. However, it may be that the NRSC RF mask represents the worst-case envelope of measured or expected spurious components from any transmitter; each transmitter may not be expected to radiate spurious energy up to the RF mask limits at every frequency. If so, then use of the NRSC limits in the out-of-band radiation subfunction is overly pessimistic and the CCIR model may provide more realistic results. Further investigation is needed to determine which model is correct.

Regardless of which out-of-band radiation model is assumed, the protection ratios shown in Figure 2 demonstrate that, although the NRSC audio standard may make a dramatic improvement in AM frequency response, it will exacerbate adjacent-channel interference problems in weaker signal areas where the desired-to-undesired signal is low. In those areas, NRSC receivers will be required to contain selectable bandwidth or variable bandwidth circuitry to avoid interference. Figure 2 indicates that existing protection ratios are entirely inadequate to prevent adjacent-channel interference, even with today's narrowband receivers.

VI. RSS CALCULATIONS AND ADJACENT-CHANNEL SKYWAVE INTERFERENCE

The existing methods specified in the FCC Rules for the calculation of nighttime skywave interference ignore many signals that may contribute substantially to the interference environment. Over the years, the number of these signals has multiplied, making the true interference environment much worse than it is calculated to be. This section examines the two most significant problems with present interference calculation methods: the exclusion method used when calculating the RSS, and the omission of adjacent-channel skywave signals from interference consideration.

A. The RSS and the 50% Exclusion Method

The RSS, or root-sum-square, is intended to characterize the nighttime interference level of a station by combining the effects of all interfering signals into one net number. Because the various interfering signals arrive with random phase and modulation, the proper way to add them is on a power basis rather than on a voltage basis. The field strength voltage of each interfering signal is squared to obtain power, the squares are added, and the square root is taken to return to voltage. This root-sum-square voltage is multiplied by 20 to obtain the quantity conventionally known as the "RSS." Thus the RSS is the field strength that a desired signal must have to be 20 times, or 26 dB above, the interference level on the channel. Since 26 dB is the protection ratio, a station with a field strength at or above the RSS will provide interference-free service as it is now defined. Therefore, the value of the RSS is the limit of interference-free service; the RSS is also commonly known as the "limit."

It is impossible to add a new station to a channel without creating some additional interference to all the other stations

12 "To avoid interference" means only to prevent the weighted signal-to-interference ratio from becoming worse than 26 dB.

on that channel, although the amount of interference added to many of the stations may be extremely small. So if the FCC Rules specified that the RSS was to be calculated by taking into account every interfering signal, and if the Rules also prohibited, as they now do, any increase in the RSS,[13] then it would be impossible to add any new stations at all. To make it easier to add new stations, the FCC adopted the fiction that a new station will not increase the existing RSS unless the new station's interference contribution is at least 50% of the existing RSS or more than the smallest interference contribution already in the RSS. This is known as the "50% exclusion method."

B. Understatement of Interference and Overstatement of Coverage

The 50% exclusion method makes it possible to legally add a significant amount of new interference to an existing station, as long as it is done without raising this artificial measure of interference, the 50%-exclusion RSS. This has indeed occurred. Interference conditions are worse than they are calculated to be, and much worse than was expected some 50 years ago when the 50% exclusion method was adopted. Computer studies of several hundred AM stations have been made and were reported in [7] and [8]. Even though these studies did not take all interference contributions into account (only the ten greatest contributors were included), they showed that the 50% exclusion method understates the true interference level on a channel by more than 4 dB for some stations. The average understatement was approximately 2 dB.

In addition to allowing new interference to be created, the 50% exclusion method results in unrealistic predictions of nighttime service. As discussed above, the RSS is the limit of interference-free service. Nighttime service contours are defined as the field strength contour having the value of the calculated RSS. A station with a calculated RSS of, for example, 3.0 mV/m is considered to have interference-free service out to the 3.0 mV/m contour. If that station happens to be one for which the 50% exclusion method results in underestimation of interference by 4 dB, the station's true interference-free service would extend only to the smaller 4.8 mV/m contour. In a large metropolitan area, the population within those two contours could differ by many thousands of persons.

C. Alternative RSS Calculation Methods

Several ways have been suggested to produce a more realistic or otherwise "better" RSS. First, the exclusion concept could be retained but the calculation procedure changed. One alternative is the "n-highest contributor method," in which a certain number of stations, such as the four or eight greatest interference contributors, are included in the RSS and the rest excluded. Another alternative is to change the exclusion percentage to some smaller number such as 35%, 25%, or 15%. Both alternatives would tend to raise the calculated RSS closer to the actual interference level by including more stations. Both alternatives would reduce the amount of new interference that could be caused[14] but would retain some ability to add new stations or to improve existing ones.

Second, exclusion could be eliminated entirely, requiring all interference contributions to be included in the RSS calculation, but stations could be permitted to cause incremental increases in interference of 1 dB or perhaps some smaller amount. This option would retain some potential for new stations or facility improvements. The advantage of this option over an exclusion method is that it eliminates an inconsistency in the Rules. Under the 50% exclusion method, a new station can go on the air, or a station that is not now a contributor to another station's RSS can improve its facilities, and each is permitted to cause up to 1 dB of additional interference. However, a station that is already a contributor to another station's RSS is not permitted to raise that RSS at all, so it would be prevented from a facility improvement even if that improvement would also cause only a 1 dB interference increase. The second option would eliminate this inconsistency.

Third, exclusion could be eliminated while retaining the prohibition against increases in the RSS. As discussed above, this would prevent all further increases in interference, but would also prevent most new stations and most improvements in facilities.

D. Comparison of Alternatives

The ramifications of the first option, which is to modify the exclusion method, have been investigated in detail by Lahm and reported in [8]. He found that the n-highest contributor method was undesirable, even though it would more accurately represent the true interference levels on a channel, because of its inconsistent effects on the threshold of entry into the RSS from station to station and from channel to channel. The n-highest contributor method would yield substantial differences in the amount of new interference that a new or modified facility could cause, depending on the particular distribution of existing interference contributions on its channel.

Lahm found that a reduction in exclusion percentage provides better results. For 35% exclusion, the calculated RSS is increased by an average of 0.9 dB over that now calculated with 50% exclusion. For 25% exclusion and 15% exclusion the average increase is 1.5 dB and 1.8 dB, respectively; note that the magnitude of the increase decreases with decreasing exclusion levels. These increases in calculated RSS were found to be relatively consistent from station to

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13 FCC Rules generally prohibit a new facility from increasing the RSS of another station if that RSS is above the normally protected value.

14 A new RSS contribution of 50% will increase the actual interference level by up to 1 dB. Contributions of 35%, 25%, and 15% correspond to increased interference values of up to approximately 0.5 dB, 0.25 dB, and 0.1 dB, respectively.

station and channel to channel. Furthermore, the threshold of entry into the RSS was also consistent. A decrease in exclusion percentage from 50% to 25% has a substantial effect on the calculated RSS and on the amount of new interference that can be caused, while a further decrease to 15% has only a small marginal effect. Lahm concluded that an exclusion percentage of 25% was reasonable and in keeping with the desire to better define the interference-free coverage and to protect stations from interference.

The second option, which is to eliminate exclusion while permitting any station to increase interference by a specified amount, appears to offer no significant advantages over a 25% exclusion method; indeed, it appears to offer no significant benefits at all. The proposal to permit 1 dB or even 0.5 dB of additional interference to be caused is little different from the present undesirable situation that has permitted the creation of substantial increased interference. It would actually be worse, because in eliminating the FCC rule inconsistency mentioned above, all stations would be permitted to increase interference, not just new stations or stations that do not now contribute to the calculated RSS.

Even if the amount of permissible interference for the second option were to be defined as 0.25 dB, the problem of potential abuse through multiple applications for 0.25 dB interference increases would still need to be solved. Further, when comparing the first option using an exclusion percentage of 25%, with the second option using a corresponding increased interference amount of 0.25 dB, the FCC rule inconsistency becomes immaterial. It would be very unlikely for an existing station to be prevented from making a desired change only because it cannot cause a 0.25 dB RSS increase; the protection requirements could easily be met through the choice of power or antenna pattern.

In support of the third option, which is to completely eliminate exclusion, it has been suggested that the AM band is mature and that interference protection is more important than new stations or improved facilities. While this may be an accurate assessment, the third option does present severe practical problems without offsetting benefits. It would be very burdensome to include *all* stations in the calculated RSS. There may be 50 or more stations on one channel in the U.S. alone. Those stations, foreign stations, and possibly adjacent-channel stations[15] would all have to be included. The task of data gathering and computation, even with modern computer data bases, would become monumental. Yet even the long-term incremental interference-protection benefits of the third option over those of a reduced exclusion percentage are on the order of only 1 dB. The third option is not attractive.

The above comparison supports Lahm's conclusion that the existing RSS exclusion principle be retained but the exclusion percentage reduced to 25%. Such a change in the RSS calculation method would make the RSS a more accurate indicator of true interference levels on a channel. Predictions of coverage would be more accurate, causing the calculated interference-free contour level for some stations to change as much as several dB.

E. Future Interference Levels

One should not be overly optimistic about the effect that a change in RSS calculation method would have on interference levels in the AM band. Changing the exclusion method would not change the actual level of nighttime interference, it would change only the calculated level. No stations would be required to cause less interference if the exclusion method were changed. At best, an improved exclusion method can only prevent or reduce future increases in interference. Therefore, in evaluating the impact on interference of a new exclusion method, the important question is: how much does the actual interference level that could eventually exist differ from what now exists?

Consider a hypothetical Station A on a channel with 15 other nighttime signals. Station A's actual nighttime interference level, represented by its total RSS of 5.00 mV/m, is made up of contributions from all 15 of those signals. However, the present 50%-exclusion RSS of 3.50 mV/m understates that interference by about 3 dB. With 50% exclusion, a new interference contribution of 1.74 mV/m could be added, which would increase the total RSS to 5.29 mV/m, an increase of 0.49 dB. With 25% exclusion, a new interference contribution of 0.87 mV/m could be added, which would increase the total RSS to 5.08 mV/m, an increase of 0.14 dB. If exclusion were eliminated entirely, no increase would be possible, of course.

In this example, changing from 50% to 25% exclusion would make only a 0.35 dB difference in the amount of actual new interference that could be created by a new station. Eliminating exclusion entirely would make less than 0.5 dB difference. The small differences are a result of the maturity of the AM band, which has many stations per channel and significantly understated interference levels.

Although Station A was a hypothetical example, it is not unrepresentative. A computer study of many stations could be performed to better characterize the actual differences in effect between the various exclusion method alternatives. Even without such a study it is clear that, due to the maturity of the AM band, a change in RSS calculation method is unlikely to have a major impact on future interference. The effect on interference-free contour accuracy is much more significant.

F. The Effect of Multiple 10% Interferers

The existing RSS calculation method combines the 10%-time field strengths of all interfering signals to determine the total interference level. It might appear that the calculation procedure assumes "worst case" conditions; each interferer is assumed to be continuously present even though the 10%-time interference level is used in the calculation. Perhaps the present calculation method yields artificially high estimates of interference under multiple-interferer conditions. This section of the report demonstrates that the existing RSS calculation

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15 See the discussion of adjacent-channel skywave interference in Section VI-G of this report.

method is indeed a proper procedure for combining multiple 10% interferers.

Section 73.182(l) of the FCC Rules defines interference to exist when the skywave field strength of an undesired station, or the RSS interference level of two or more stations, exceeds specified levels for 10% or more of the time. In other words, the total interference, as defined in theory, is considered to be the 10%-time value of the RSS combination of the individual interferers.

The definition differs from the following procedure which is used, in practice, to calculate the total interference:

1. The 10%-time field strength of each interfering signal is determined using the curves and formulas in Figures 1a, 1b, or 2, as appropriate, of Section 73.190
2. The individual 10%-time field strengths are combined in the RSS formula.

In other words, the total interference, as calculated in practice, is considered to be the RSS combination of the 10%-time values of the individual interferers.

Thus for the results of interference calculations to be correct, the 10%-time value of the RSS combination of the interferers must be equal to the RSS combination of the 10%-time values of the interferers. This equivalence is not intuitively obvious. However, its validity is demonstrated in the paper by Anderson, "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers," which is attached as Appendix F. Anderson's paper, prepared for inclusion in this report, directly addresses the issue of interference from multiple interferers. He has also provided a computer program, SKYIN, described in Appendix G, which permits interested users to perform their own calculations.

Anderson analyzes multiple interferers statistically, explicitly taking into account the continuous voltage variation of each one. In Section 7.0 of his paper he demonstrates that, regardless of the number or amplitude of the multiple interferers, the effect of the sum of the interferers on the signal-to-interference ratio is the same as the effect of a single interferer with equivalent power. Therefore, the existing RSS calculation method produces correct estimates of total 10%-time interference even though the 10%-time values of the interferers are individually specified prior to calculating the RSS.

G. Adjacent-channel Skywave Interference

It is apparent from Section V of this report that first-adjacent-channel signals can produce significant amounts of interference. Yet the FCC Rules provide no interference protection from nighttime adjacent-channel skywave interference. It is likely that much of the increased nighttime interference on the AM band over the last 40 years is due to adjacent-channel skywave signals.

Two approaches have been suggested for treating adjacent-channel skywave signals. In the Notice, the Commission suggests that one alternative would be to amend Section 73.182(n) of the Rules to require inclusion of skywave signals in the calculation of the adjacent-channel RSS.[16] While this alternative would result in accounting for adjacent-channel skywave interference in allocation studies, it would be a cumbersome method of achieving that desirable end. It would require additional time-consuming calculations, calculations that are not now normally required because, as described below, Section 73.182(n) is not pertinent to most nighttime allocation situations.

A station's protected daytime contour, which is generally the 0.5 mV/m contour, is usually more extensive than its protected nighttime contour. Therefore, the prohibition against daytime 0.5 mV/m contour overlap of adjacent-channel stations results in the two stations being so far apart that there is seldom any calculated adjacent-channel groundwave interference at night. If skywave signals were required to be included in the RSS calculations of nighttime adjacent-channel interference specified by Section 73.182(n), new RSS calculations would be required at numerous points along the protected contour.

The Commission's other suggested alternative, which is to include adjacent-channel skywave signals in conventional RSS calculations, would be a far better way to take account of adjacent-channel interference in allocation studies. A typical nighttime allocation study consists of RSS limit calculations for the pertinent stations on the proposed channel, with a showing that the proposed operation would not enter any RSS that is above the normally protected value. This showing is included in the application for construction permit.

Most RSS calculations are now done by computer. The co-channel stations to be included in the study are selected, the computer calculates the skywave field strengths of each station at each chosen site, and the RSS at each site is computed using the 50% exclusion rule. It would be a relatively simple task to include adjacent-channel stations in the study and to redefine the RSS formula to include adjacent-channel skywave signals weighted by the appropriate protection ratio. The application showings now required could be retained, but with the inclusion of adjacent-channel data. Substantial additional engineering time would not be required.

Inclusion of adjacent-channel skywave signals in the RSS would be in accordance with the CCIR methods in [9] and with procedures specified in the 1982 Region 2 Agreement [10]. Each specifies a formula for usable field strength which includes weighted adjacent-channel signals in an RSS calculation.

ACKNOWLEDGEMENTS

In addition to the funding provided by the National Association of Broadcasters, Hammett & Edison provided

16 Section 73.182(n) now specifies the inclusion of only groundwave signals in the calculation of the RSS value of undesired adjacent-channel field strengths.

significant resources of its own toward the completion of this report. The author is grateful for the firm's generous support.

Several individuals made substantial contributions to this report. Robert P. Smith, Jr., of Hammett & Edison developed the user-friendly ADJACENT programs from Gröschel's original work. Robert Orban of Orban Associates, Inc., San Francisco, supplied the design of the NRSC filter used in the computer programs. Bronwen L. Jones, consultant, helped in the evaluation of alternative psophometric curves. Richard A. Kennedy and James T. Gotshall of Delco Electronics Corporation helped to interpret adjacent-channel protection ratio data and supplied information about future NRSC receiver parameters. Karl D. Lahm, P.E., of Karl D. Lahm & Associates, Inc., Fairfax, Virginia, provided helpful insight on RSS issues.

Special thanks go to Harry R. Anderson, P.E., of H. R. Anderson & Associates, Inc., Eugene, Oregon. Mr. Anderson wrote computer programs EMIN and SKYIN and the paper of Appendix F. He was also instrumental in the preparation of the text sections on atmospheric and man-made noise, minimum usable field strength, and the effects of multiple 10% interferers. His knowledge of communications engineering principles, and his patient answers to innumerable questions, were greatly appreciated.

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[10] "Final Acts ... ," *op.cit.*, Annex 2, Section 4.7.1.

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Appendix A

"Characteristics and Applications of Atmospheric Radio Noise Data." CCIR Report 322–3 (Draft), XVIth Plenary Assembly, Dubrovnik 1986.

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Appendix B

"Man-made Radio Noise." CCIR Report 258–4, XVIth Plenary Assembly, Dubrovnik 1986, Vol. VI, pp. 207–214.

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Appendix C
Instructions for Operation of Program "EMIN"

Introduction

These instructions describe the operation of a computer program for the calculation of minimum usable field strength, E_{min}.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. The master diskette contains the source code file EMIN.FOR and executable file EMIN.EXE. The programs may be copied, such as to a hard disk, but no additional disk space is necessary for program execution. The programs were compiled with Microsoft FORTRAN v4.01 and are designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run more slowly. A coprocessor-equipped machine is recommended.

All output data appears on the screen. Neither a printer nor graphics capability is required.

Program description

The noise environment for AM broadcast reception is dominated by two noise types: atmospheric and man-made noise. Both are typically characterized as non-gaussian, white noise processes that are non-stationary; that is, their statistical properties change with time and bandwidth. To estimate E_{min} in the presence of this type of noise, the statistical properties of the noise must be evaluated in a specified bandwidth.

The program allows the user to specify any desired set of parameters to define the grade of service, average noise power, statistical variation of the noise, bandwidth, frequency, and the parameters needed to assess the time availability and service probability. Operation of the program is self-explanatory using the information displayed during the run.

Grade of service

The program first performs a grade of service analysis, finding the level of signal necessary to be above the noise level by the specified number of dB for the specified percentage of time. This is found by evaluating the amplitude probability distribution (APD) function for the noise. The APD function gives the instantaneous noise level exceeded a certain percentage of time relative to the rms noise level. The APD function used in the program is a computer model presented in [1], which approximates the empirical descriptions presented in CCIR Report 322-3. Based on the studies in [2], both atmospheric and man-made noise have similar statistical properties, so the same APD computer model can be used for both types.

The three parameters used to construct the APD are F_{am}, V_{dm}, and bandwidth. F_{am}, which represents the average noise power, moves the amplitude of the APD up or down but does not affect its shape. The shape of the APD is determined by V_{dm} and bandwidth. The value of V_{dm} given in the noise measurement data is for an effective noise bandwidth of 200 Hz. Its value is automatically adjusted by the program to the actual noise bandwidth, using the equations found in [3]. For atmospheric noise, the program user obtains the value for V_{dm} from the graphs in Report 322-3. For man-made noise, the values for V_{dm} were derived from [2] and are built into the program.

Time availability

The result of the grade of service analysis is a signal level, R (dB), which is the level of the required received signal above the average noise level. This indicates that the specified grade of service will be available for 50 percent of the time since the calculation of R was based on the median value, F_{am}. If a higher time availability is required, the value of F_{am} is adjusted based on its statistical variation, as indicated by the upper decile, D_u. For example, for a time availability of 90 percent, the value of F_{am} is adjusted upward by adding the value of D_u, since the 90-percent point is exactly the upper decile value.

The value of F_{am}, as adjusted, is F_a. The program automatically adjusts F_{am} for a specified time availability. For atmospheric noise, this is done using the D_u supplied by the user. For man-made noise, the values for D_u were taken from [2], if available, and are built into the program.

With the value of F_a and R known, the program calculates the value of E_{min} using the equation

$$E_{min}\ (\text{dBmV/m}) = F_a + R + 10\log_{10}(BW) + 20\log_{10}f_{MHz} + 48.5$$

where E_{min} is the minimum usable field strength, in dB relative to 1 mV/m

BW is the effective noise bandwidth in Hz, and

f_{MHz} is the frequency in MHz.

Service probability

The value for E_{min} calculated using the above equation is only an estimate. Since median values for all parameters were used to determine this value for E_{min}, this estimate provides the specified grade of service for the specified time availability for only 50 percent of the paths or circuits. This is equivalent to a service probability of 50 percent.

To increase the service probability, or confidence level, above 50 percent, E_{min} must be increased to take into account the uncertainties in the estimates of the parameters used to determine E_{min}. The uncertainty or variability in any estimate is indicated by its standard deviation, or σ value. Each of the parameters that was used to formulate the variables in the equation for E_{min} (F_{am}, V_{dm}, D_u) has an associated standard deviation which is provided in Report 322–3. For man-made noise, these parameters are generally not available and will therefore appear in the output as zeros.

A fourth element of uncertainty is the accuracy with which a given value of field strength can be predicted. When calculating the signal required to produce a desired signal-to-noise ratio, the signal is assumed to be known and constant. In reality it, too, varies from its expected value. This uncertainty is represented by the standard deviation of the expected received signal strength. For AM broadcast groundwave signals, considerable differences may exist between the actual and the predicted field strength due to uncertainties in the ground conductivity, reflections from nearby metallic objects (wires, buildings, towers), or physical elements (hills and abrupt conductivity boundaries) along the propagation path. These uncertainties are not accounted for in the current FCC field strength prediction method. Based on a relatively small amount of data, one study [4] found that the standard deviation of actual field strengths compared to predicted field strengths was about 1.4 dB. For skywave or other types of propagation paths, another value may be more appropriate.

With all four standard deviations or uncertainty factors identified, the total uncertainty can be found as the root-sum-square of the four individual standard deviations. That is, the variance of the final estimate for E_{min} is equal to the sum of variances of each constituent part of E_{min}. This summing operation is performed by the computer program.

With the total standard deviation, σ_T, found for the estimated E_{min}, E_{min} can be adjusted for service probabilities other than 50 percent. Assuming the variation is normally distributed, E_{min} is increased by $\sigma_T t$, where t is the standard normal deviate. For a service probability of 50 percent, t equals 0. For a service probability of 90 percent, t equals about 1.28. The program automatically evaluates t to determine the final adjusted value of E_{min} that achieves the required service probability.

Program execution

The program is run by typing "EMIN<ret>". A title screen will appear, followed by an instruction screen. The user is then asked sequentially for the required input data as discussed above. When all data has been entered, the program will display "Working . . ." while E_{min} is being calculated.

When the calculation is complete, a results screen will be displayed which tabulates all of the input data and the calculated value of E_{min}. Results can be printed using the "PrtSc" keyboard command. The user can then select another run or exit from the program.

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Appendix D

Gröschel, G: "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems." EBU Review – Technical, No. 169, June 1978, pp. 122–136.

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Appendix E
Instructions for Operation of Program "ADJACENT"

Introduction

These instructions describe the operation of a computer program for the calculation of relative adjacent-channel protection ratio, A_{rel}.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. Protection ratio calculations require two BASIC programs, ADJACENT and ADJPRO. ADJACENT is a user-friendly data entry program; ADJACENT chains to ADJPRO, which is the program that does the calculations. Execution of the two programs may also generate other files.

The master diskette contains source code files (ADJACENT.BAS, ADJPRO.BAS) and executable files (ADJACENT.EXE, ADJPRO.EXE) for both programs, and three other related files (ADJPRO.DAT, NRSC.FSR, NRSC.OUT). Enough disk space remains on the master diskette for program operation and storage of several new data files but, if a hard disk is available, it is suggested that the master diskette be copied to the hard disk. The programs were compiled with Microsoft QuickBASIC v3.0 with coprocessor support and are designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run extremely slowly (one run may take 30 minutes or more, compared to about 60 seconds with a coprocessor). A coprocessor-equipped machine is highly recommended.

A printer will provide a hard-copy of the output data, but the program will run without it (output data can be viewed on the screen). Plotting and graphics routines are not included as there is no standard plotting or graphics protocol for the PC.

Program setup

Users should familiarize themselves with the paper, "A mathematical model for the calculation of the adjacent-channel interference in single-sideband and double-sideband AM sound broadcasting systems," by G. Gröschel, published in the E.B.U. Review – Technical, June 1978. The computer program is modeled directly on the techniques described in the paper. During program setup, the user defines the subfunctions corresponding to each technical parameter that contributes to the overall transmitter and receiver response. These consist of:

- F0: the carrier (can be suppressed for single-sideband transmission)
- F1: spectral power density of the modulation signal
- F2: transmitter band limiting
- F3: transmitter preemphasis
- F4: transmitter out-of-band radiation
- F5: transmitter noise
- F6: receiver band limitation
- F7: psophometric curve
- F8: receiver deemphasis
- F9: receiver notch filter
- F10: receiver out-of-band selectivity.

In addition, the user specifies a "modulation factor," discussed in the Gröschel paper and below, which takes into account the depth of modulation and the amount of compression.

The program is run by typing "ADJACENT<ret>." The setup screen then appears; the help screen (press <F1>) explains how to use the setup screen. Once all fields are showing the correct information, typing "X" (no return) executes ADJPRO. Typing <Esc> exits the program. Typing either "X" or <Esc> will save the current setup screen data in the file ADJPRO.DAT.[1]

Following is a description of the fields in the setup screen:

Transmission mode. Select DSB/ISB (double sideband/independent sideband) or SSB (single sideband). Selection of mode automatically modifies the various subfunctions, and changes the setup screen, to match the mode requirements. This is discussed in detail below.

Type of study. Select SINGLE or SWEEP, and enter the difference frequency (dF) or difference frequency range and step size to be used. To obtain first- and second-adjacent-channel protection ratios, select SWEEP, with dF=10000 Hz to 20000 Hz every 10000 Hz.

FS/FR functions. Select COMPUTED, FROM DISK, or FROM KEYBOARD. Normal mode is COMPUTED, in which FS (the composite transmitter response) and FR (the composite receiver response) are calculated at the time of program execution from the transmitter and receiver subfunctions (F0 through F10) specified below. FROM DISK indicates that previously stored FS and FR values, if any, will be retrieved from disk. (The file name of the stored values will be requested at time of program execution.) FROM KEYBOARD permits FS and FR, from –25,000 Hz to +25,000 Hz in 100 Hz steps, to be manually entered. Use of FROM KEYBOARD is expected to be rare.

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[1] As supplied on the master diskette, ADJPRO.DAT contains the settings for NRSC transmission and "Ideal" NRSC reception, as defined in Section V of the report.

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Tabulate subfunctions. Select YES or NO. If YES, select frequency range from low to high. Selection of YES will print out FS, FR, and F0 through F10, at 100 Hz increments across the selected range.

Print FS/FR. Select YES or NO. Selection of YES will print out FS and FR from 0 Hz to ±25,000 Hz in 100 Hz increments.

Allow changes to FS/FR. Select YES or NO. Selection of YES will allow changes to FS and FR at any desired frequency to be manually entered from the keyboard. If FS/FR are COMPUTED, Print FS/FR is YES, and Allow changes to FS/FR is YES, then FS/FR will first be computed and printed for examination before the program asks for changes.

Save FS/FR to disk. Select YES or NO. Selection of YES will cause FS/FR values to be saved to a disk file for future use. At the time of execution, the program will ask for the filename to be used. FS/FR filenames will automatically be given the extension ".FSR".[2]

Modulation spectrum. Select USASI NOISE or CCIR NOISE. USASI noise has been recently used to characterize modern U.S. program material.

Modulation factor. Enter value from 0.01 to 2.00. An appropriate value for very highly compressed program material is 1.00. Modulation factor is related to "loudness." It affects the peak level of the sideband energy, A_m, but does not affect its shape, which is defined by F1, F2, and F3. While at first it might appear that the choice of modulation factor is critical, in fact it has a negligible effect on A_{rel}. Any overall change in sideband energy will indeed affect the adjacent-channel protection ratio, A, but its effect on the co-channel protection ratio, A_O, will be essentially equal. Since $A_{rel} = A - A_O$, A_{rel} will be affected little.[3]

TRANSMITTER DATA

Band limiting. Select LOW PASS, IDEAL, NRSC, or AK-5. If LOW PASS or IDEAL is selected, screen will also ask for filter parameters. Band limiting characteristic depends whether DSB/ISB or SSB transmission mode was selected. If SSB is selected, the screen will also prompt for carrier reduction and undesired sideband suppression. The filters have the following characteristics:

LOW PASS is an nth-order Butterworth filter of the selected attenuation rate and bandwidth. For DSB/ISB mode, the response is 3 dB down at ± the selected bandwidth, and attenuates at the specified rate above and below the passband. For SSB mode, the response has the same attenuation rate, but a lower 3 dB point of 0 Hz.

IDEAL is a filter with flat response within the selected bandwidth and, for DSB/ISB transmission, 100 dB attenuation at the ± cutoff frequencies and beyond. For SSB transmission, the filter is down by the selected amount of undesired sideband suppression from 0 Hz to the negative cutoff frequency, and is 100 dB down at that frequency and beyond.

NRSC is a 9th-order elliptic-function filter with a passband of ±9600 Hz (0.162 dB ripple) and a stopband of ±10,100 Hz (minimum attenuation 50 dB). NRSC is not available in SSB mode.

AK-5 is a 4500 Hz, 60 dB/octave filter characteristic used in Germany. It is not available in SSB mode.

Preemphasis. Select NONE, TC, or NRSC. If TC is selected, the screen will also prompt for time constant in microseconds.

Noise. Enter residual noise in dB below carrier. Typically assumed to be 100 dB down.

Out-of-band radiation. Select CCIR, NRSC MAX, or NRSC TEST. CCIR is the out-of-band radiation subfunction described in the Gröschel paper. If CCIR is selected, the screen will also prompt for intermodulation attenuation ("IM atten") in dB, which is typically assumed to be 30-40 dB. NRSC MAX and NRSC TEST are the maximum limits and test limits, respectively, of the emission limitation for AM broadcast transmission specified in NRSC Standard No. NRSC-2. This parameter has a significant effect on second-adjacent-channel protection ratios.

Carrier reduction. Only used with SSB transmission. Enter carrier reduction in dB below full carrier.

Undesired sideband suppression. Only used with SSB transmission. Used to specify undesired sideband suppression in ideal band limiting filter (see above).

RECEIVER DATA

Band limiting. Select LOW PASS, NRSC, or MBF. If LOW PASS is selected, the screen will also prompt for filter parameters. Band limiting characteristic depends whether DSB/ISB or SSB transmission mode was selected. The LOWPASS and NRSC filters are specified identically to those in the transmitter data. The MBF filter simulates an E.B.U. reference receiver. NRSC band limiting is not available in SSB mode.

Deemphasis. Select NONE, TC, or NRSC. If TC is selected, the screen will also prompt for time constant in microseconds.

Psophometric curve. Select CCIR–468 or CCITT–P53. CCIR–468 is most appropriate for medium-wave AM broadcasting. The psophometric curve represents the objectionability of sound as a function of frequency. It is needed in the calculations because, for adjacent-channel signals, the interfering frequencies are shifted by 10 kHz or 20 kHz

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2 As supplied on the master diskette, NRSC.FSR contains FS for NRSC transmission and FR for "Ideal" NRSC reception.

3 This is true in the usual case where the adjacent-channel interference is dominated by the sideband energy, not by the carrier energy. If the carrier energy were the dominant contributor to adjacent-channel interference, a change in sideband energy would affect A_O and A_{rel}, not A.

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and the energy contribution at each frequency must be properly weighted to correspond to the sensitivity of the ear.[4]

Out-of-band selectivity. Enter response in dB. Typically assumed to be 100 dB down.

Notch filter. Select NONE, IDEAL, or LC. If IDEAL or LC selected, the screen will prompt for resonant frequency Fr. IDEAL puts a 200 dB notch at exactly the selected frequency. If LC is selected, the screen will prompt for other LC notch filter parameters as described in the Gröschel paper.

Program execution

When all setup screen fields are as desired, pressing X will exit ADJACENT and execute ADJPRO. If FS/FR are to be retrieved from disk, the program will display all .FSR files and prompt for a selection. If FS/FR are to be input from the keyboard or changed, the program will prompt for the data. FS/FR will be printed if so specified. If FS/FR are to be saved to disk, the program will ask for a filename (extension .FSR will always be assigned).

When FS/FR calculations have been completed, the screen will display the following: a summary of input data; the three calculated Gröschel parameters of equivalent bandwidth Be, maximum power density Am, and out-of-band radiation factor Kr (if CCIR is selected); and a scrolling table of calculated protection ratios. If only a few frequency separations are being calculated, all input and output data will be simultaneously visible.

The program will ask whether output is to be printed, and then whether it is to be saved. Output can be saved in a user-specified filename and reviewed later at DOS level, using a TYPE command or other available file-examination utility.[5] After the two questions have been answered, the program returns to the ADJACENT setup screen for another run. If no other run is desired, type <Esc> to exit.

Output data

The program displays the relative adjacent-channel protection ratio Arel, and the contribution to Arel of the carrier (Atr) and the sidebands (Asb) of the adjacent-channel signal. Arel is a power summation of Atr and Asb. Users are encouraged to read the discussions in the Gröschel paper on interpretation of data and limitations of the numerical method. In particular, note that the relative adjacent-channel protection ratios calculated by the program are based on a determination of power. The numerical method does not take into account the additional 3 dB of co-channel noise suppression that results from coherent detection of the desired signal in the receiver. Therefore, values of A_{rel} calculated by the computer program must be corrected by –3 dB.

Program modification

Users with access to a QuickBASIC compiler are encouraged to modify the programs to meet their individual requirements, such as to include alternative subfunctions. Note that the program contains mathematical expressions that must be compiled on a coprocessor-equipped machine, using QuickBASIC with coprocessor support.

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4 The psophometric curve is defined in equal 100 Hz increments, as are the other subfunctions. The program does not differentiate between a single tone and an equal-energy 100 Hz band of noise, even though the tone would be psychoacoustically more objectionable. Therefore, even though a protection ratio calculation may indicate that the interfering carrier does not contribute significant adjacent-channel interference, implying that a 10 kHz notch filter would make no audible improvement, a psychoacoustic test might show a notch filter to be effective.

5 As supplied on the master diskette, NRSC.OUT contains the output for calculations of A_{rel} at 10 kHz and 20 kHz under conditions of NRSC transmission and "Ideal" NRSC reception.

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Appendix F

Anderson, H.R.: "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers."

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SIGNAL-TO-INTERFERENCE RATIO STATISTICS FOR AM BROADCAST GROUNDWAVE AND SKYWAVE SIGNALS IN THE PRESENCE OF MULTIPLE SKYWAVE INTERFERERS

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Abstract - **The development of a statistical description of the signal-to-interference ratio (SIR) for AM broadcast groundwave and skywave signals in the presence of multiple skywave interference signals is presented. The analysis assumes that the interfering signal envelope amplitudes are Rayleigh-distributed random variables with a lognormal distribution used to describe the long-term variations of the sum envelope amplitude. The resulting statistical description is used to evaluate the SIR degradation for a number of "interference exclusion" formulas under consideration for frequency allocation purposes.**

1.0 INTRODUCTION

Describing the statistics of the signal-to-interference ratio (SIR) of AM broadcast groundwave signals in the presence of multiple skywave interfering signals is important to understanding the reception and coverage possibilities of an AM broadcast station. Previously, the SIR has been calculated assuming the skywave fields were static; that is, not varying with time. With a constant desired groundwave signal amplitude, the resulting SIR was also a constant quantity.

It is the intent of this paper to consider the statistical variations of the combined skywave signals and to develop a statistical description of the SIR. This description is in the form of a probability density function (pdf) and associated cumulative distribution function (cdf). The cdf can be directly used to determine the percent time for which a given SIR is exceeded.

Following the analysis for a constant amplitude desired groundwave signal, the method will be extended for the case when the desired signal is a time-varying skywave signal.

2.0 SKYWAVE SIGNAL AMPLITUDE STATISTICS

AM broadcast skywave signals propagate primarily during nighttime hours by means of electromagnetic energy radiated from the transmitting antenna reflecting off the ionosphere and returning to earth at some distance from the transmitting antenna. AM broadcast signals reflect off both the E layer of the ionosphere at about 100 km above the earth and from the F layer at about 220 km above the earth. In North America, the dominant skywave propagation mechanism is via the E layer with an average altitude taken to be 100 km [1].

The amplitude of a skywave signal as received on earth varies primarily due to two mechanisms - the changing altitude and charged particle density in the reflecting layer and the fact that the skywave signal as received is actually the composite sum of several signals reflecting from different parts of the reflecting layer. The amplitude of each constituent part of the signal varies in amplitude and phase due to the changing layer characteristics. It can be shown [2] that with as few as six such reflecting signals, the amplitude variation of the sum is a gaussian-distributed random variable while the phase (relative to some arbitrary fixed reference) is a uniformly-distributed random variable.

For a signal with a gaussian-distributed total amplitude, the probability distribution of the envelope of that signal is Rayleigh-distributed. As the signal amplitude varies, the received signal appears to "fade" in and out, being louder and less noisy at times and weaker and more noisy at other times. Since the amplitude variation is Rayleigh-distributed, the term "Rayleigh-fading" has been used to describe this effect. The nature of the amplitude distribution of the skywave signal has been confirmed by measurements [3].

The pdf for the random variable v with a Rayleigh distribution is given by

$$p_V(v) = \frac{v}{\sigma^2} \exp\left[\frac{-v^2}{2\sigma^2}\right] \qquad (1)$$

The corresponding cdf is given by

$$P_V(v) = 1 - \exp\left[\frac{-v^2}{2\sigma^2}\right] \qquad (2)$$

The voltage amplitude which is exceeded 50 percent of the time (median) can be readily found by integrating the pdf as follows:

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$$0.5 = \int_v^\infty p_V(v)\,dv = \exp\left[\frac{-v^2}{2\sigma^2}\right] \tag{3}$$

which yields a median value of 1.177σ. Similarly, the voltage exceeded 10 percent of the time is:

$$0.1 = \int_v^\infty p_V(v)\,dv \tag{4}$$

This gives a 10 percent time voltage of 2.146σ.

From this it is apparent that the voltage exceeded 10 percent of the time for a Rayleigh distribution is always about 5.2 dB higher than the median voltage. If the 10 percent time voltage is known or calculated using propagation curves, it can be used to find σ and thereby fully describe the distribution.

While measurements show that the short term (within an hour) variations in the signal envelope amplitude are Rayleigh-distributed, measurements taken over a longer period of time (from days to months) show a statistical variation in the median received field strength which is more closely described by a lognormal distribution [3,4].

The lognormal pdf is given by

$$p_V(v) = \frac{1}{v\sqrt{2\pi\sigma^2}} \exp\left[\frac{-(\ln v - a)^2}{2\sigma^2}\right] \tag{5}$$

where a is the mean value. The lognormal cdf is given by

$$P_V(v) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{(\ln v - a)}{\sigma\sqrt{2}}\right)\right] \tag{6}$$

where erf is the error function.

As shown above, the 10 percent time voltage for the Rayleigh distribution is only 5.2 dB above the median value. However, it is common in currently employed skywave field strength prediction methods to set the 10 percent time value at 8 dB [5] or 10 dB [1] above the median value, indicating that the lognormal distribution is the appropriate choice to describe the long term variations in the skywave signal strength.

3.0 COMPUTATION OF THE COMPOSITE INTERFERENCE PDF

In most situations, the total skywave interference at a given point in a station's coverage area is the sum of several co-channel interfering signals arriving from different stations with different power levels and transmitting antenna characteristics. Typically, the interfering signal from each is computed using the 10 percent time amplitude FCC propagation curves, and taking into account the interfering station's radiated power and antenna radiation characteristics at the appropriate vertical departure angle which results in an ionospheric reflection at the given point in the desired station's coverage area.

The total power in the composite interfering signal is the sum of the power of the contributing interfering signals. This power is given by the envelope voltage squared divided by the receiver input impedance. As shown above, for each interferer the 10 percent voltage can be used to find σ^2 which is then an indication of the power contributed by that interferer.

The problem of adding up the interfering signals can be easily solved by recognizing that each interfering envelope voltage can be resolved into quadrature voltage components, each of which is a gaussian random variable (r.v.). The gaussian quadrature components of all the interferers can then be added to yield a composite gaussian r.v. with σ^2 of the sum equal to the sum of the constituent σ^2 from each interferer and with a mean value equal to the sum of the mean values. If $N(a, \sigma^2)$ is used to indicate a normal or gaussian-distributed r.v., then the distribution of the sum of any M gaussian r.v.'s is given by:

$$N\left[\sum_{m=1}^{M} a_m\,,\ \sum_{m=1}^{M} \sigma_m^2\right] \tag{7}$$

Since all of the skywave signals have zero mean values (i.e., no d.c. component), the sum of the mean values a_m in (7) is zero.

Each of the individual σ_m^2 can be found from the predicted 10 percent time voltage as described above. By summing the σ^2 for both quadrature components, the quadrature components can then be used to find the Rayleigh distribution of the composite envelope voltage with

$$\sigma_T^2 = \sum_{m=1}^{M} \sigma_m^2 \tag{8}$$

This composite σ_T^2 can now be used to find the median value of the Rayleigh distribution which describes the total interference; that is, median $= 1.177\sigma_T$. This median value is then used for a in the lognormal distribution pdf equation given in (5). The standard deviation of the lognormal distribution as indicated by σ in (5) can be set to correspond to 8 or 10 dB as found in [5] or [1]. For FCC purposes, the upper decile value is 8 dB above the median, which corresponds to $\sigma = .72$ in equation (5).

The value of σ in the lognormal distribution given above produces the appropriate distribution when the voltage levels are around 1 mV/m or less. At higher voltage levels, the distribution is somewhat skewed.

It is recognized that this transition from the Rayleigh distribution to the lognormal distribution is a simplified, ad hoc approach. This ad hoc approach is not incorrect,

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however, because the empirical data on skywave amplitudes generally falls between a Rayleigh distribution and a lognormal distribution. In other words, the distribution of amplitudes cannot be strictly characterized as Rayleigh or lognormal using some statistical-physical model of the ionospheric reflection mechanism. The distributions are approximate, empirical models which represent a reasonable match to the data. However, a more refined analysis of the interdependence of the two distributions can be done. This analysis is presented in the next section.

4.0 CONDITIONAL DISTRIBUTION OF RAYLEIGH SKYWAVE SIGNAL AMPLITUDES

In [4], the skywave amplitude is described as being Rayleigh-distributed over short periods (hours) with the median hourly value of this Rayleigh distribution itself a random variable (over long periods) with a lognormal distribution. The envelope voltage at any time, then, is a conditional Rayleigh probability density function which depends on lognormally-distributed median values.

If $p_V(v)$ represents the pdf over all time, then $p_V(v|z)$ represents the conditional pdf with median value z where z is a lognormally-distributed r.v. For a Rayleigh-distributed r.v., the median is proportional to the standard deviation ($z = 1.177\sigma$), so that one can write

$$p_V(v|z) = \frac{v}{(z/1.177)^2} \exp\left[\frac{-v^2}{2(z/1.177)^2}\right] \tag{9}$$

Our objective is the unconditional pdf $p_V(v)$ which is given by

$$p_V(v) = \int_0^\infty p_V(v|z)\, p_Z(z)\, dz \tag{10}$$

where $p_Z(z)$ is a lognormal pdf. Substituting the appropriate pdf's into (10) yields

$$p_V(v) = \int_0^\infty \frac{v}{(z/1.177)^2} \exp\left[\frac{-v^2}{2(z/1.177)^2}\right] \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[\frac{-(\ln z - a)^2}{2\sigma^2}\right] dz \tag{11}$$

Rearranging terms results in

$$p_V(v) = \int_0^\infty \frac{1.385v^2}{z^3\sqrt{2\pi\sigma^2}} \exp\left[\frac{-v^2}{2(z/1.177)^2} + \frac{-(\ln z - a)^2}{2\sigma^2}\right] dz \tag{12}$$

This somewhat cumbersome integral can be solved numerically to find the unconditional pdf for v over all time. The mean value of the lognormal distribution given by a in (12) would be found from the average of the hourly median values over a long period of time. As before, the value of σ can be chosen so that the voltage exceeded 10 percent of the time approximately matches the data.

5.0 COMPUTATION OF THE PDF FOR THE SIGNAL-TO-INTERFERENCE RATIO

The pdf for the SIR can be found by first converting the lognormal pdf from (5) in volts to a pdf in dBmW and doing the corresponding process for the desired signal amplitude in volts. The pdf of the SIR in dB is then found by subtracting the interference pdf in dBmW from the signal pdf in dBmW.

The signal amplitude in dBmW and the interference amplitude in dBmW are both random variables so that the SIR is also a random variable. The pdf of the sum (or difference) of two r.v.'s is given by the convolution of the pdf's, as follows:

$$p_Z(z) = p_X(x) * p_Y(-y) \tag{13}$$

For this case, z represents the SIR, x represents the desired signal level in dBmW, and y represents the interference level in dBmW.

The process of converting the envelope voltage pdf in volts (or mV/m) to dBmW across 1 ohm starts with the relationship:

$$S = 20\log(\text{mV}) - 30 \qquad \text{dBmW} \tag{14}$$

where S is power and mV is the voltage in millivolts. If the relationship between two quantities is known, the pdf for one can be found in terms of the pdf for the other using the following relationship:

$$p_S(s) = p_V(v)\left|\frac{dv}{ds}\right| \tag{15}$$

Starting with (14) and performing the operations indicated by (15), the resulting pdf for the power s in dBmW is

$$p_S(s) = p_V\left(10^{((s+30)/10)}\right)\, 10^{((s+30)/10)}\, \frac{\ln 10}{20} \tag{16}$$

The pdf for $p_V(v)$ is given by (5). To find $p_S(s)$, it is a matter of substituting the argument

$$10^{((s+30)/10)}$$

into equation (5) for v, and multiplying in the other components of (16), to arrive at the final equation for the pdf of s in dBmW.

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The convolution in (13) can now be performed. Since this analysis was implemented on a computer, the convolution was done by a numerical method which is somewhat more efficient than the straight multiplication and summation approach. The technique goes as follows:

1. Take the Fast Fourier Transform (FFT) of each pdf

2. Multiply the two FFT's together

3. Take the inverse FFT of the result from step 2.

Since FFT's can be done very rapidly, this approach to a convolution is much faster than the straight multiplying method.

The convolution in (13) was performed using a constant desired signal amplitude of 1.0 mV/m (-30 dBmW across 1 ohm) and several different combinations of interfering signal amplitudes corresponding to various interference "exclusion" principles currently under consideration for frequency allocation purposes. Note that the pdf of the constant amplitude desired signal is simply a delta function at the signal level -30 dBmW.

Tables 1 through 5 show tabulations of various percent-time points for which the SIR is exceeded for the cases which were studied. The results show that for the addition of one interferer at the 50% exclusion level (that is; it would not be permitted if its amplitude were greater than 50% of the first interferer), that the SIR at the 50% time point is degraded by about 1 dB. This is found by comparing the 50% percent time points in Tables 1 and 2. For the 25% exclusion case, the degradation in SIR is about 0.27 dB (compare Tables 1 and 3). Similarly, for the four additional interferers and 50% exclusion, the SIR is degraded about 3 dB from the 1 interferer case. For 25% exclusion, the SIR is degraded by about 1 dB.

6.0 COMPUTATION OF THE PDF FOR THE SIR FOR A TIME-VARYING DESIRED SIGNAL

If the constant amplitude desired groundwave signal represented by x in (13) is replaced with a time-varying skywave signal (such as the 50% time secondary skywave service of Class I-A stations in the United States) the analysis in the last section can be repeated and a new set of SIR statistics produced for such skywave coverage areas. The lognormal pdf for the desired signal is established using the 50% time (median) value and the same σ value used before to set the upper decile point at 8 dB above the median. Convolving the resulting desired signal pdf in dBmW with the combined interference pdf in dBmW yields the SIR pdf.

The results of this process are shown in Tables 6 through 10. The tables show that the 50% time degradation in SIR is about what it was for the constant amplitude case. However, the standard deviation of the SIR is much greater owing to the spread in the desired signal amplitude. The 90% time point for the single interferer case (Table 6) is about 11 dB below the median value. The relative differences in the SIR statistics between the 50% exclusion and 25% exclusion cases are the same as for the constant amplitude desired signal case discussed in Section 5.0.

7.0 IMPACT ON SIR OF MULTIPLE INTERFERERS VERSUS A SINGLE INTERFERER

For frequency allocation purposes in the United States, it is common to use the root of the sum of the squares (RSS) of the amplitudes of multiple interferers to arrive at an indication of the signal-to-interference ratio. Currently, this RSS calculation is done using the 10 percent time signal amplitudes for each of the interferers as given by the appropriate propagation curve. This procedure suggests to some that a "worst case" assumption has been made that the 10 percent time signal level from each interferer is continuously present rather than present or exceeded only 10 percent of the time.

It is easy to show that the probability of multiple independent interferers all exceeding their 10 percent levels simultaneously at any given time is much smaller than 10 percent. However, only considering whether or not a 10 percent threshold is exceeded provides a very incomplete description of the sum voltage of multiple interferers since the contributing voltages involved are continuous, rather than discrete, random variables. To find the complete statistical description of the sum voltage, an approach like that taken in Section 3.0 of this paper must be used where the continuous statistical voltage variation of the constituent interferers is explicitly taken into account.

Consider the case of N interferers where the rms voltage of the ith interferer is given by $\sqrt{2}\sigma_i$. From Section 2.0, for a Rayleigh distribution the 10 percent time voltage is $2.146\sigma_i$. The RSS of the 10 percent time voltages of this set of N interferers is then

$$\text{RSS} = \sqrt{\sum_{i=1}^{N}(2.146\sigma_i)^2} \tag{17}$$

$$\text{RSS} = \sqrt{4.605\sum_{i=1}^{N}\sigma_i^2} \tag{18}$$

Now consider a single interferer with an rms voltage $\sqrt{2}\sigma_0$ and with a power level equal to the sum of the powers of the N individual interferers. The total power for the sum of the N interferers is the sum of the individual powers. The individual power for each (across 1 ohm) is given by the rms voltage squared, or $2\sigma_i^2$. The sum of these powers is then

$$\text{Total power} = P_T = \sum_{i=1}^{N} 2\sigma_i^2 \tag{19}$$

The equivalent single interferer will have a power equal to P_T. The power of this single interferer across 1 ohm is also equal to its rms voltage squared, or $2\sigma_0^2$.

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TABLE 1

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	26.11 dB
80	28.86
70	30.84
60	32.54
50	34.12
40	35.70
30	37.40
20	39.38
10	42.13

TABLE 2

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.09 dB
80	27.85
70	29.83
60	31.52
50	33.11
40	34.69
30	36.39
20	38.37
10	41.12

TABLE 3

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.83 dB
80	28.58
70	30.57
60	32.26
50	33.85
40	35.43
30	37.12
20	39.11
10	41.86

TABLE 4

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m
10% time amplitude of interferer 3: 0.0250 mV/m
10% time amplitude of interferer 4: 0.0250 mV/m
10% time amplitude of interferer 5: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.96 dB
80	25.71
70	27.69
60	29.39
50	30.97
40	32.55
30	34.25
20	36.23
10	38.98

TABLE 5

Constant desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m
10% time amplitude of interferer 3: 0.0125 mV/m
10% time amplitude of interferer 4: 0.0125 mV/m
10% time amplitude of interferer 5: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	25.09 dB
80	27.85
70	29.83
60	31.52
50	33.11
40	34.69
30	36.39
20	38.37
10	41.12

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TABLE 6

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.79 dB
80	26.68
70	29.49
60	31.88
50	34.12
40	36.36
30	38.76
20	41.56
10	45.45

TABLE 7

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	21.78 dB
80	25.67
70	28.47
60	30.87
50	33.11
40	35.35
30	37.74
20	40.55
10	44.44

TABLE 8

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	22.52 dB
80	26.41
70	29.21
60	31.61
50	33.85
40	36.09
30	38.48
20	41.29
10	45.17

TABLE 9

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0250 mV/m
10% time amplitude of interferer 3: 0.0250 mV/m
10% time amplitude of interferer 4: 0.0250 mV/m
10% time amplitude of interferer 5: 0.0250 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	19.64 dB
80	23.53
70	26.33
60	28.73
50	30.97
40	33.21
30	35.61
20	38.41
10	42.30

TABLE 10

50% time desired signal amplitude: 1.00 mV/m

10% time amplitude of interferer 1: 0.0500 mV/m
10% time amplitude of interferer 2: 0.0125 mV/m
10% time amplitude of interferer 3: 0.0125 mV/m
10% time amplitude of interferer 4: 0.0125 mV/m
10% time amplitude of interferer 5: 0.0125 mV/m

Percent Time	Signal-to-Interference Ratio Exceeded:
90 %	21.78 dB
80	25.67
70	28.47
60	30.87
50	33.11
40	35.35
30	37.74
20	40.55
10	44.44

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$$2\sigma_0^2 = \sum_{i=1}^{N} 2\sigma_i^2 \tag{20}$$

The 2's cancel so

$$\sigma_0 = \sqrt{\sum_{i=1}^{N} \sigma_i^2} \tag{21}$$

The 10 percent time voltage for this single interferer is $2.146\sigma_0$ or

$$\text{10 percent time voltage} = 2.146 \sqrt{\sum_{i=1}^{N} \sigma_i^2} \tag{22}$$

The RSS of the 10 percent time voltage of this single interferer is just

$$\text{RSS} = \sqrt{\sum_{k=1}^{1} \left(2.146 \sqrt{\sum_{i=1}^{N} \sigma_i^2} \right)^2} \tag{23}$$

$$\text{RSS} = \sqrt{4.605 \sum_{i=1}^{N} \sigma_i^2} \tag{24}$$

Since the RSS value for the single interferer equals the RSS value for the sum (equation (18)), the variances are also the same and the Rayleigh distribution of the single interferer is the same as the Rayleigh distribution of the sum of the multiple interferers. It is clear, then, that regardless of the number or amplitude of the multiple interferers, the effect of the sum of interferers on the SIR is the same as the effect of a single interferer with equivalent power.

It should be noted that this analysis applies only to the ratio of the desired signal power to the total undesired signal power. It does not deal with the psychoacoustical effects, or listenability, of a single interferer versus multiple interferers. One might intuitively argue that a single interferer will more drastically degrade listenability than multiple interferers (though the SIR is the same), because the single loud interferer will cause more distraction from the desired program than will a "babble" of lower level interferers. Listenability tests of various interference circumstances will ultimately be needed to resolve this issue.

Since a Rayleigh distribution with $\sigma = \sigma_0$ provides a complete description of the statistical characteristics of the sum of N interferers, it is now possible to return to the earlier question of the probability that the sum voltage will be equal to or above some combination of 10 percent time voltage levels from the individual interferers. For example, assume that $N = 8$ and that each of the eight interferers has a 10 percent time amplitude of 2.146σ. The probability that the sum voltage will be, for instance, four times the 10 percent time voltage of one interferer is

$$\text{Probability} = \int_{4\times 2.146\sigma}^{\infty} \frac{v}{\sigma_0} \exp\left[\frac{-v^2}{2\sigma_0^2}\right] dv \tag{25}$$

From equation (21), and with $N = 8$, we have

$$\sigma_0 = \sqrt{\sum_{i=1}^{N} \sigma_i^2} = 2.828\sigma \tag{26}$$

Putting this value of σ_0 into (25) and performing the integration (from (3))

$$\text{Probability} = \exp\left[\frac{-(8.584\sigma)^2}{2(2.828\sigma)^2}\right] \tag{27}$$

This results in a probability of 0.009998 that the sum voltage will exceed 4 times the 10 percent time voltage of a single interferer.

For this case, the ratio of the 10 percent time voltage of the sum to the 10 percent time voltage of one of the eight constituent interferers (with all the σ_i's the same) is

$$\frac{2.146\sqrt{\sum_{i=1}^{N} \sigma_i^2}}{2.146\sigma_i} = \sqrt{N} = 2.828 \tag{28}$$

8.0 CONCLUSIONS

The foregoing analysis used statistical descriptions for the amplitude of a desired AM broadcast groundwave signal and multiple interfering skywave signals to develop a statistical description of the desired signal-to-interference ratio. The resulting probability density function was used to evaluate the percentage of time SIR's are exceeded with a variety of interfering signal combinations. The results show that adding four equal interferers, each at a level equal to 50% of a first interferer, degrades the 50% time SIR by a little more than 3 dB. If the four added interferers are all set at a level equal to 25% of the first interferer, the 50% time SIR is degraded by only 1 dB.

A similar analysis was conducted using a time-varying desired signal with a lognormal amplitude distribution. The results show that the spread of the SIR distribution increases so that the 90% time point is about 11 dB below the 50% time point. However, the relative changes in the SIR statistics between the various combinations of interference cases is the same as for the study with a constant amplitude desired signal.

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A comparison of the impact on the SIR of multiple interferers with the impact on the SIR of a single interferer of equivalent power shows that the effect was the same in both cases.

9.0 REFERENCES

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Appendix G
Instructions for Operation of Program "SKYIN"

Introduction

These instructions describe the operation of a computer program to calculate signal-to-interference ratio statistics for AM broadcast groundwave and skywave signals in the presence of multiple skywave interferers.

Diskette description

The diskette is a double-density 5-1/4" 360 kb floppy. The master diskette contains the source code file SKYIN.FOR and executable file SKYIN.EXE. The programs may be copied, such as to a hard disk, but no additional disk space is necessary for program execution. The programs were compiled with Microsoft FORTRAN v4.01 and are designed to run on almost any PC-compatible computer.

Hardware requirements

A typically equipped PC with 256 kb or more is required. The program was designed to use the capabilities of the math coprocessor. The program contains emulation routines that will permit it to run without the coprocessor, but it will run more slowly. A coprocessor-equipped machine is recommended.

All output data appears on the screen. Neither a printer nor graphics capability is required.

Program description

Users should familiarize themselves with the paper, "Signal-to-Interference Ratio Statistics for AM Broadcast Groundwave and Skywave Signals in the Presence of Multiple Skywave Interferers," by H. Anderson, which is Appendix F of this report. The paper describes the calculations made by the program and gives several examples.

Program execution

The program is run by typing "SKYIN<ret>". After a title screen appears, the user is asked to select a constant amplitude or lognormal-fading desired signal and to enter its amplitude. If a lognormal-fading signal is selected, there will be a delay while the computer calculates its probability density function (pdf).

The user is then asked for the number of interferers (up to 10) and their amplitudes, and the computer begins its calculations. When the calculation is complete, a results screen will be displayed which tabulates all of the input data and the signal-to-interference ratio exceeded from 10% to 90% of the time in steps of 10%. Results can be printed using the "PrtSc" keyboard command. The user can then select another run or exit from the program.

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Appendix H

Program Diskettes
Programs EMIN, ADJACENT, SKYIN

AM 20.
5.12.88

John Rice: 632 9660

Year of major AM. Log. shift?

MARCH 29 1941

Julius:

1941 KQV microfilm

WAKR.

WSPZ DOUGLASVILLE GEORGIA 1520 KHZ II 871230
APP ND-D D
BP870831AA

870327AI RET 870805-PETITION FOR RECONSIDERATION

WKVI KNOX INDIANA 1520 KHZ II N LAT 41-19-20 W LONG 86-36-17 870903
APP 2.00 KW-LS ND-D D PSA .00000KW
(DAY) 870821AE
RAD(MV/M/KW): DAY 365.08
AMENDMENT 870528-870316AJ RETURNED 870727-PETITION FOR RECONSIDERATION

WKVI KNOX INDIANA 1520 KHZ II 870903
APP ND-D D
870821AE

AMENDMENT 870528-870316AJ RETURNED 870727-PETITION FOR RECONSIDERATION

WTHE MINEOLA NEW YORK 1520 KHZ II 870820
APP ND-D D
BP840430AC

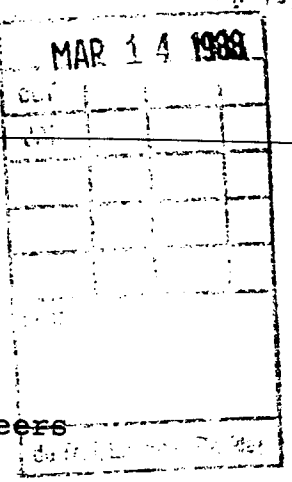
KOMA OKLAHOMA CITY OKLAHOMA 1520 KHZ I-B 870715
APP 50.00 KW DA-N U
(NIGHT) BP870217AO
THEO RMS(MV/M): NIGHT 2629.67
N LAT 35-20-00 W LONG 97-30-16 (NIGHT)

NEW MAGNOLIA TEXAS 1520 KHZ II N LAT 30-13-25 W LONG 95-45-35 871221
APP 5.00 KW-LS DA-D D PSA .00000KW
(DAY) 870507AF
THEO RMS(MV/M): DAY 664.53
APPLICATION DISMISSED 871102

NEW HARTSELLE ALABAMA 1530 KHZ II 800602
APP ND-D D
800527AB

I 9/2.

AM-21.



Radiotechniques

402 TENTH AVENUE • HADDON HEIGHTS, NJ 08035

(609) 546-8008

March 8, 1988

Mr. Ron Rackley, President
Association of Federal Communications Consulting Engineers
DuTriel, Lundin and Rackley
1019 19th Street NW
Suite 300
Washington, DC 20036

From EXCOM
4/16/88

Dear Ron:

I am writing this to request the opportunity to describe a proposed improvement to directional AM antenna systems with negative resistance operating impedances for one or more towers to the AFCCE executive committee, and potentially to the membership at the March 16th meeting.

WFIL is an AM broadcast station operating on 560 kHz with 5,000 Watts, DA-2. The station licensee is undertaking changes to the station directive antenna system authorized under a construction permit BP-870608AH. The physical antenna construction and installation of equipment is nearly complete, and the station antennas are in substantial adjustment, as determined by field measurements.

One tower of the daytime antenna system returns a substantial amount of power to the array, and has a substantial negative operating impedance. During construction, and initial tuning of the antenna system, this tower was merely terminated in its predicted conjugate impedance, consisting of a load resistor, and reactance in series. When the tower was connected to the phasor, parameters re-established, and transmission lines matched a serious decrease in apparent fidelity was noted relative to the conditions when the negative tower was merely terminated.

Motorola stereo performance was marginal for the day pattern with the antenna return power re-entrant in the system, and uncompensated common point impedance slope was poor. Further studies show that the pattern shape shifts dramatically with frequency.

WFIL has motor driven components installed at the antenna coupler of the negative tower, with the controls remotely located on the front of the phasor cabinet. A 50 Ohm load resistor was installed in the place of the line, and the line was disconnected from the power divider at the phasor, effectively disabling the negative tower tap of the power divider. The common point impedance was reset to the desired value, and the negative tower was trimmed to correct the 2 degree shift making the on carrier parameters identical. The uncorrected common point impedance

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AFCCE

March 8, 1988

slope improved by 2:1, and the pattern shape shifts improved very significantly.

The licensee wishes to request permanent authorization to permit terminating the negative tower in a passive load, and increase transmitter power to compensate for the power dissipated in the load. I would like to propose that the Association support this request before the FCC because it will improve the performance of at least some AM stations by a significant amount, with no negative impacts, save a slightly higher electric bill for the station.

I would appreciate it if you could arrange to have this item entered as an agenda item for the March meeting. Time is of the essence for the station, as we need to file the 301 in a timely manner, and the licensee would like to present this to the Commission with the Association aware of the proposal, and possibly supporting it.

Sincerely,

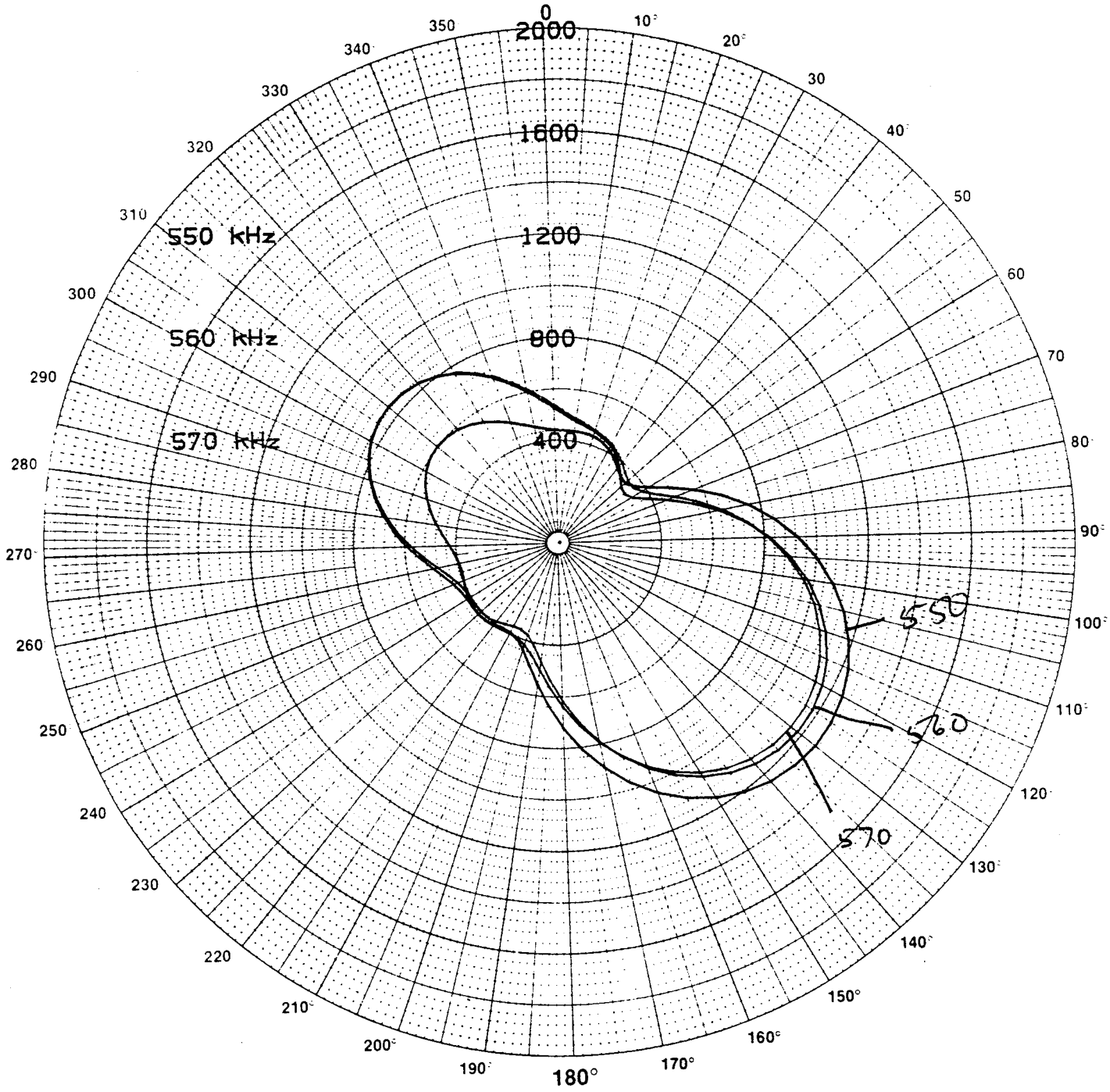
Ted Schober

Edward A. Schober, PE
Member

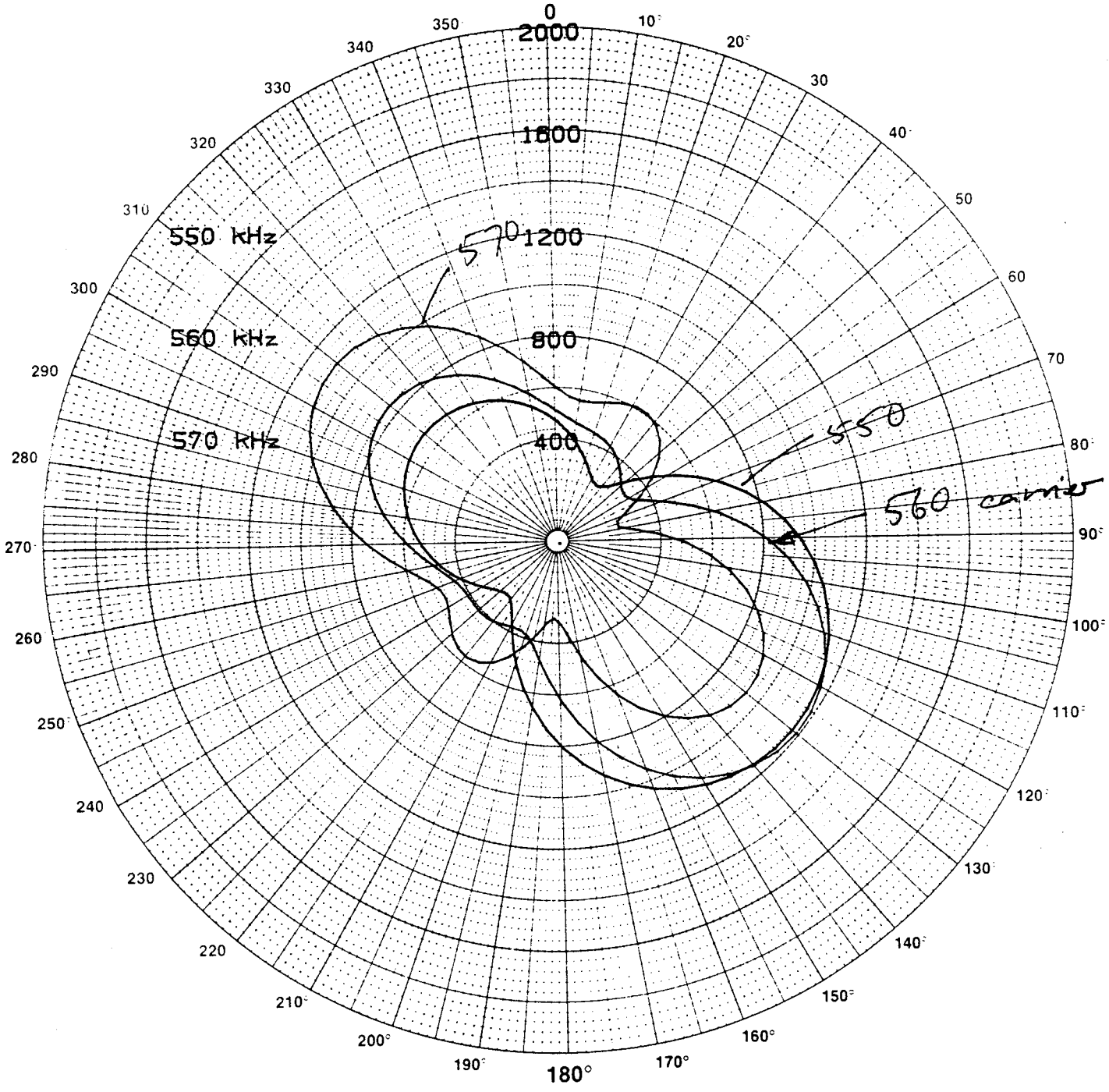
encl. Plot of theoretical pattern utilizing measured antenna parameters vs frequency with, and without load resistor.

cc: Russ Mundschenck - Chief Engineer WFIL

WFIL Measured Parameters - With Resistor



WFIL Measured Parameters - No Resistor



AM-22.

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This is an unofficial announcement of Commission action. Release of the full text of a Commission order constitutes official action. See MCI v. FCC, 515 F 2d 385 (D.C. Circ. 1975)

Report No. DC-1147 ACTION IN DOCKET CASE April 7, 1988

FCC REAFFIRMS AND ORDERS RESUMPTION OF PROCESSING OF AM APPLICATIONS FOR 14 FOREIGN CLEAR CHANNELS (MM DOCKET 84-281)

The Commission has reaffirmed rules establishing new full-time AM stations on the foreign (Canadian, Mexican or Bahamian) Class I-A channels, and directed the staff to resume the processing of applications for AM stations on the 14 foreign clear channels that had been suspended pending the completion of this proceeding.

This proceeding was initiated to consider changes in the domestic rules governing the use of the 14 AM frequencies after the terms of new international agreements enabled the United States to use these frequencies at night.

After careful review of the record, the FCC decided not to adopt rules imposing non-technical acceptance criteria on applications for new full-time stations on the foreign Class 1-A clear channels for the same reasons they were deleted for domestic clear channels in MM Docket 85-39.

These new rules place important emphasis on technical criteria for the acceptance of applications for new stations. The FCC pointed out that imposing non-technical acceptance criteria could result in frequencies lying fallow and, consequently, in the public being deprived of new AM radio service in the few areas where full-time opportunities exist. The Commission said it was reluctant to adopt non-technical acceptance criteria where their net effect may be to hinder the rapid development of new full-time AM service or to delay the public's access to new or increased radio service without producing significant countervailing benefits.

Since the FCC's studies show that the vast majority of opportunities for establishing new full-time stations already exists in areas with limited or no service, there was no compelling justification for the imposition of service based criteria to encourage applicants to apply in these unserved or underserved areas.

Moreover, the Commission emphasized that the absence of ownership based criteria will not preclude applications by minorities and noncommercial broadcasters in both urban and rural areas. On the other hand, the FCC indicated such ownership based criteria would have limited the acceptance of applications for use of the foreign clear channels to minority and noncommercial applicants.

(over)

Originally, the FCC proposed following the example used for the U.S. clear channels, since that proceeding also developed technical and eligibility rules to govern applications for new full time Class II stations. The FCC adopted threshold standards designed to promote applications in areas having the greatest need for service.

However, in 1985, the FCC concluded that such application criteria were no longer necessary. The National Black Media Coalition appealed the FCC's decision, challending the FCC's refusal to adopt special provisions for minority and noncommercial applicants.

The Court remanded the case to the Commission, concluding that the FCC's divergence from its original proposal and its failure to provide a prior opportunity for comment on its studies constituted a failure to comply with the Administrative Procedure Act. The Court did not rule against the part of the decision that permitted nighttime operation for daytime-only stations.

Pursuant to the remand, the FCC issued the Further Notice to reopen the proceeding. Comments were requested on a proposal to accept applications to use the foreign clear channels based solely on technical criteria (i.e. based on interference considerations) and thereby dispense with the imposition of non-technical acceptance criteria. In particular, the FCC directed the attention of commenters to another proceeding in which the FCC deleted similar non-technical acceptance criteria then applicable to the 25 U.S. Class I-A clear channels.

Action by the Commission April 6, 1988, by Second Report and Order (FCC 88-135). Commissioners Patrick (Chairman), Quello and Dennis.

-FCC-

News Media contact: Audrey Spivack at (202) 632-5050.
Mass Media Bureau contact: Vicki Assevero at (202) 632-7792.

23.

GEORGE C. DAVIS
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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF CHIEF ENGINEER
TECHNICAL RESEARCH DIVISION
T.R.R. REPORT 1.2.7.

SUPPRESSION PERFORMANCE
OF
DIRECTIONAL ANTENNA SYSTEMS
IN THE
STANDARD BROADCAST BAND

BY
HARRY FINE
JACK DAMELIN

WASHINGTON 25, D. C.

FEDERAL COMMUNICATIONS COMMISSION
Washington 25, D. C.

September 6, 1957

INTER-OFFICE MEMORANDUM

FOR: Information

TO: Chief Engineer

FROM: Chief, Applied Propagation Branch

SUBJECT: Suppression Performance of Directional Antenna Systems in the Standard Broadcast Band.

The attached report has been prepared to supply information which has long been needed for allocation in the standard broadcast band. It is believed that some of the results will be of appreciable use to the Broadcast Bureau.

Harry Fine

Harry Fine, Chief
Applied Propagation Branch

Jack Damelin

Jack Damelin

SUMMARY (1)

The suppression performance of directional antenna systems in the standard broadcast band is studied both near-in to the arrays and at the greater distances in the range of the skywave fields. In both cases, it is found that the measured fields are greater than the theoretically calculated fields, assuming perfectly conducting smooth earth, the departures increasing with the theoretical suppression and being much more substantial for the skywave fields. Methods are developed to estimate the average and maximum effective radiated fields expected in these suppression directions. In addition, based on the form of these estimates, the probable nature of the physical mechanisms, which cause these departures from theory, is discussed. For the close-in fields, the departures are probably caused by radiation from large objects and reflection from gross irregularities of the terrain in all azimuthal directions, whereas for the skywave fields - these departures are most likely caused by incoherence in the fields from the individual elements of the array, introduced by scattering from terrain and ionospheric irregularities.

INTRODUCTION

This report is a study of the suppression performance of directional antenna systems in the standard broadcast band (540 - 1600 kc) both near-in to the arrays and at the greater distances in the range of skywave fields. For years, the operating performance of directional arrays has been treated as a matter of judgement by experienced engineers and few attempts have been made to systematize the results of the available measurements although the need for such a study has long been recognized. An attempt will be made here to correlate the measured with the theoretical performance in order to give practical systematic estimates which are believed to be better in most cases than sheer judgement. Also, it is hoped from this study to arrive at a better understanding of the fundamental physical processes involved in radiation from directional antennas in the standard broadcast band.

The study will be divided into two parts. The first will treat with the close-in groundwave fields, as measured in proofs of performance submitted to the Commission. The second part will study the skywave suppression measurements on directional arrays, made in April 1949 by NARBA Committee IA.

NEAR-IN PERFORMANCE

For this type of performance, there are much data which have been submitted to the FCC in various proofs-of-performance for standard broadcast facilities. These horizontal radiation patterns for the directional arrays have been measured near the arrays but far out enough so that the array appears to be approximately a point source.

Selected for the study were the measured patterns of 13 arrays in 55 azimuthal directions with the greatest emphasis on those directions involving the greatest suppressions. The directional arrays were also chosen to have a wide practical range of frequency, ratio of Erss to Erms, and ratio of Emax to Erms; where Emax is the maximum horizontal field of the array, Erms is the horizontal R.M.S. (root-mean-square) field corresponding to the average power in the horizontal plane, and Erss is the horizontal R.S.S. (root-sum-square) field of the individual antenna elements. These data are plotted in Figure 1 in the form of measured versus theoretical horizontal inverse distance fields per kilowatt at one mile. With this type of plot, the greater the suppression - the smaller would be the inverse distance field radiated in the direction of suppression per kilowatt of average array power. As expected, the measured fields do not generally give the suppressions predicted by the theoretical fields for perfectly conducting smooth terrain; the departures from the theoretical fields increasing with the theoretical suppression. It is apparent that the theoretical fields, as such, may not be used for estimating the true performance of directional arrays, especially when large suppressions are involved.

It seems reasonable to expect, assuming the arrays are properly adjusted that the main sources contributing to the discrepancies between the measured and theoretical fields are:

1. Re-radiation from large objects and reflection from gross irregularities of the terrain in all azimuthal directions about the array,

2. Reflection from smaller off-path objects and less irregular terrain in the same general direction,

3. Changes in the fields of the individual elements of the directional array because of irregular terrain.

Presumably, the effects of finite ground conductivity are made negligible by using the inverse distance fields at one mile, obtained by matching the measured field intensity versus distance curves against those calculated for finite conductivity. Which of the above sources are mostly responsible for the appreciable departures from theoretical fields may be determined by the correlation studies which were made of the measured fields with the maximum theoretical fields for various horizontal bracket angles, with Erms fields, with Emax, and with Erss.

Figures 2, 3, and 4 compare the measured fields with those estimated by adding the theoretical field for the pertinent azimuthal direction in quadrature with the indicated percentages of the theoretical Erms, Emax and Erss fields. A similar curve could have been drawn, using the maximum theoretical horizontal field within some bracket angle but the results along these lines showed less correlation and greater departures than did Figures 2, 3, or 4. The percentages used in Figures 2, 3, and 4 are the ones giving the best fit to the data for these various approaches considering the logarithm of the field intensity as the fundamental unit. These optimum percentages were found mainly by trial and error procedures.

By visual observation or even by comparing the standard errors, it is almost impossible to determine whether the Erms estimates of Figure 2 or the Emax estimates of Figure 3 shows the better correlation. No combination of Erms, Emax, and Erss gives any significantly better fit to the data.

The dependence on the Emax and Erss fields, shown in Figures 3 and 4 respectively are not significant fundamental correlations, as may be seen by examining Figures 5, 6, 7 and 8. Figures 5 and 6 show the deviations of the measured fields from the Erms estimates of Figure 2 when plotted against the ratios of Emax/Erms and Erss/Erms, respectively. If there were any fundamental trends with Emax or Erss, they would show up on this type of plot. To complete the proof that

the only significant fundamental correlation is with Erms, there are plotted in Figure 7 the deviations from the Emax estimates of Figure 3 versus Emax/Erms, and in Figure 8 the deviations from the Erss estimates of Figure 4 versus Erss/Erms. These latter two plots show that there are trends still left when Emax or Erss are used as the basis for estimates. Apparently, the practical ranges in variation of Emax/Erms and Erss/Erms are so small compared to the variation of the data that artificial trends in Emax and Erss are produced.

Figure 9 shows that there are no frequency trends to be considered, at least in the standard broadcast band, when the Erms estimates are used. A similar plot, not shown, of the deviations from the Erms estimates versus the number of elements in the array, would indicate that the number of elements in the array does not affect the quality of the estimate.

Figure 9A is a plot of the deviations of the measured fields from the Erms estimates of Figure 2 versus the theoretical fields. This plot shows that the scatter is spread over most of the range of theoretical fields. It is to be expected from practical considerations that the scatter would decrease for the higher fields where the extraneous scatter fields represent a smaller percentage of the on-path radiated field.

Many of the data points in Figures 2, 3, and 4 represent different azimuth angles for the same station. In the analysis, the data was weighted so that all points within a 90° spread had the same total weight as a single independent point. Using this system of weighting, the results were the same as would have been obtained without weighting.

It has thus been found that the best estimate for the near-in suppression fields is given by the root sum square of the theoretical smooth earth field in the pertinent direction and 3.5% of Erms. The standard error for this type of estimate was 2.8 db. However, this standard error applies to freshly adjusted arrays, since the proofs-of-performance measurements, used in this study, fall into this category. It is expected that as time progresses, the currents and phases in the various elements of the array may vary, some appreciably.1/

1/ F.C.C. Report No. T.R.R. 1.2.6 "Physical Limitations to Directional Antenna Systems in the Standard Broadcast Band" by Harry Fine.

However, these variations will not usually affect Erms much, although they may change the theoretical field greatly, especially in directions of high suppression. Consequently, these operating variations should not affect too greatly the measured fields, since the contribution of the theoretical fields in these critical null directions is usually much less than that from Erms. As an educated guess, the standard error for estimating the suppression fields by the Erms method of Figure 2 should be in the order of 3.5 db for all arrays, including those not freshly adjusted.

In practice, an applicant for standard broadcast facilities submits to the Commission a theoretical horizontal radiation pattern for the directional array and superimposed upon this pattern are drawn M.E.O.V. (maximum expected operating values) estimates for those critical azimuthal directions in which objectionable interference might occur. These proposed M.E.O.V. fields depend mostly upon how much tolerance can be allowed and also upon the experienced judgement of the designing engineer. Figures 10 and 11 show that the minimum M.E.O.V. tolerances can be set systematically by adding the theoretical field in quadrature with approximately 15% of the horizontal R.M.S. field.

Having determined that the deviations of the measured from theoretical fields show by far the greatest correlation with the R.M.S. fields, the physical mechanism which causes the fill-in of the nulls of directional arrays becomes somewhat clarified. Since the R.M.S. field is a direct measure of the average power radiated in the horizontal plane, the fill-in of the nulls must be caused mainly by fields which are likely to come from any azimuthal direction. Only re-radiation from large objects and reflections from gross irregularities in the terrain around the array could supply these fields from all directions. The 2.8 db standard error would be explained by the irregularities in height, angle of reflection, and horizontal spacing of these large re-radiating objects and of the irregular terrain.

Summing up the results of this section, it has been found that the near-in fields which are measured for freshly adjusted directional antenna arrays can be estimated with a standard error in the order of 2.8 db by adding the theoretical fields in the pertinent azimuthal direction in quadrature with 3.5% of the horizontal R.M.S. fields. In addition, the minimum M.E.O.V. tolerances can be systematically set by adding the theoretical fields for the pertinent azimuthal directions in quadrature with approximately 15% of the horizontal R.M.S. fields. Finally, from the above correlation study, it appears that the fill-ins of the nulls are caused mainly by re-radiation from large objects and reflection from gross irregularities of the terrain in all azimuthal directions.

SUPPRESSION OF SKYWAVE FIELDS FROM DIRECTIONAL ARRAYS (6)

The performance of directional antennas in suppressing skywave signals, received at distances greater than several hundred miles will be considered in this section. Estimates from the theoretical calculations based on perfectly conducting smooth earth will be developed for the effective skywave radiated fields.

Back in 1949, the government-industry Subcommittee IA of the NARBA (North American Regional Broadcasting Agreement) Preparatory Committee began this type of investigation with measurements on 28 directional arrays at 22 different recording sites within the single hop E layer reflection range. Beyond submitting a preliminary summary of the theoretical and measured suppression ratios, this study was never completed, unfortunately. These measurements represent the best data available. For the present study, the data over 55 paths from 14 stations to 16 different recording sites were selected from the NARBA data. This data was selected both for reliability and to give as wide a spread as possible with frequency, distance, number of elements, Erss/Erms, and Emax/Erss.

The measurements were made throughout the night after regularly scheduled operations in April, 1949 by running the broadcast stations continuously for several nights on the following cycle:

a) 9 minutes of directional operation
b) 1 minute of silence
c) 9 minutes of non-directional operation
d) 1 minute of silence

Before the measurements were started, the arrays were adjusted to rated performance by the station engineers who had originally adjusted the arrays.

Non-directional operation was obtained by feeding a central element plus grounding and de-tuning the other towers of the array. Actually, one of the important factors considered by the NARBA Subcommittee IA in selecting stations was their ability to operate with non-directional characteristics, so that most of the stations selected for these tests operated regularly as non-directional during the daytime, and the others could be easily converted for the tests. Adequate checks were made to ensure proper non-directional operation. By measuring the ratios of non-directional to directional fields, the uncertainties of path attenuation were eliminated or at least minimized.

The selected data is plotted in Figure 12 as measured versus theoretical suppression ratios at the pertinent elevation angle. If the measured and theoretical ratios agreed, the 45° line would be the locus of the data points. It is apparent that the measured ratios show much less suppression than the theoretical ratios, the divergence increasing as the theoretical suppression ratio increases.

There are a number of physical factors which could affect the suppression ratios. Chief among these are:

1. Scattering from irregular terrain in the general direction of the pertinent azimuth angle will modify and cause the vertical radiation patterns for each element of the array to differ from theory as well as from the patterns of other elements of the array, even though the physical tower heights are the same. Further departures may occur because the element used for non-directional operation may have its vertical pattern modified.

2. Reflection from gross irregularities in the terrain and re-radiation from large objects in all azimuthal directions from the array may modify the suppression.

3. Ionospheric irregularities will increase the incoherence caused by the ground scatter. Thus, if the vertical patterns from every element have different lobes, the ionospheric reflection areas for the main contributions from each element to the resultant received fields may well be different.

4. The finite conductivity of the ground modifies the vertical radiation pattern and causes a tuck-in at small angles of departure from the ground, resulting in vertical plane overhangs. This overhang increases, with distance from the transmitting antenna.[2/] Consequently, calculations based on perfectly conducting ground would be in error. In the present instance, this factor is relatively unimportant, except insofar as it affects ground reflections for the case of arrays with equal height elements such as most of these were, since it affects the vertical antenna pattern factor about the same for all the elements of an array and such effects would tend to cancel out in taking the ratio of non-directional to directional operation.

2/ "Skywave Field Intensity I" by J. A. Pierce, Technical Report No. 158, Cruft Laboratory, Harvard University.

In order to determine which sources contribute mostly to the appreciable departures from the theoretical suppressions, correlation studies were made of the measured suppression ratios with those estimated from the maximum theoretical fields for various combinations of vertical and horizontal bracket angles, from the theoretical root-sum-square fields, from the theoretical maximum fields in any azimuthal direction, and from the theoretical root-mean-square fields. It was found that the use of bracket angles showed the poorest correlation. Whether the root-sum-square maximum and root-mean-square fields for the pertinent vertical angles were used or whether the corresponding horizontal plane values were employed made negligible difference, so that the results in terms of the horizontal fields will be shown since the solutions are more practical.

Figures 13, 14, and 15 compare the measured suppression ratios with those estimated by adding the indicated percentages of the theoretical Erss, Emax, or Erms fields in quadrature with the theoretical directional field at the pertinent elevation angle. The percentages used in these figures are the ones giving the best fit to the data, considering the logarithm of field intensity as the fundamental unit. These optimum percentages were also found chiefly by trial and error.

For this case of received skywave signals, it is found that the best estimates of the experimental data are in Figure 13, where 9% of Erss was added in quadrature to the theoretical directional fields at the pertinent vertical angles and in the pertinent azimuthal direction. The standard error of estimate was 4.2 db. No combination of the Erss, Emax, and Erms fields gave any more significant estimates.

As for the previous case of the near-in fields, the spread of the data with respect to Emax/Erss and Erss/Erms was not large enough to show which of the above fields had true correlation with the measured data. These artificial correlations are again best observed by studying the deviations of the measured from estimated suppressions. Figures 16 and 17 show the deviations from the Erss estimates of Figure 13 versus Emax/Erss and Erss/Erms, respectively. Figure 16 shows no trend with Emax, whereas Figure 17 indicates that there may be a slight trend with Erms, but any such trend is not significant considering the scatter of the data. Figure 18 is a plot of the deviations from the Emax estimates of Figure 14 versus Emax/Erss, and Figure 19 shows the deviations of the Erms estimates versus Erss/Erms. Both indicate that definite trends with Erss remain. Thus, it is apparent that of the three estimates - only that from Erss gives a significant fundamental trend.

Figure 20 is a plot of the deviations from the Erss estimates of Figure 13 versus frequency. There appears to be a slight trend with frequency, but it is not significant statistically within the standard broadcast frequency range. Figure 20A shows the deviations from the Erss estimates as plotted against the theoretical suppressions. Surprisingly enough, the deviations are scattered fairly uniformly over most of the range of theoretical suppressions and do not increase markedly as the suppression ratios increase beyond about 10. Figure 21 shows that the quality of the Erss estimates does not vary with distance in the one hop E layer reflection range. Likewise, a similar plot of the deviations from the Erss estimates versus the number of elements in the directional array would indicate that neither the estimate nor the scatter of data depends upon the number of elements.

It should be pointed out that many of the data points represent measurements on the same arrays at slightly different azimuthal angles, giving undue weight to such arrays unless some method of weighting is employed. In the present analysis, the points were weighted so that all points for the same array representing azimuthal directions less than 90° apart have a combined weight of a single independent point. It was on this basis that the standard error for the Erss estimate of Figure 13 was evaluated as 4.2 db, although if all points were given equal weight, the standard error would have been 5.2 db.

The standard error of 4.2 db represents the combined error or deviation in both the directional and non-directional fields. For the present purposes, only the directional field and its standard error are of interest. It can easily be shown that the greatest contribution to the standard error of Figure 13 comes from the variability of the directional fields. Thus, the measured suppression ratio might be represented as

$$(1) \quad R \cong \frac{E_{nd} \pm \Delta_{nd}}{E_d \pm \Delta_d} \cong \frac{E_{nd}}{E_d} \cdot \frac{1 \pm \Delta_{nd}/E_{nd}}{1 \pm \Delta_d/E_d}$$

where E is the theoretical field intensity, Δ is the deviation from theoretical, and the subscripts nd and d refer to non-directional and directional operation, respectively. For equal radiated power, Erss will be roughly of the same order of magnitude for directional or non-directional operation, as will be the estimates for Δ_{nd} and Δ_d which are proportional to Erss. Therefore, Δ_{nd}/E_{nd} will be much smaller than Δ_d/E_d in directions of suppression. Thus, it is apparent that most of the deviation from the theoretical suppression ratio is caused by the deviation in the directional field, since Δ_d/E_d is the largest factor in the above equation.

The standard error of the Erss estimate for the effective radiated directional skywave field is then about 4 db. However, it should be remembered that these arrays were all adjusted immediately prior to the measurements so that some allowance should be made for operational variation of the array. This variation in the array tuning and adjustment may greatly affect the theoretical directional radiated field in the pertinent direction but should not affect very much the Erss, so long as the radiated power is maintained within the limits prescribed by the Commission. Consequently, in those directions for which a large amount of suppression has been designed -i.e.

$$E_d \leq \frac{1}{10} \text{ Erss}$$

the received skywave field should not be too sensitive to operational variations of the currents and phases in the elements of the array. In addition, this standard error for the operational variation should be added in quadrature - i.e. root sum squared - with the 4 db standard error in the estimate. Thus, in those directions for which a suppression has been designed, the overall standard error of estimate should be in the order of 6 db for the effective radiated field estimated by adding the theoretical field in the pertinent direction in quadrature with 9 percent of Erss. It should be pointed out that in estimating the accuracy of a received skywave field, it would be necessary to add in quadrature with the above 6 db a standard error for the propagation curves used, since this type of error was made negligible by measuring the ratio of non-directional to directional fields.

Figure 22 compares the measured ratios with those calculated by adding 25% of Erss in quadrature with the theoretical directional field at the pertinent angle. It is seen that nearly all the measured suppression ratios are greater than these calculated values, so that this type of estimate may be used as rough gauge of the minimum suppression to be expected from a given directional array.

It is to be noted that since the ratio of Erss/Erms is a rough measure of the stability of the array, 3/ the more stable the array the smaller will be its Erss for a given Erms and the better will be its suppression performance.

3/ F.C.C. Report - T.R.R. No. 1.2.4 "Directional Antennas in the Standard Broadcast Band" by Harry Fine.

It has been shown 1/ that the resultant deviation, caused by incoherence or random deviations in the fields from the individual elements of an array, is proportional to the R.S.S. (root sum squared) field of the array. Therefore, the physical mechanism which causes these departures of measured from theoretical suppressions should be chiefly a combination of scattering from irregular terrain and ionospheric irregularities. Thus, the scattering from irregular terrain causes each element of the array to have a different vertical radiation pattern, so that the maximum contribution at the receiving end is made by fields radiated at different elevation angles from the individual antenna elements and reflected from different blobs in the ionosphere.

Summarizing the results of this study on received skywave fields, it has been found that the measured effective radiated fields in the null directions are much greater than the corresponding theoretical fields in the pertinent directions, this deviation increasing as the theoretical null increases. These deviations are apparently caused by incoherence, introduced in the fields from the individual elements of the array by scattering from irregular terrain and ionospheric irregularities. It has been found that fair estimates of the effective radiated fields in these directions of suppression are given by adding the theoretical field in the pertinent direction in quadrature with 9% of the horizontal R.S.S. field with a standard error of estimate in the order of 5 db. Also, it has been found that the maximum effective radiated field to be expected in these directions of suppression is approximately equal to the theoretical field in the pertinent direction in quadrature with 25% of the horizontal R.S.S. field.

TABLE I

Stations Employed in the Close-In Directional Antenna Suppression Study

CALL	FREQ. (kc)	Erms (mv/m)	Emax. (mv/m)	Ersa (mv/m)
KCMO	810	600	1380	670
WINS	1010	1630	3340	2080
WIBG	990	660	1450	1172
WBT	1110	1590	2680	1625
WXKW	850	580	1530	1998
KOAM	860	418	680	424
WCTT	680	175	298	208
KIDO	630	434	738	448
KING	1090	1655	2660	1618
WMAY	970	153	310	235
WTVH	1590	214	400	269
WLEX	1300	200	408	298
KSJO	1590	156	220	156

TABLE II

Stations Employed in the Skywave Antenna Suppression Study

CALL	FREQ. (kc)	Erms (mv/m)	Emax (mv/m)	Erss (mv/m)
WBAL	1090	1600	2600	1655
KOMA	1520	1700	3000	1930
WGBS	710	600	970	534
WMAZ	940	622	1500	1595
WHB	710	400	850	405
WKOW	1070	405	1200	524
KOAM	860	418	680	424
KABC	680	601	1450	724
KCMO	810	600	1380	670
WWVA	1170	1600	2550	1570
WXKW	850	570	1440	963
WNAO	850	394	940	1223
WLAC	1510	1600	2650	2018
KXEL	1540	1700	2350	1678

TABLE III

List of Receiving Locations in Skywave Antenna Suppression Study

Allegan, Michigan

Atlanta, Georgia

Baltimore, Maryland

Chicago, Illinois

Cincinnati, Ohio

Cleveland, Ohio

Dallas, Texas

Des Moines, Iowa

Detroit, Michigan

Grand Island, Nebraska

Nashville, Tennessee

Kingsville, Texas

Portland, Oregon

Salt Lake City, Utah

Rochester, New York

Richmond, Florida

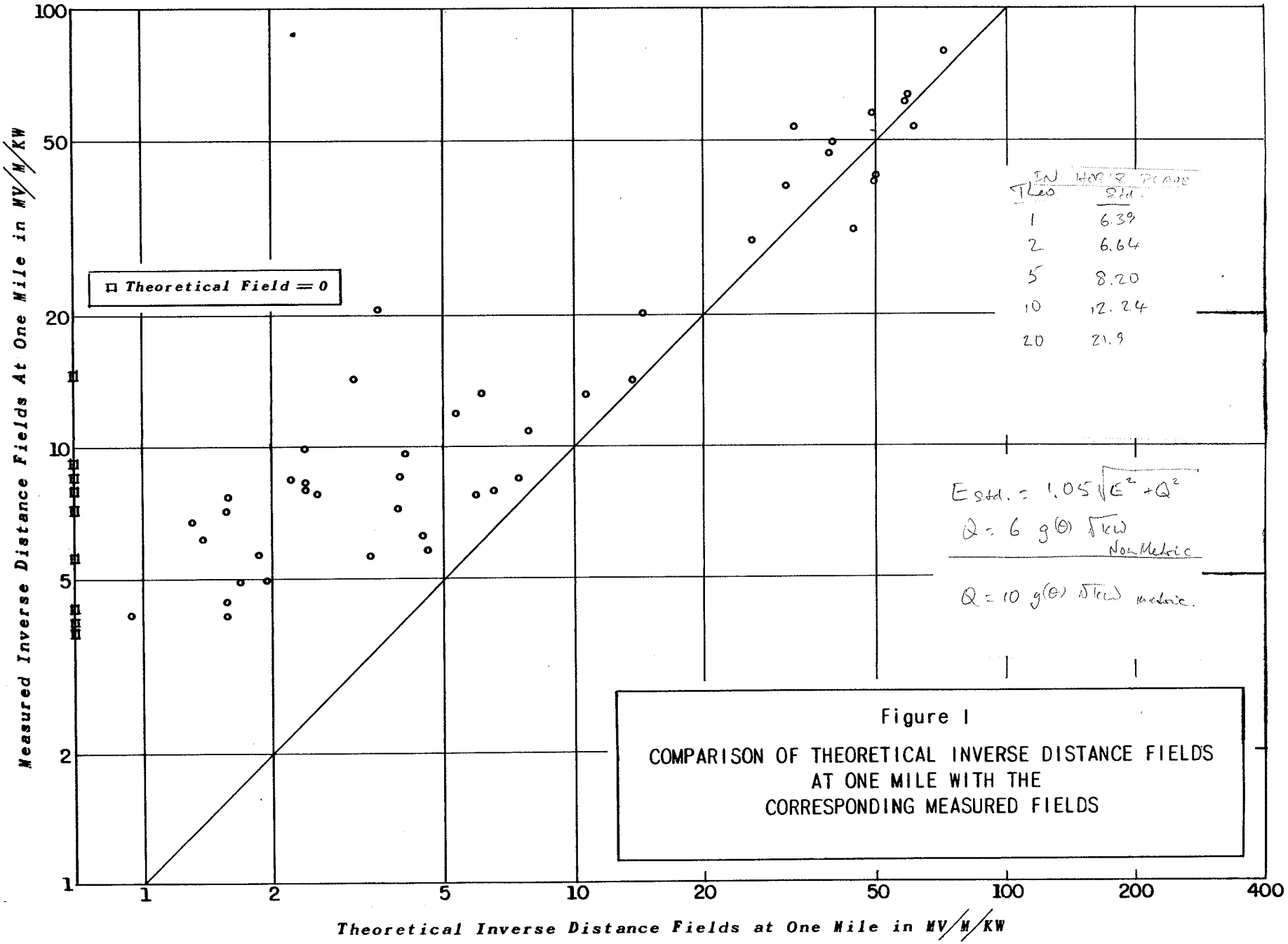


Figure I

COMPARISON OF THEORETICAL INVERSE DISTANCE FIELDS AT ONE MILE WITH THE CORRESPONDING MEASURED FIELDS

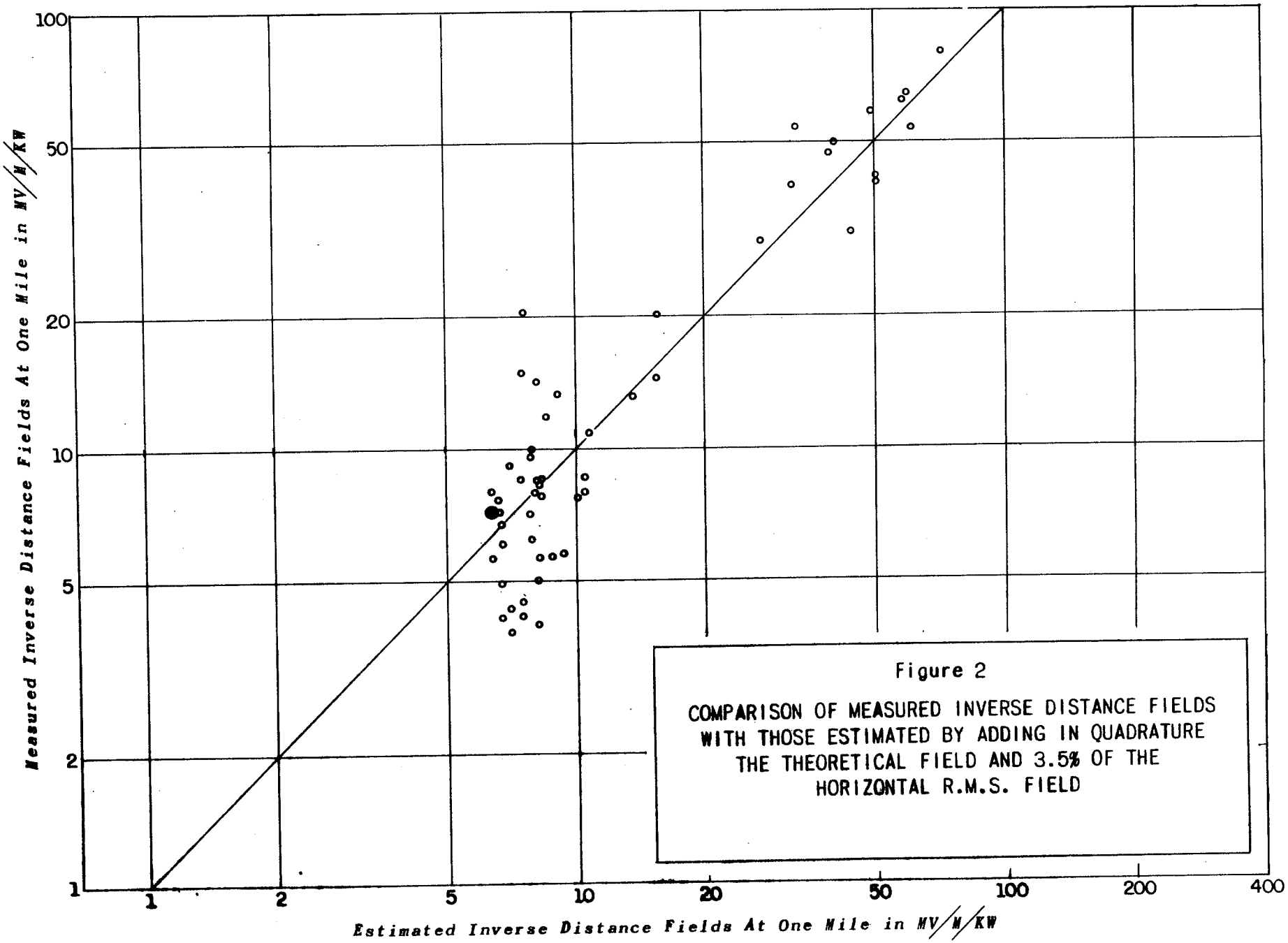


Figure 2

COMPARISON OF MEASURED INVERSE DISTANCE FIELDS WITH THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3.5% OF THE HORIZONTAL R.M.S. FIELD

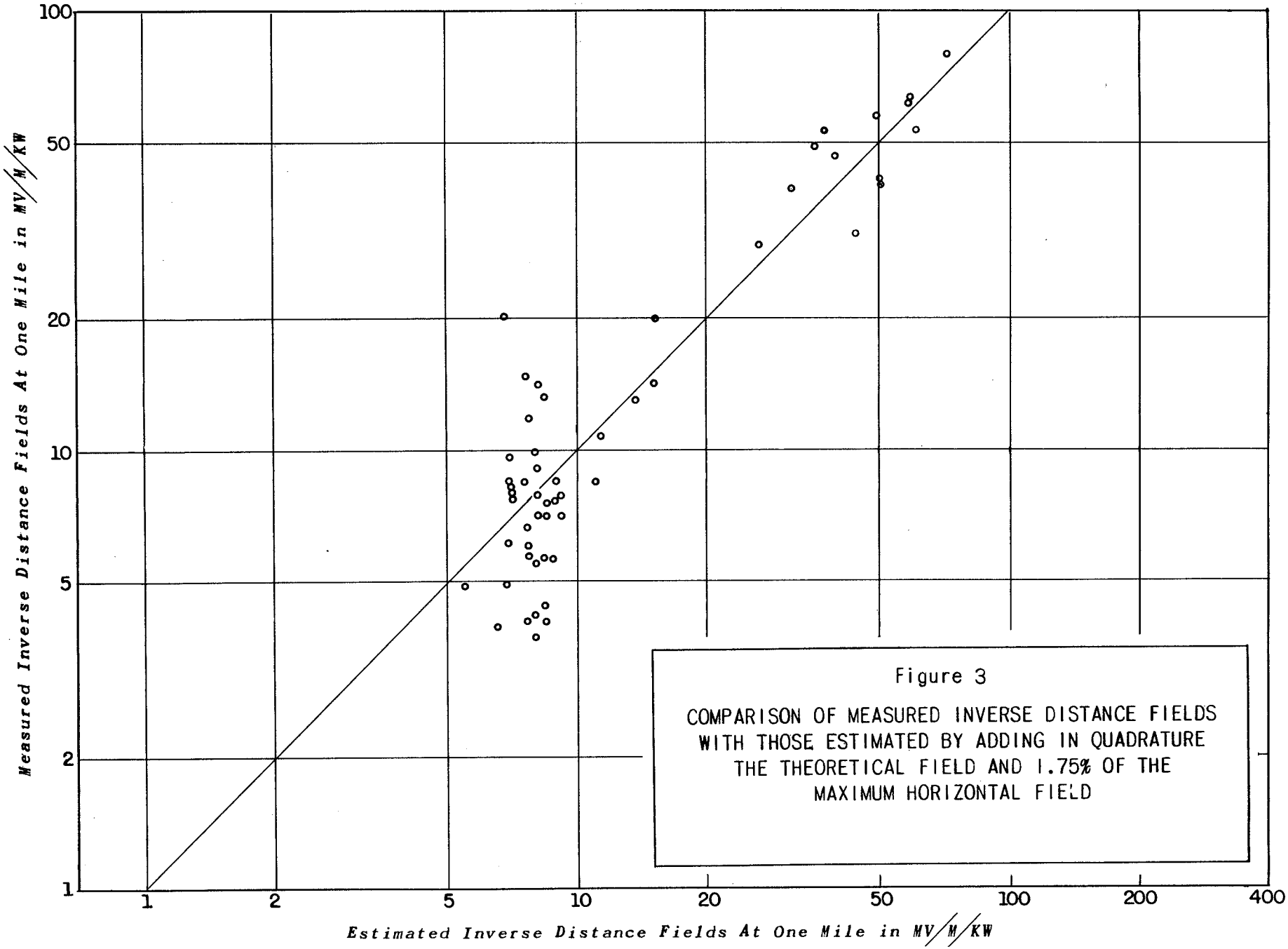
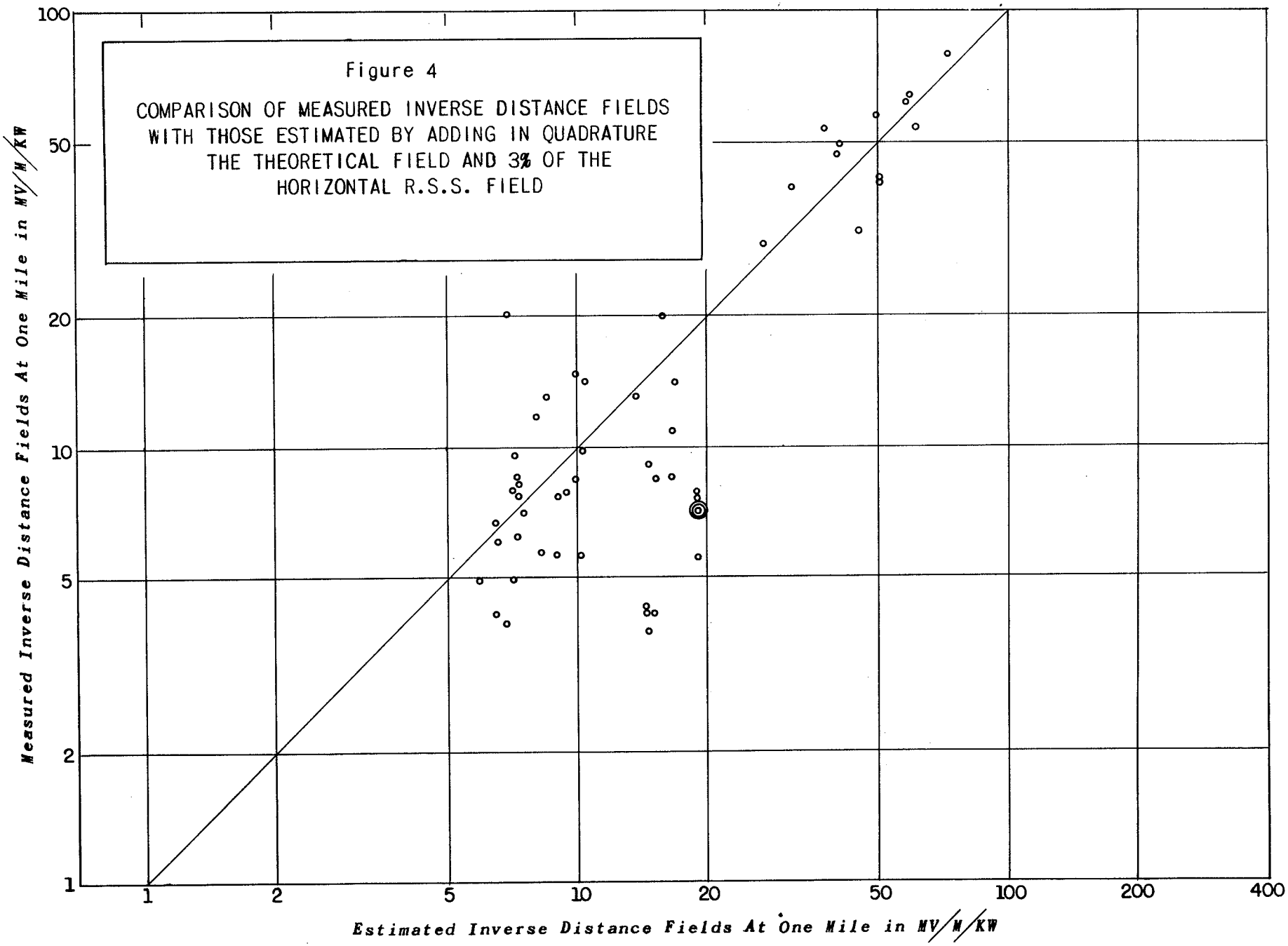
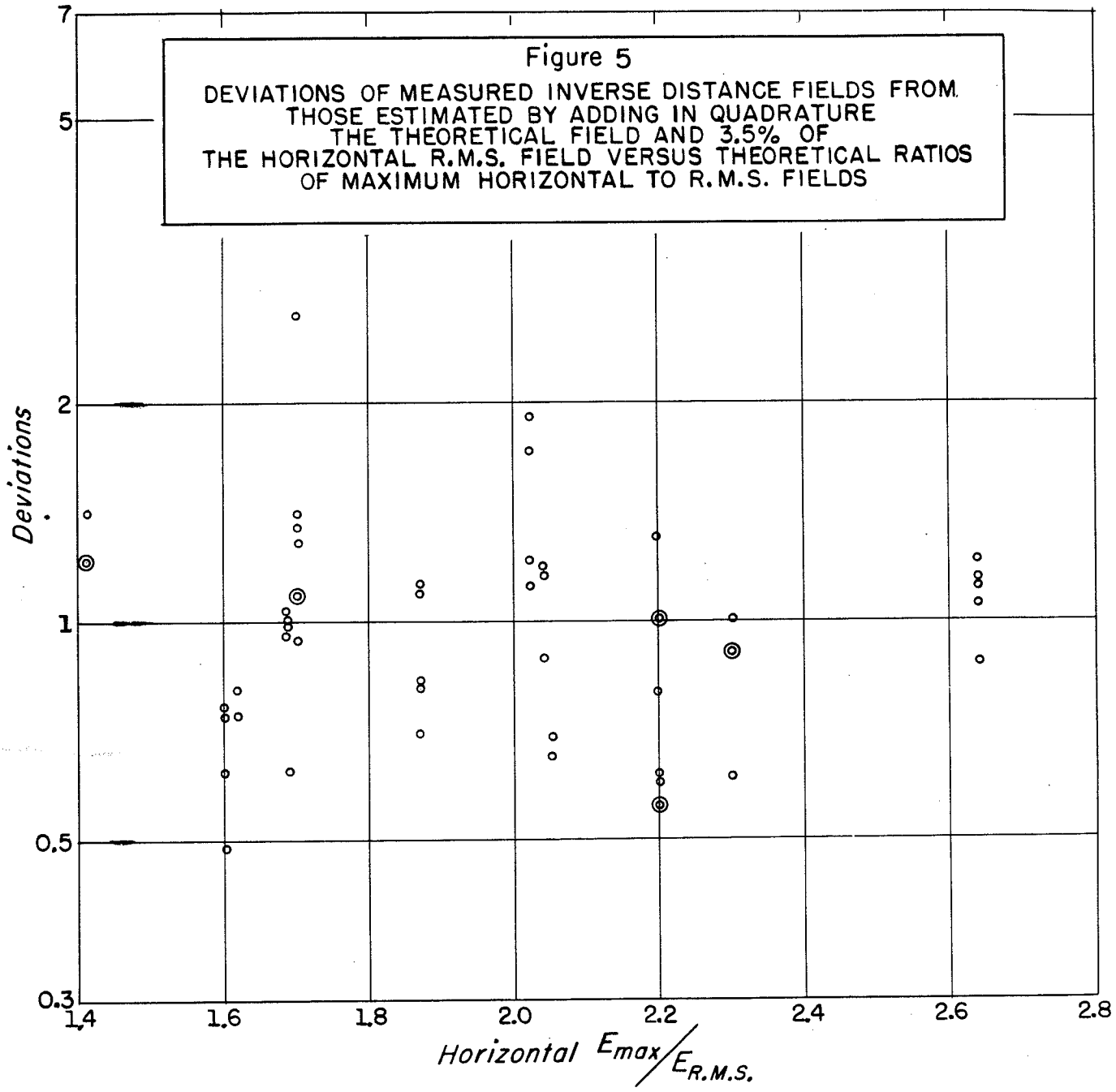
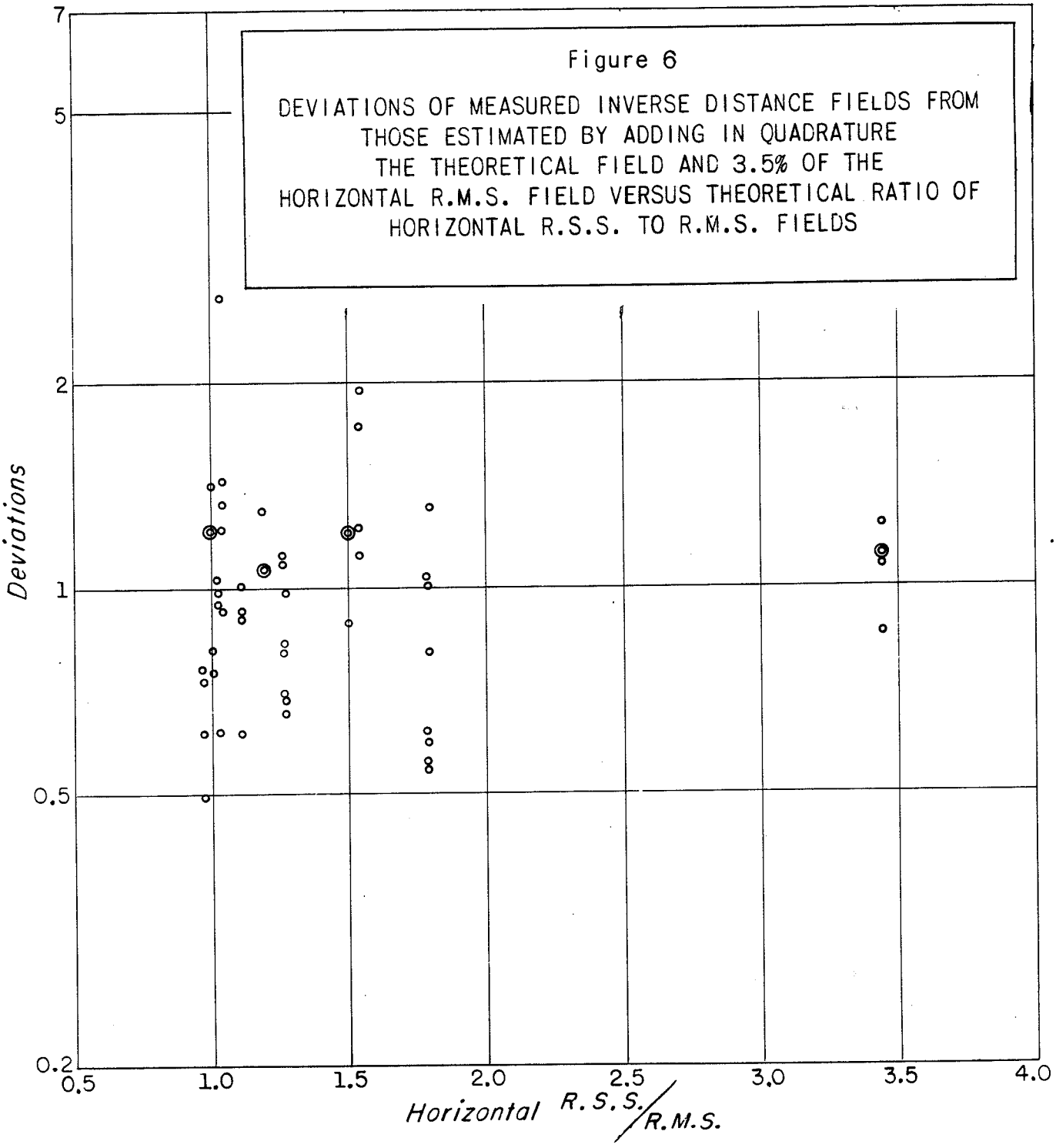


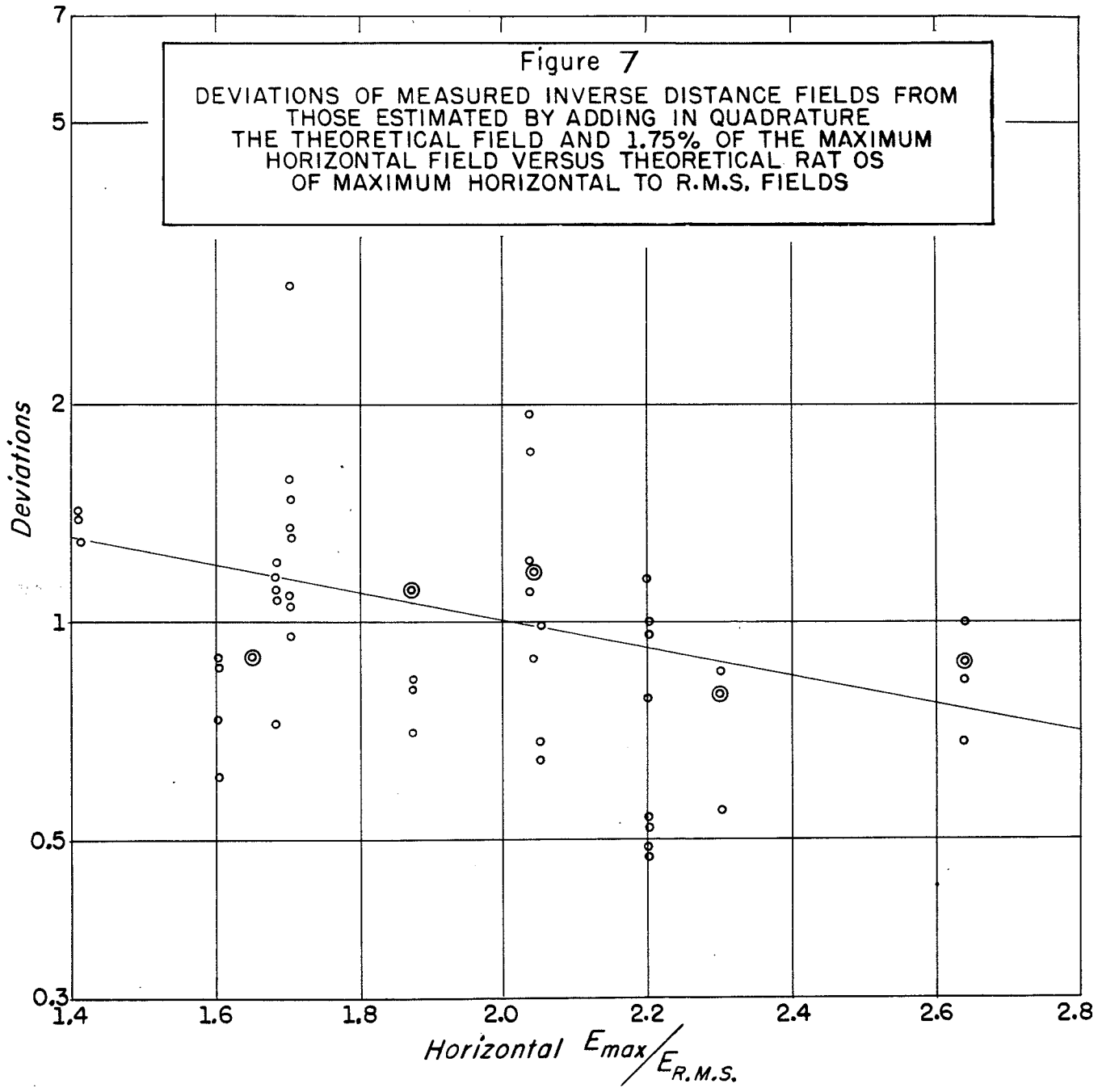
Figure 3

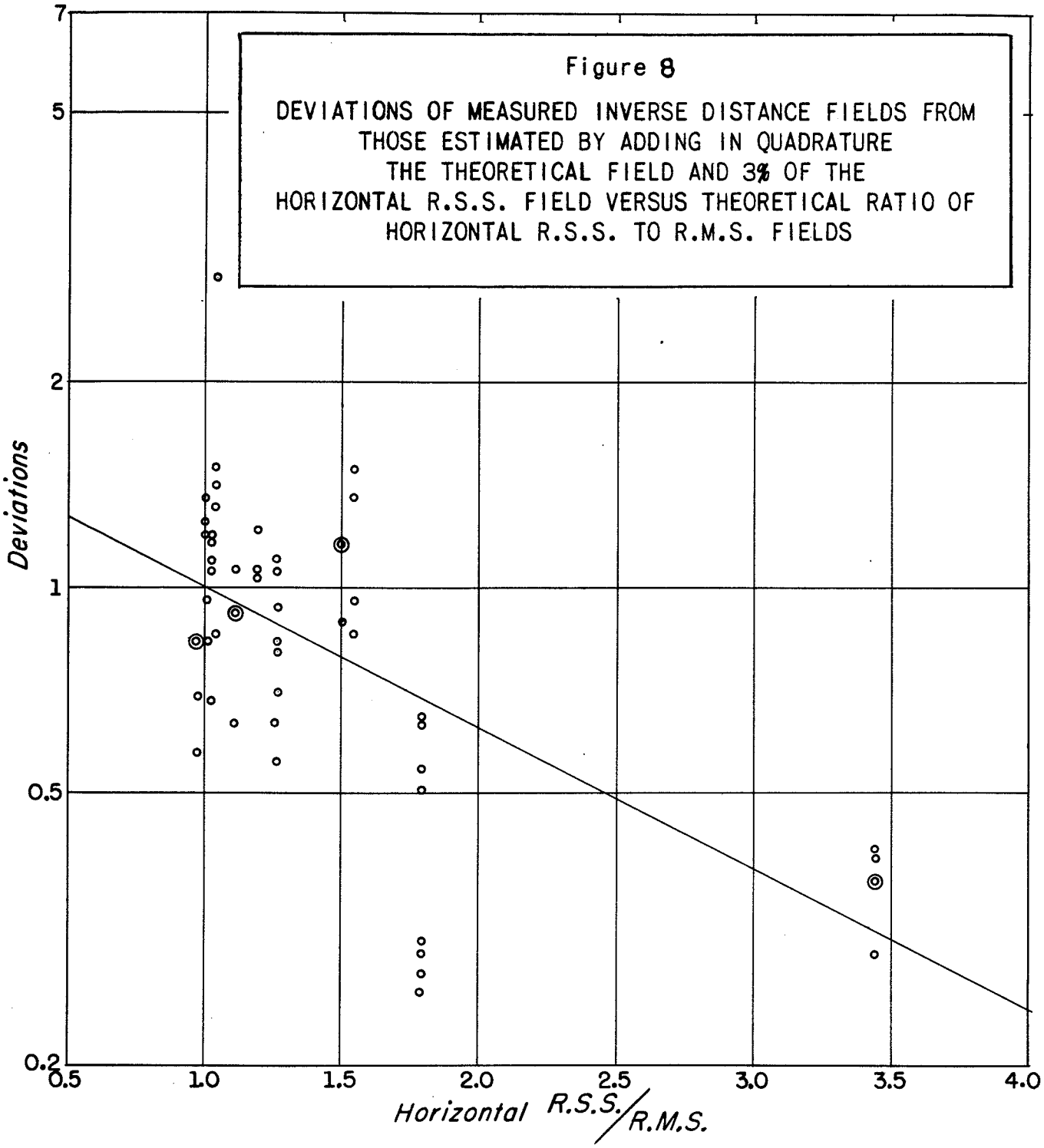
COMPARISON OF MEASURED INVERSE DISTANCE FIELDS WITH THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 1.75% OF THE MAXIMUM HORIZONTAL FIELD

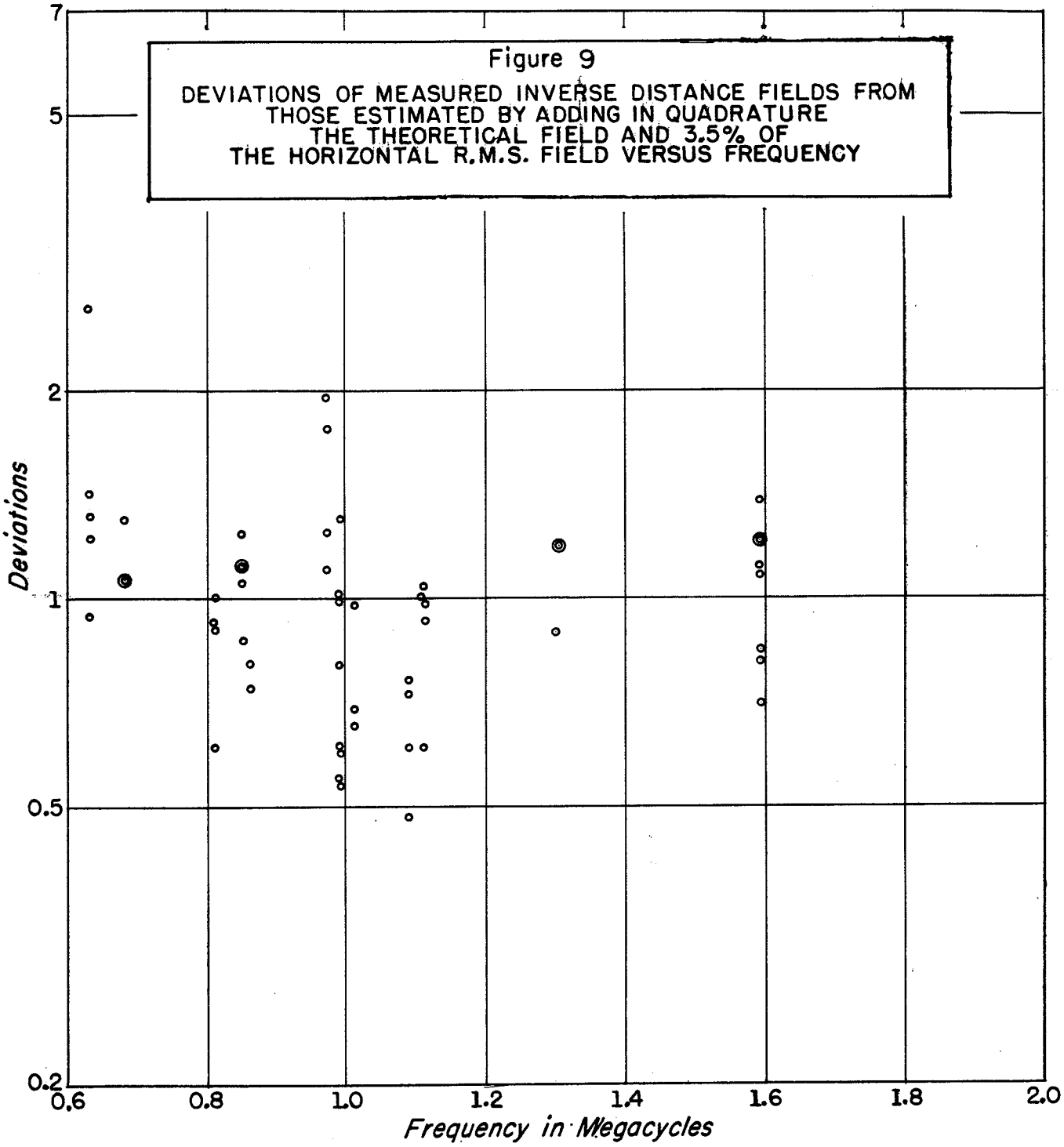

Figure 4
COMPARISON OF MEASURED INVERSE DISTANCE FIELDS WITH THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3% OF THE HORIZONTAL R.S.S. FIELD
Measured Inverse Distance Fields At One Mile in MV/M/KW
Estimated Inverse Distance Fields At One Mile in MV/M/KW
100
50
20
10
5
2
1
1
2
5
10
20
50
100
200
400


Figure 5
DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3.5% OF THE HORIZONTAL R.M.S. FIELD VERSUS THEORETICAL RATIOS OF MAXIMUM HORIZONTAL TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.3
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
Horizontal $E_{max}/E_{R.M.S.}$


Figure 6
DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3.5% OF THE HORIZONTAL R.M.S. FIELD VERSUS THEORETICAL RATIO OF HORIZONTAL R.S.S. TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.2
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Horizontal R.S.S./R.M.S.


Figure 7
DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 1.75% OF THE MAXIMUM HORIZONTAL FIELD VERSUS THEORETICAL RAT OS OF MAXIMUM HORIZONTAL TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.3
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
Horizontal $E_{max}/E_{R.M.S.}$


Figure 8
DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3% OF THE HORIZONTAL R.S.S. FIELD VERSUS THEORETICAL RATIO OF HORIZONTAL R.S.S. TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.2
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Horizontal R.S.S./R.M.S.


Figure 9
DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 3.5% OF THE HORIZONTAL R.M.S. FIELD VERSUS FREQUENCY
Deviations
7
5
2
1
0.5
0.2
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Frequency in Megacycles

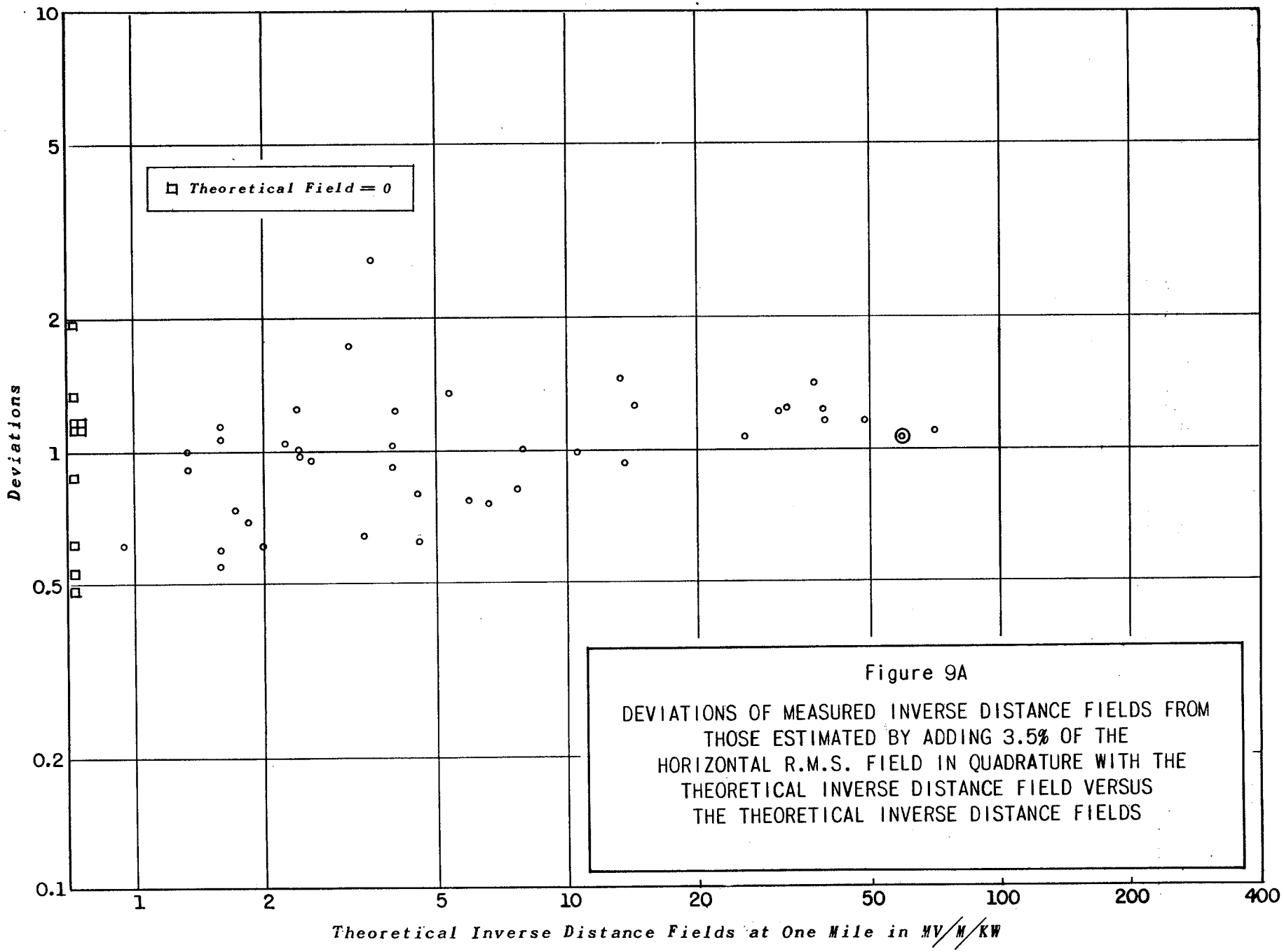


Figure 9A

DEVIATIONS OF MEASURED INVERSE DISTANCE FIELDS FROM THOSE ESTIMATED BY ADDING 3.5% OF THE HORIZONTAL R.M.S. FIELD IN QUADRATURE WITH THE THEORETICAL INVERSE DISTANCE FIELD VERSUS THE THEORETICAL INVERSE DISTANCE FIELDS

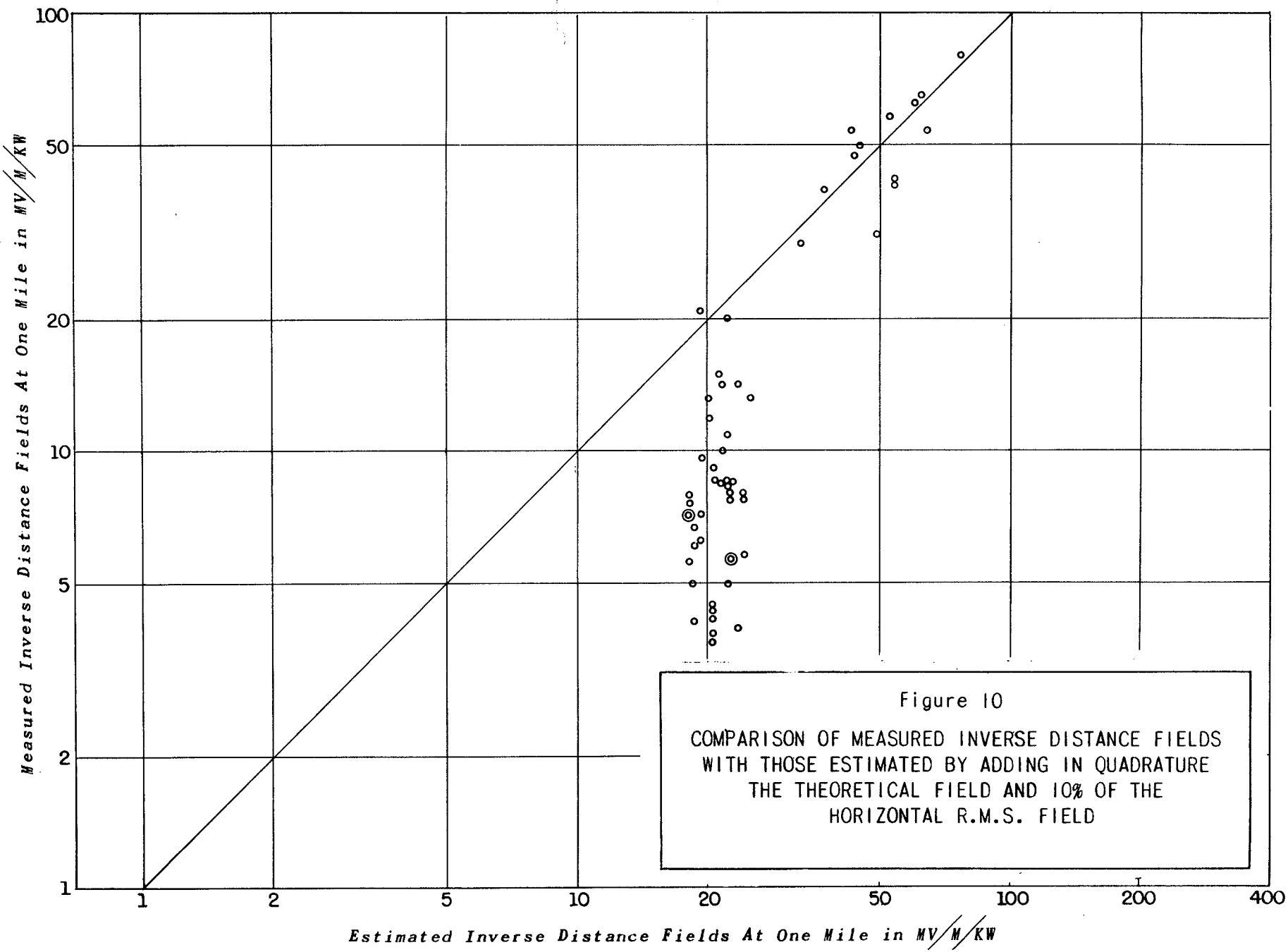


Figure 10

COMPARISON OF MEASURED INVERSE DISTANCE FIELDS WITH THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 10% OF THE HORIZONTAL R.M.S. FIELD

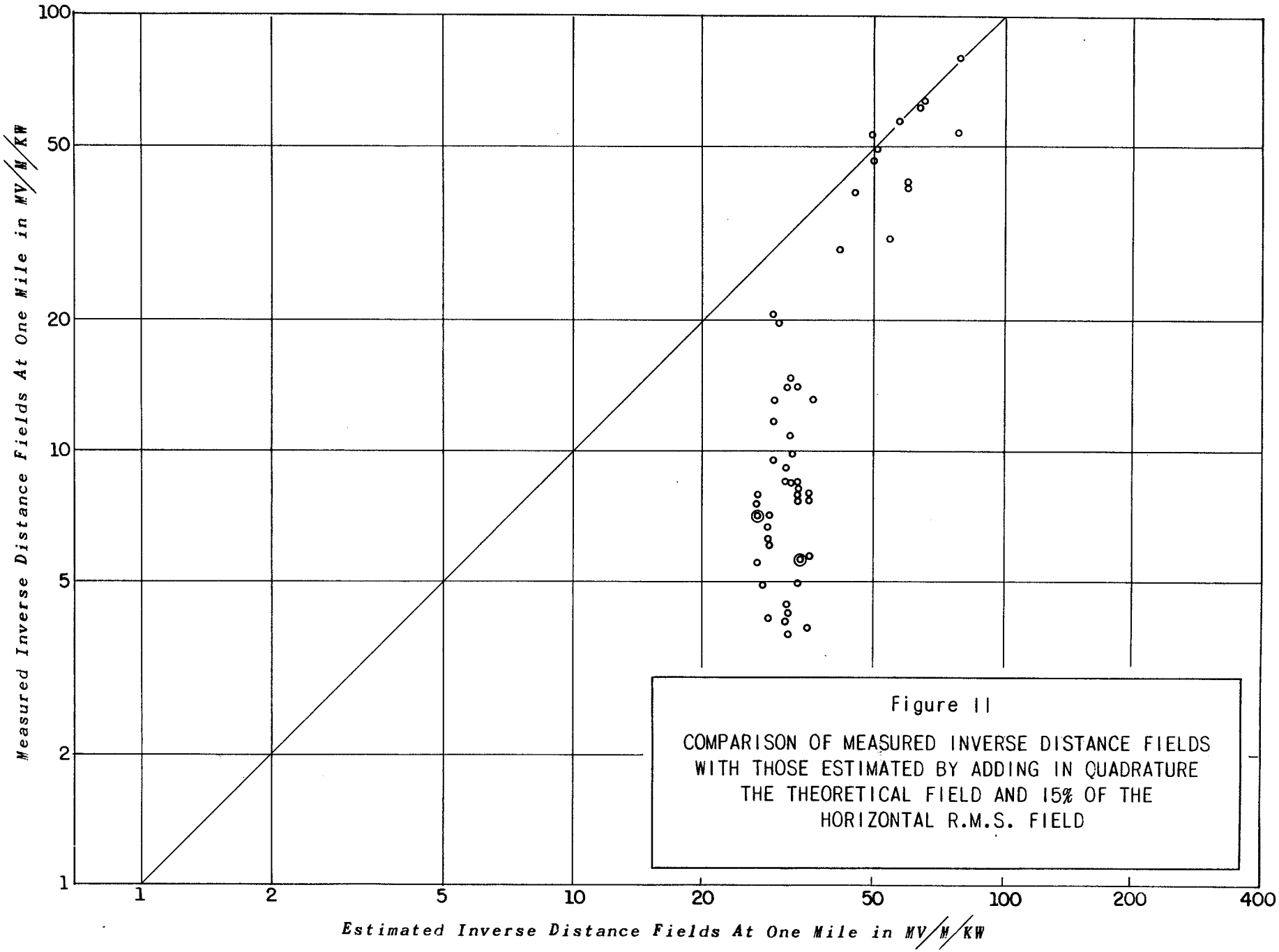
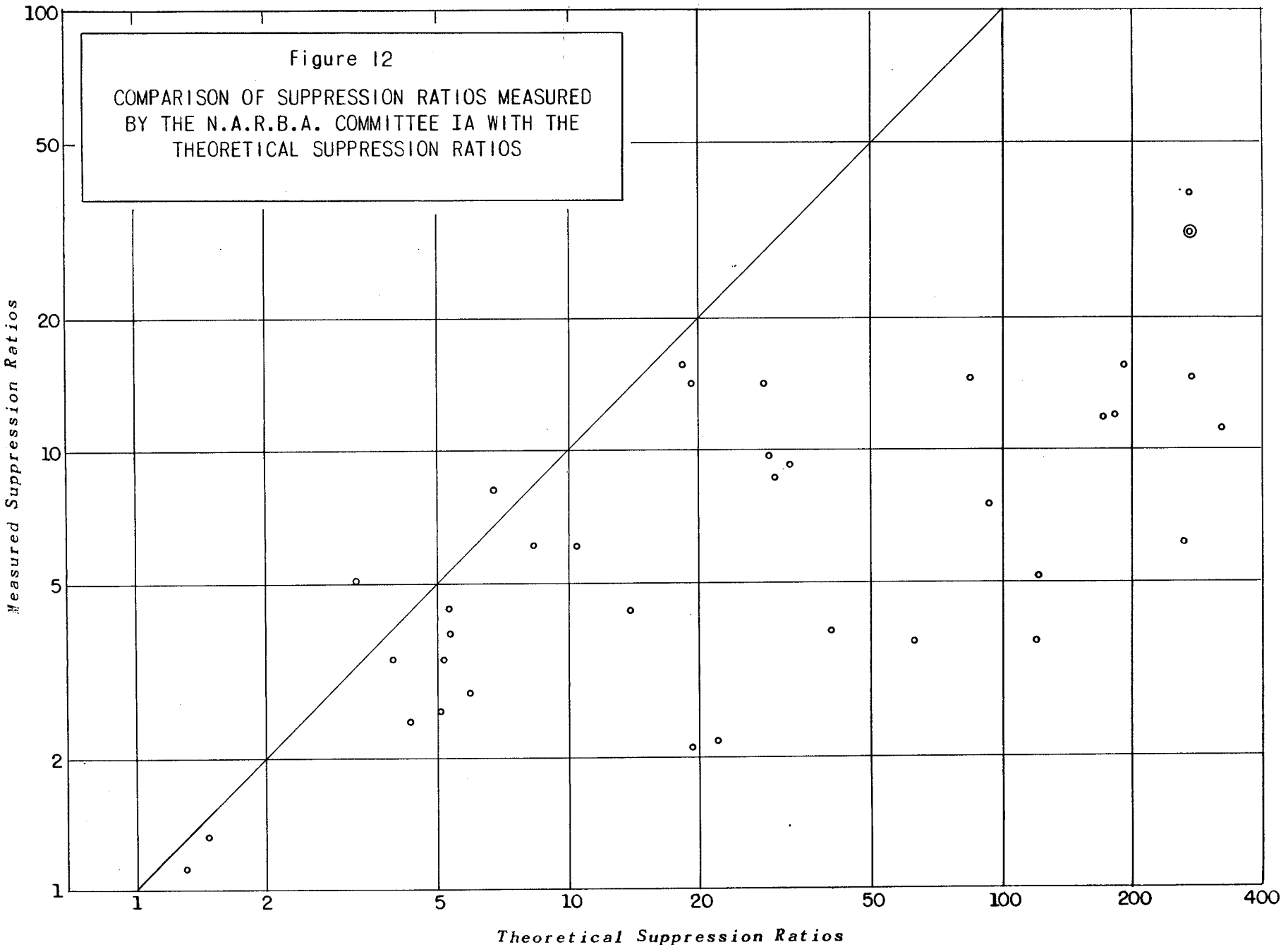


Figure 11

COMPARISON OF MEASURED INVERSE DISTANCE FIELDS WITH THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AND 15% OF THE HORIZONTAL R.M.S. FIELD


Figure 12
COMPARISON OF SUPPRESSION RATIOS MEASURED BY THE N.A.R.B.A. COMMITTEE IA WITH THE THEORETICAL SUPPRESSION RATIOS
Measured Suppression Ratios
100
50
20
10
5
2
1
Theoretical Suppression Ratios
1
2
5
10
20
50
100
200
400

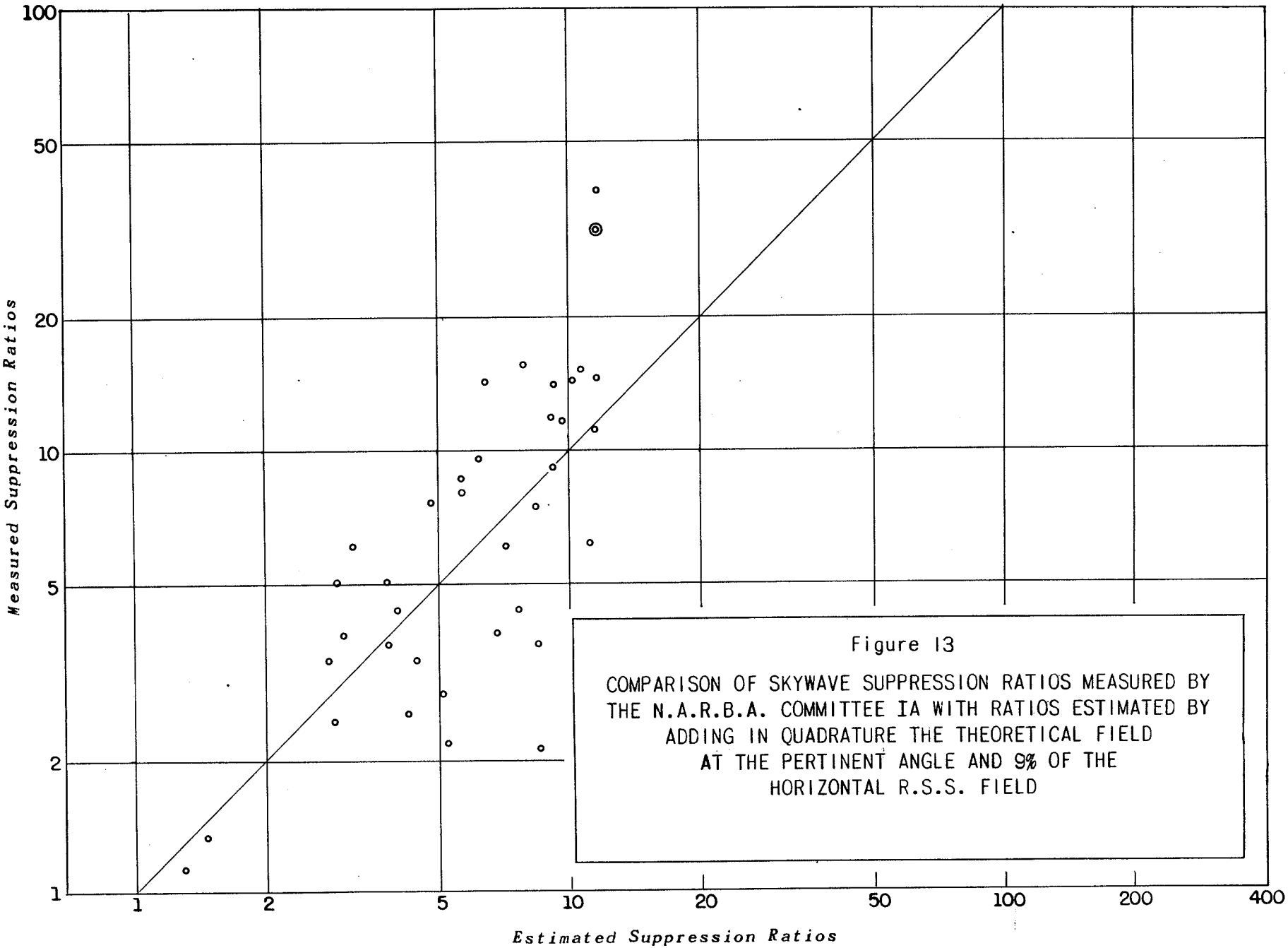


Figure 13

COMPARISON OF SKYWAVE SUPPRESSION RATIOS MEASURED BY THE N.A.R.B.A. COMMITTEE IA WITH RATIOS ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 9% OF THE HORIZONTAL R.S.S. FIELD

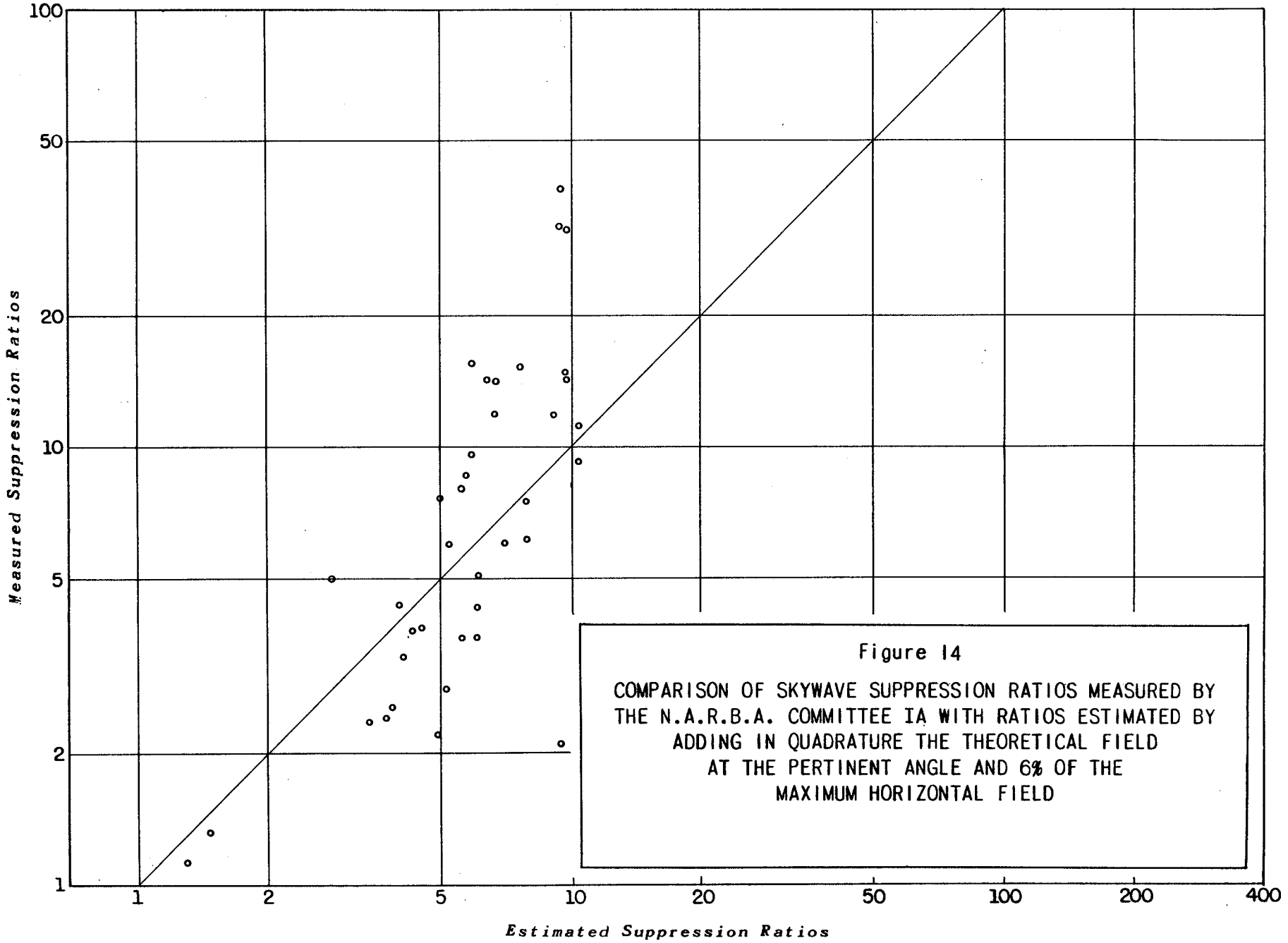


Figure 14

COMPARISON OF SKYWAVE SUPPRESSION RATIOS MEASURED BY THE N.A.R.B.A. COMMITTEE IA WITH RATIOS ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 6% OF THE MAXIMUM HORIZONTAL FIELD

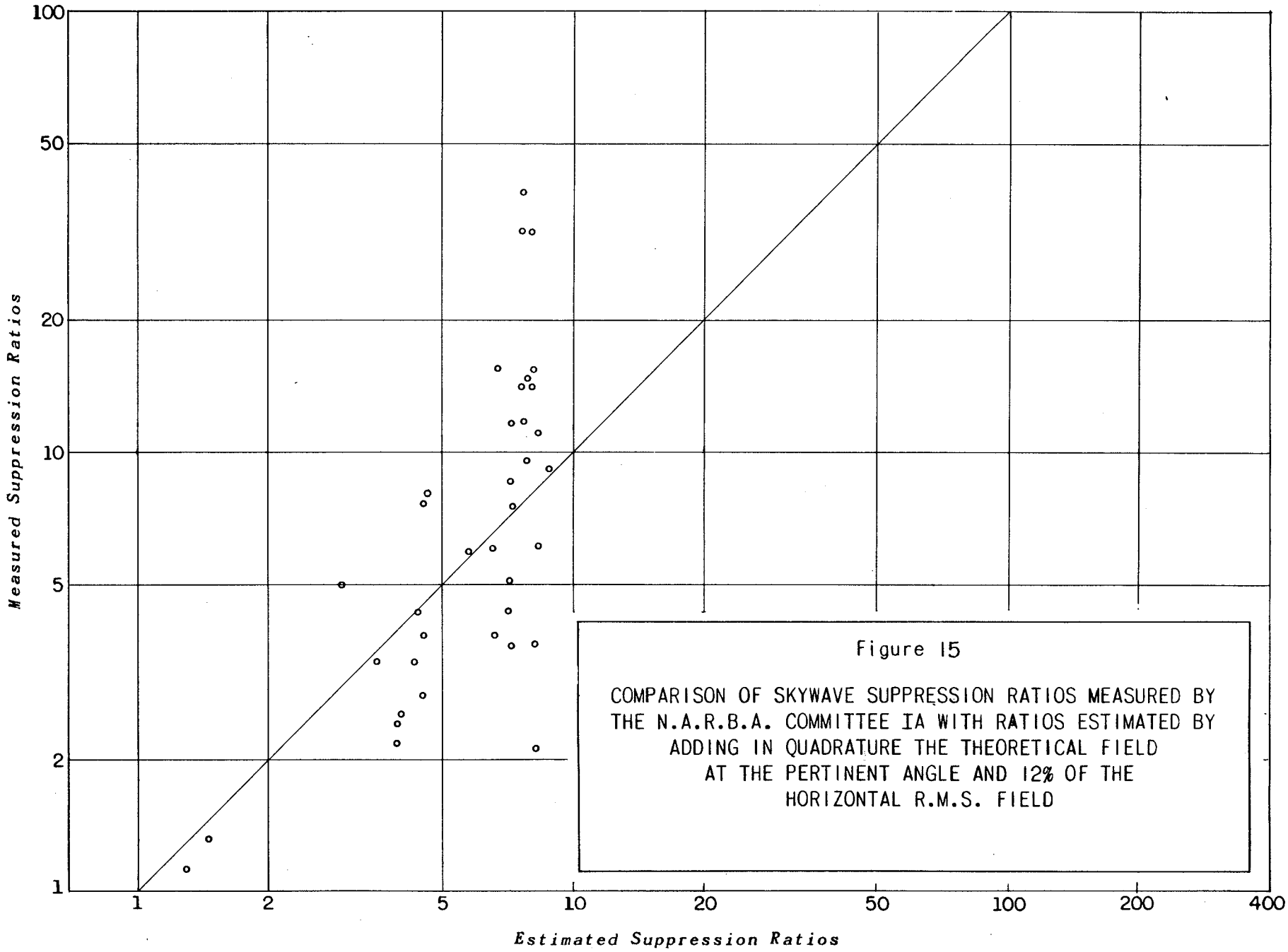
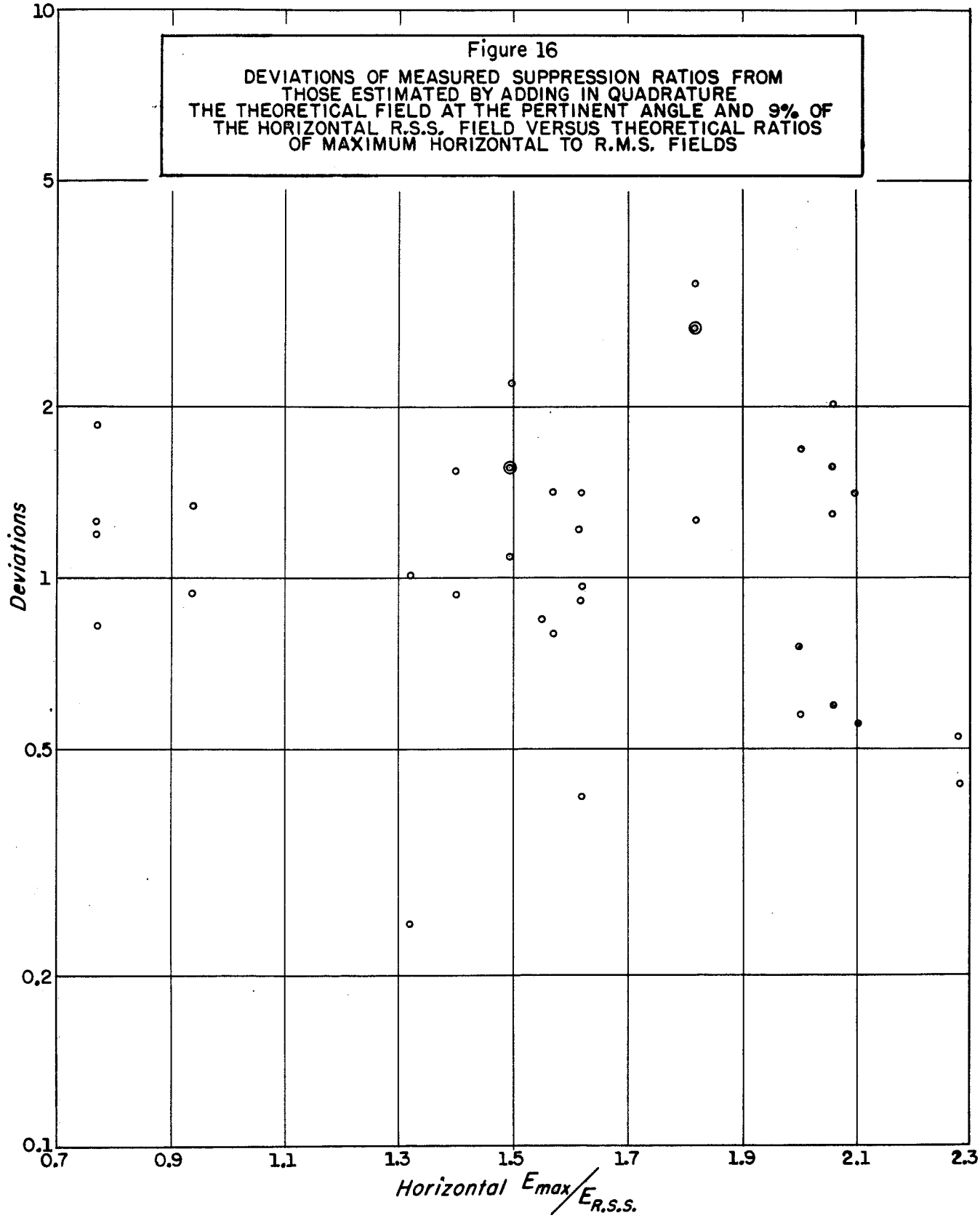


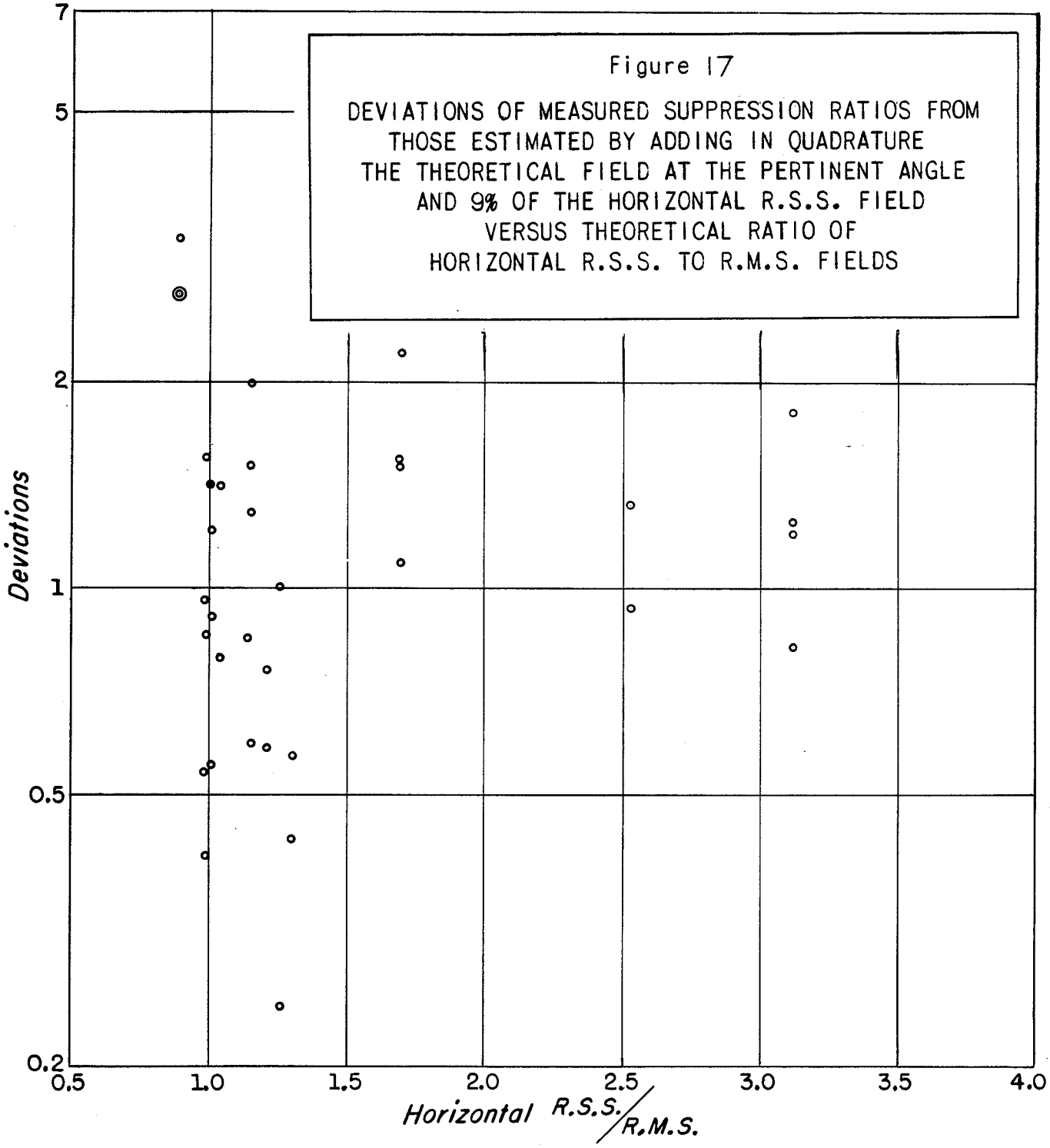
Figure 15

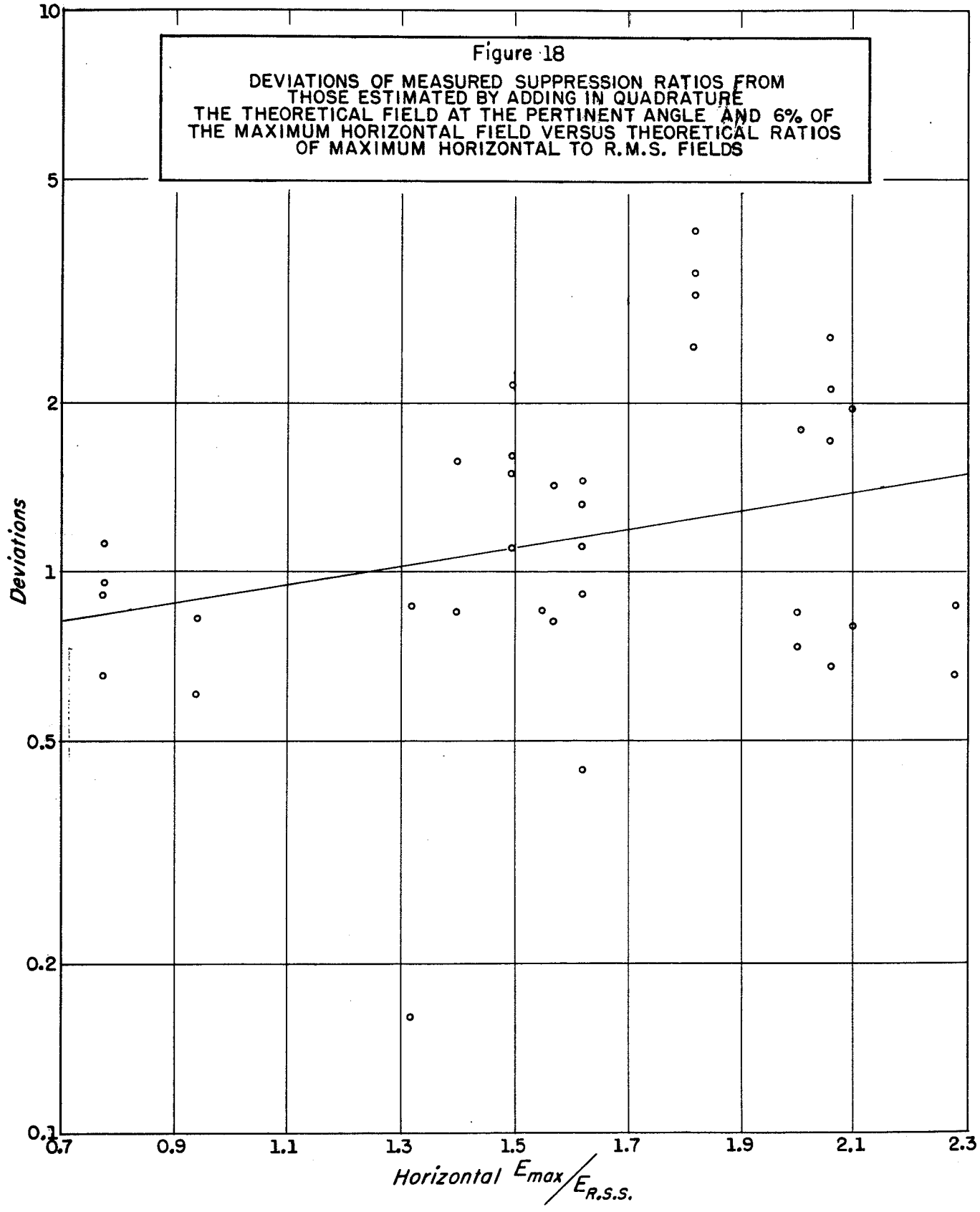
COMPARISON OF SKYWAVE SUPPRESSION RATIOS MEASURED BY THE N.A.R.B.A. COMMITTEE IA WITH RATIOS ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 12% OF THE HORIZONTAL R.M.S. FIELD

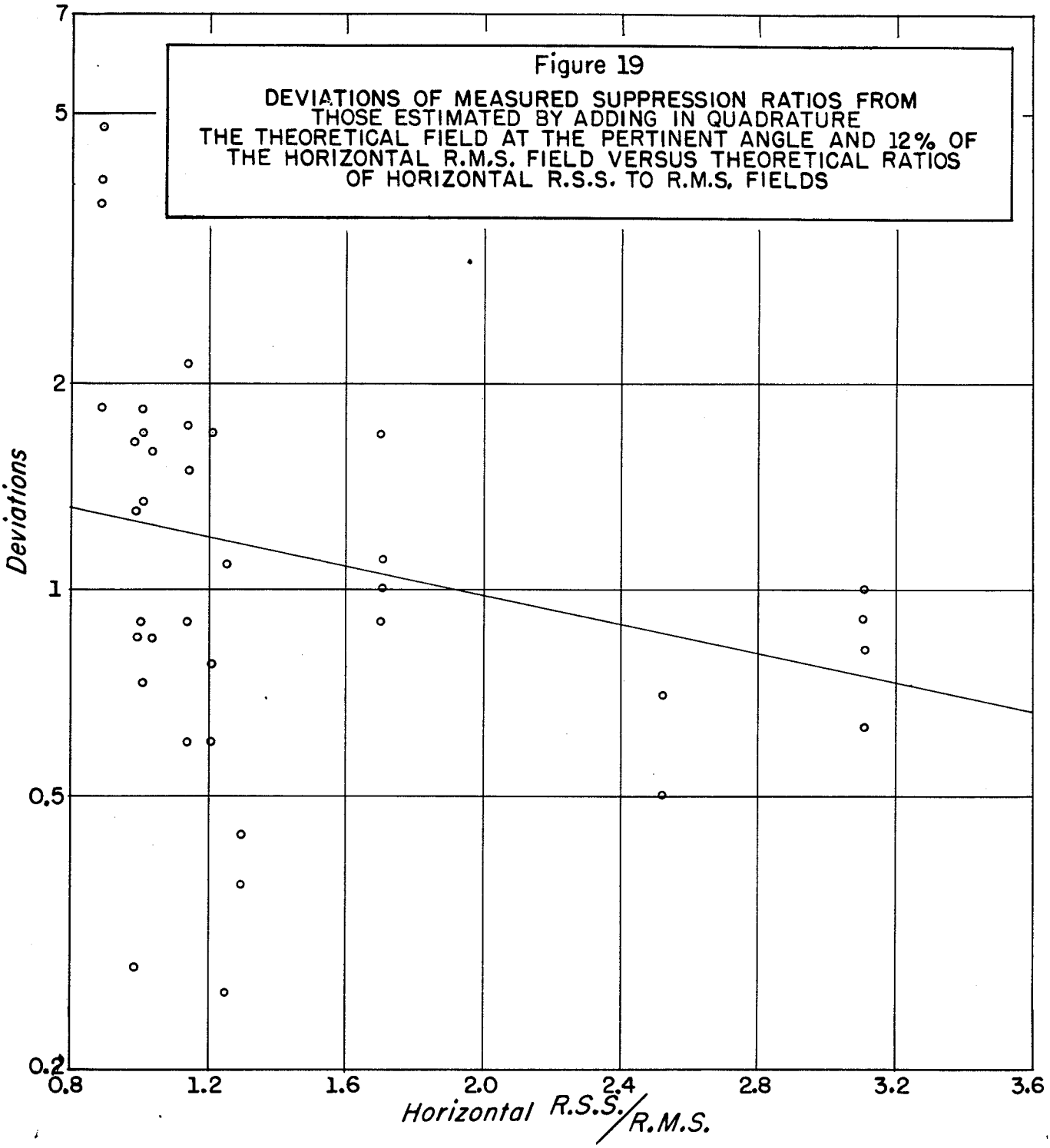
Figure 16

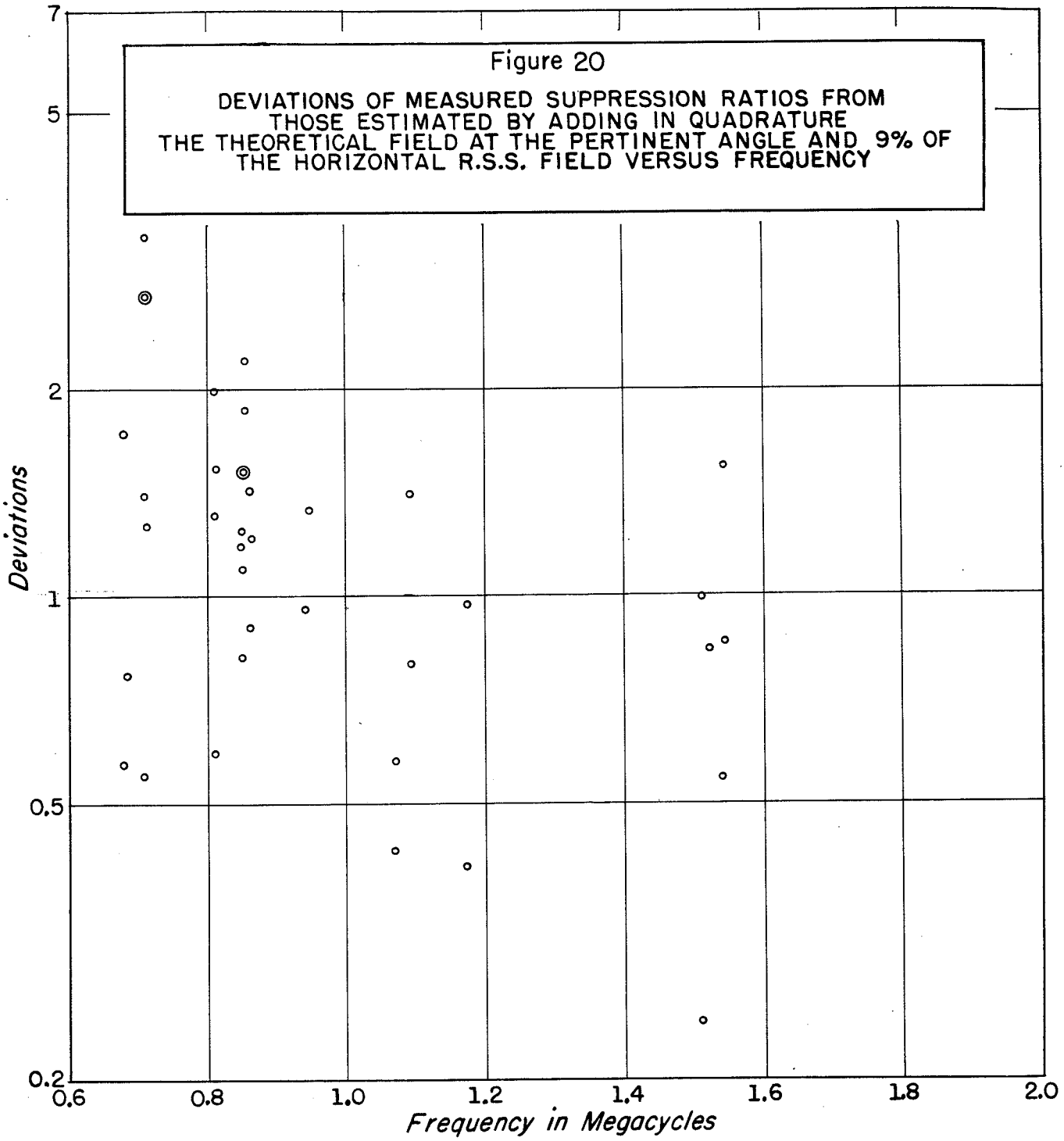
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 9% OF THE HORIZONTAL R.S.S. FIELD VERSUS THEORETICAL RATIOS OF MAXIMUM HORIZONTAL TO R.M.S. FIELDS

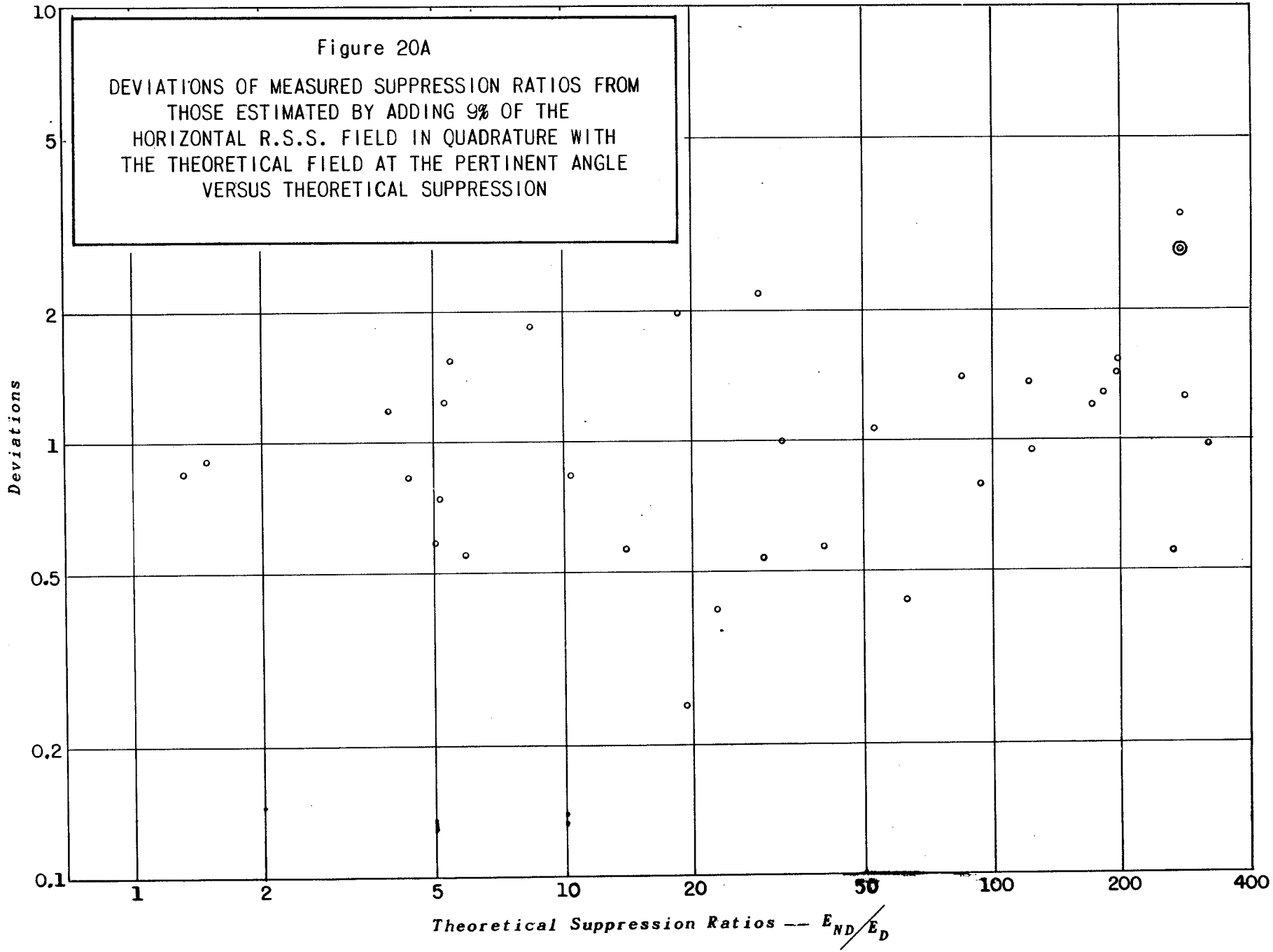


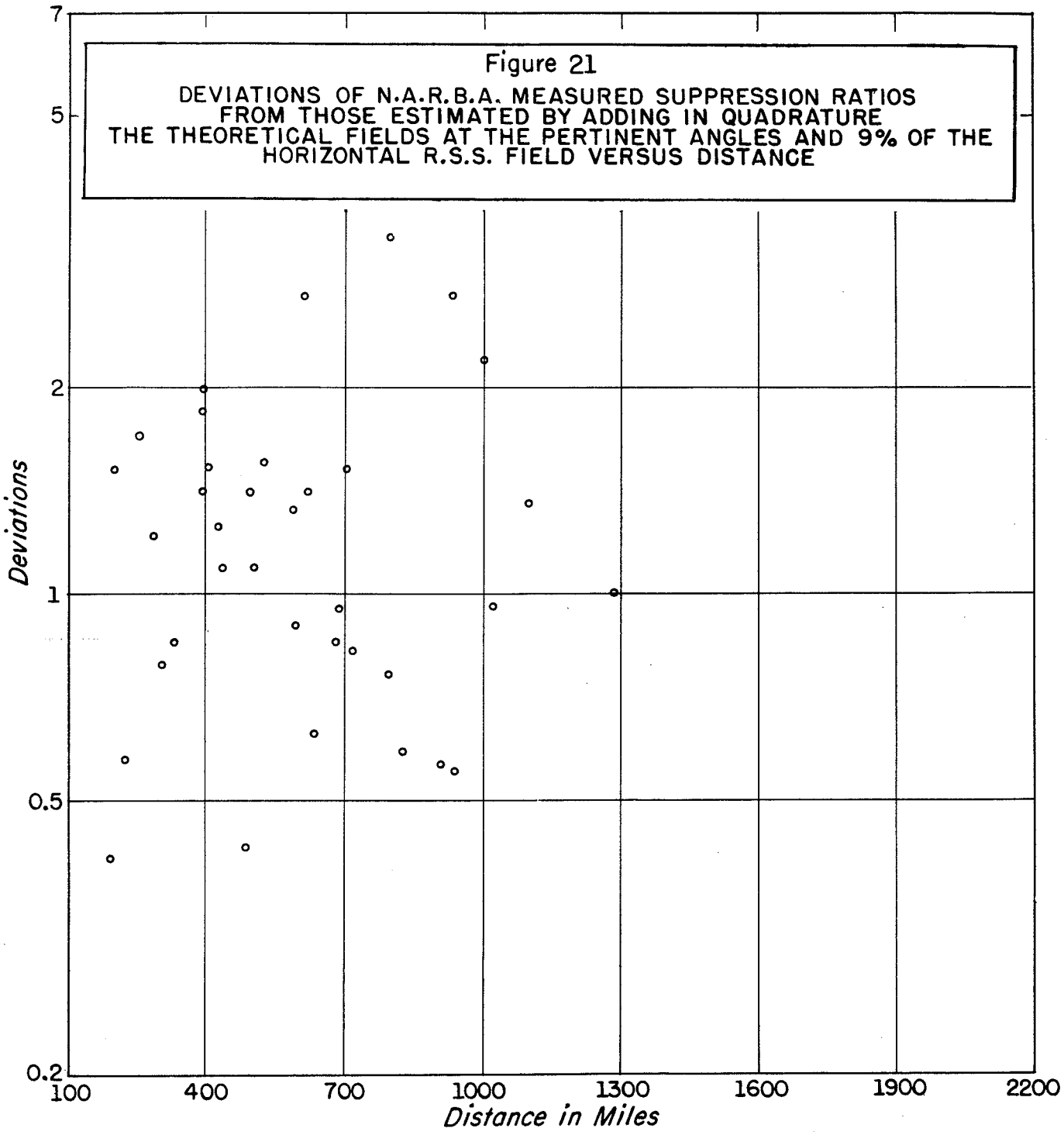

Figure 17
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 9% OF THE HORIZONTAL R.S.S. FIELD VERSUS THEORETICAL RATIO OF HORIZONTAL R.S.S. TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.2
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Horizontal R.S.S./R.M.S.


Figure 18
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 6% OF THE MAXIMUM HORIZONTAL FIELD VERSUS THEORETICAL RATIOS OF MAXIMUM HORIZONTAL TO R.M.S. FIELDS
Deviations
10
5
2
1
0.5
0.2
0.1
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
Horizontal $E_{max}/E_{R.S.S.}$


Figure 19
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 12% OF THE HORIZONTAL R.M.S. FIELD VERSUS THEORETICAL RATIOS OF HORIZONTAL R.S.S. TO R.M.S. FIELDS
Deviations
7
5
2
1
0.5
0.2
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
Horizontal R.S.S./R.M.S.


Figure 20
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 9% OF THE HORIZONTAL R.S.S. FIELD VERSUS FREQUENCY
Deviations
7
5
2
1
0.5
0.2
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Frequency in Megacycles


Figure 20A
DEVIATIONS OF MEASURED SUPPRESSION RATIOS FROM THOSE ESTIMATED BY ADDING 9% OF THE HORIZONTAL R.S.S. FIELD IN QUADRATURE WITH THE THEORETICAL FIELD AT THE PERTINENT ANGLE VERSUS THEORETICAL SUPPRESSION
Deviations
10
5
2
1
0.5
0.2
0.1
1
2
5
10
20
50
100
200
400
Theoretical Suppression Ratios — E_{ND}/E_D


Figure 21
DEVIATIONS OF N.A.R.B.A. MEASURED SUPPRESSION RATIOS
FROM THOSE ESTIMATED BY ADDING IN QUADRATURE
THE THEORETICAL FIELDS AT THE PERTINENT ANGLES AND 9% OF THE
HORIZONTAL R.S.S. FIELD VERSUS DISTANCE
7
5
2
1
0.5
0.2
Deviations
100
400
700
1000
1300
1600
1900
2200
Distance in Miles

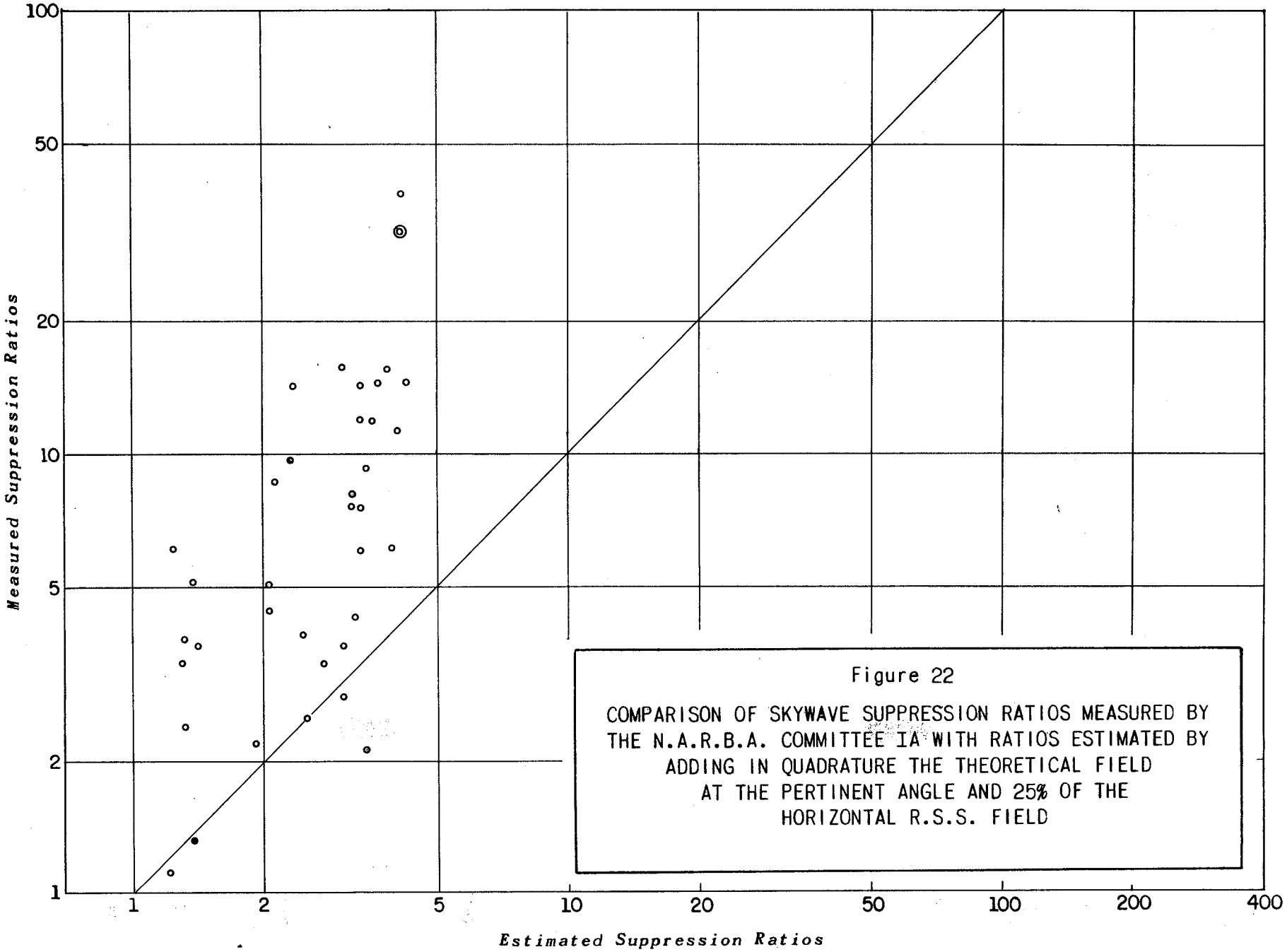


Figure 22

COMPARISON OF SKYWAVE SUPPRESSION RATIOS MEASURED BY THE N.A.R.B.A. COMMITTEE IA WITH RATIOS ESTIMATED BY ADDING IN QUADRATURE THE THEORETICAL FIELD AT THE PERTINENT ANGLE AND 25% OF THE HORIZONTAL R.S.S. FIELD

AM 24.

I 9e.

MAR 14 1988

Radiotechniques

402 TENTH AVENUE • HADDON HEIGHTS, NJ 08035

(609) 546-8008

March 8, 1988

Mr. Ron Rackley, President
Association of Federal Communications Consulting Engineers
DuTriel, Lundin and Rackley
1019 19th Street NW
Suite 300
Washington, DC 20036

DON: F.Y.I.
This was presented to the MARCH 16, 88 EX COMM meeting.
4/9/88 Marvin
WOULD LIKE TO DISCUSS 4/17/88

Dear Ron:

I am writing this to request describe a proposed improvement to directional AM antenna systems with negative resistance operating impedances for one or more towers to the AFCCE executive committee, and potentially to the membership at the March 16th meeting.

WFIL is an AM broadcast station operating on 560 kHz with 5,000 Watts, DA-2. The station licensee is undertaking changes to the station directive antenna system authorized under a construction permit BP-870608AH. The physical antenna construction and installation of equipment is nearly complete, and the station antennas are in substantial adjustment, as determined by field measurements.

One tower of the daytime antenna system returns a substantial amount of power to the array, and has a substantial negative operating impedance. During construction, and initial tuning of the antenna system, this tower was merely terminated in its predicted conjugate impedance, consisting of a load resistor, and reactance in series. When the tower was connected to the phasor, parameters re-established, and transmission lines matched a serious decrease in apparent fidelity was noted relative to the conditions when the negative tower was merely terminated.

Motorola stereo performance was marginal for the day pattern with the antenna return power re-entrant in the system, and uncompensated common point impedance slope was poor. Further studies show that the pattern shape shifts dramatically with frequency.

WFIL has motor driven components installed at the antenna coupler of the negative tower, with the controls remotely located on the front of the phasor cabinet. A 50 Ohm load resistor was installed in the place of the line, and the line was disconnected from the power divider at the phasor, effectively disabling the negative tower tap of the power divider. The common point impedance was reset to the desired value, and the negative tower was trimmed to correct the 2 degree shift making the on carrier parameters identical. The uncorrected common point impedance

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402 TENTH AVENUE • HADDON HEIGHTS, NJ 08035

AFCCE

March 8, 1988

slope improved by 2:1, and the pattern shape shifts improved very significantly.

The licensee wishes to request permanent authorization to permit terminating the negative tower in a passive load, and increase transmitter power to compensate for the power dissipated in the load. I would like to propose that the Association support this request before the FCC because it will improve the performance of at least some AM stations by a significant amount, with no negative impacts, save a slightly higher electric bill for the station.

I would appreciate it if you could arrange to have this item entered as an agenda item for the March meeting. Time is of the essence for the station, as we need to file the 301 in a timely manner, and the licensee would like to present this to the Commission with the Association aware of the proposal, and possibly supporting it.

Sincerely,

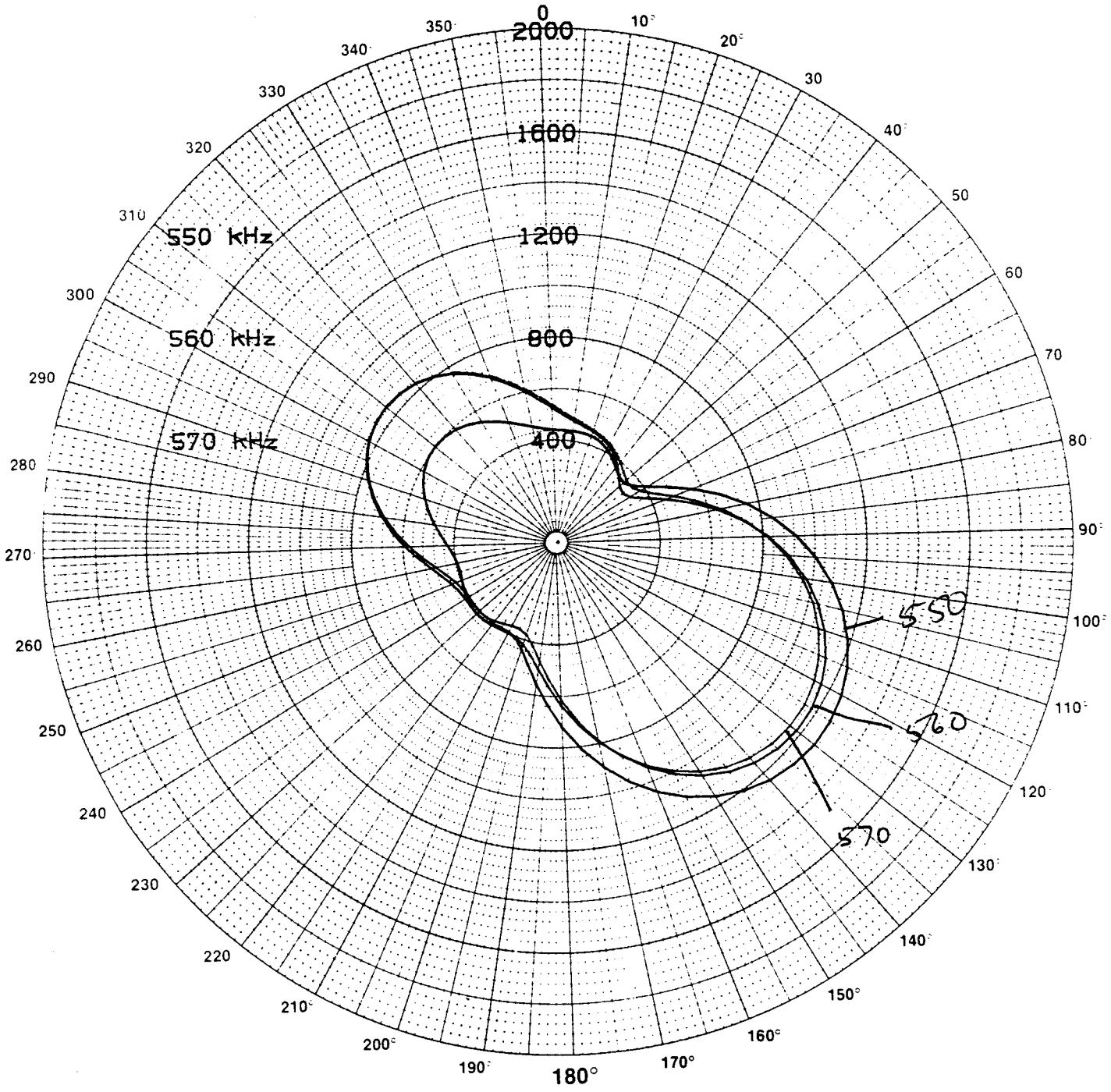
Ted Schober

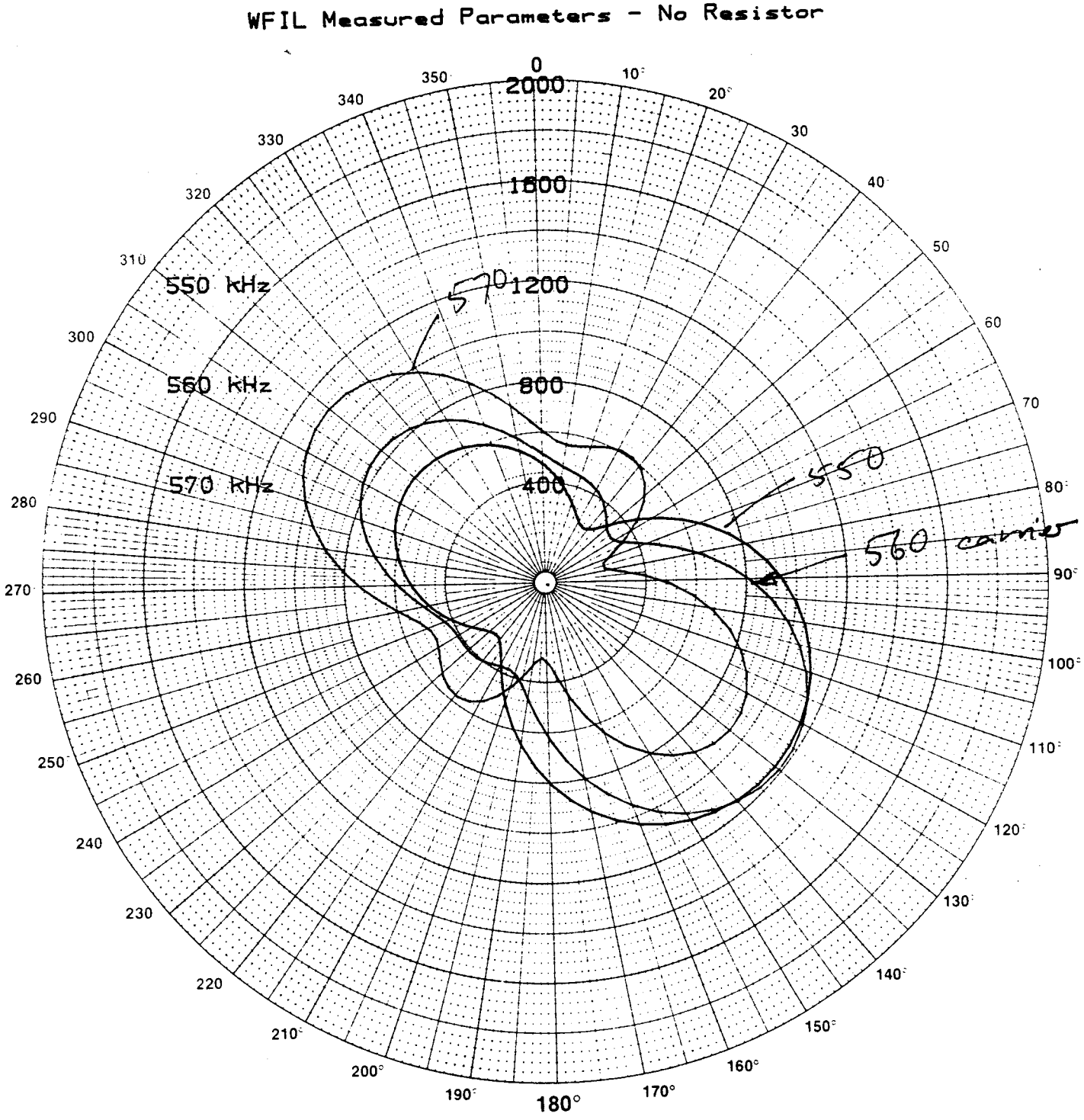
Edward A. Schober, PE
Member

encl. Plot of theoretical pattern utilizing measured antenna parameters vs frequency with, and without load resistor.

cc: Russ Mundschenck - Chief Engineer WFIL

WFIL Measured Parameters - With Resistor




WFIL Measured Parameters - No Resistor
0
10°
20°
30
40
50
60
70
80
90°
100°
110°
120
130
140°
150°
160°
170°
180°
190°
200°
210°
220
230
240
250
260
270
280
290
300
310
320
330
340
350
2000
1600
1200
800
400
550 kHz
560 kHz
570 kHz
570
550
560 carrier

AM 25
3/88

ENGINEERING CONSIDERATIONS:

___ Complies with all engineering rules

___ There are no engineering objections, petitions or requests for waiver associated with this case.

ADDITIONAL COMMENTS:

OMNIDIRECTIONAL ANTENNA SYSTEM:

Coordinates: o ' " North; o ' " West.

Omnidirectional Antenna System described as:

Type of Tower:

Overall Height in Feet: ___ Height of Radiator: __Feet, ___ Wavelength

_____Buried Copper Wire Radials ____Feet.

Ground Screen:_____Feet by _____ Feet.

Type of Excitation: _____

Estimated Radiation Per One Kilowatt per one kM _____ mV/m

DIRECTIONAL ANTENNA SYSTEM

CALL: _____ FREQUENCY: _____

FILE NO: _____ POWER: _____

COORDINATES: _____ ' _____ " NORTH _____ ' ____ " WEST

1. **DESCRIPTION OF DIRECTIONAL ANTENNA SYSTEM:**

No. and Type of Elements: _____

_____

_____

_____

Height Above Insulators: _____

Overall Height: _____

Spacing and Orientation: _____

_____

_____

_____

Ground system: _____

_____

_____

_____

Nondirectional Antenna: _____

2. **THEORETICAL SPECIFICATIONS:**

PHASING	TOWER	
	NIGHT:	_____
	DAY :	_____
FIELD RATIO	NIGHT:	_____
	DAY :	_____

The inverse distance field strength at a distance of one kilometer from the above antenna in the directions specified shall not exceed the following values:

Azimuth	Radiation

THE AUTHORITY GRANTED IS SUBJECT TO THE FOLLOWING CONDITIONS:

A complete nondirectional proof of performance, in addition to a complete proof on the (day) and (night) directional antenna system, shall be submitted before program tests are authorized. The nondirectional and directional field strength measurments must be made under similar environmental conditions.

A partial proof of performance on the (day) and (night) directional antenna system made in accordance with Section 73.154(a) of the Rules, shall be submitted before program tests are authorized.

Operation by remote control authorized.

If remote control authorization is desired, necessary to file complete FCC Form 301-A.

Painting and lighting of the proposed antenna tower(s) in accordance with paragraphs _____of FCC Form 715.

Antenna obstruction markings not required.

Permittee shall install a type accepted transmitter, or submit application (FCC Form 301) along with data prescribed in Section 73.1660(b) should non-type accepted transmitter be proposed.

Before program tests are authorized, permittee shall submit a complete nondirectional proof of performance to establish that the efficiency is at least _____mV/m/kW at one kilometer, as proposed. The proof shall include at least eight approximately equally-spaced radials with sufficient close-in points such that the inverse distance field can be clearly established. (See Section 73.186 FCC Rules).

The proposed antenna shall be excited with a symmetrical folded unipole feed, utilizing a minimum of three folds.

A request must be submitted in accordance with Section 73.99 of the Rules if a Pre-Sunrise (PSRA) and/or a Post-Sunset Authorization (PSSA) is desired using the facilities specified in this authorization.

The license application to cover this authorization may refer to and rely upon the technical data contained in the engineering report filed _____to establish that the array is adjusted to within the pattern authorized

herein.

Before program tests are authorized, permittee shall submit sufficient current distribution measurement data to establish clearly that the current distribution approximates that of an antenna with electrical height of _____, as proposed.

Before program tests are authorized, permittee shall submit sufficient data to establish that the inverse distance field at one kilometer is essentially _____mV/m/kW, as proposed.

This authorization is subject to the condition that the permittee shall accept overlap from grant of the proposal of_____ ( ), _____.

An antenna monitor of sufficient accuracy and repeatability, and having a minimum resolution of 0.1 degrees phase and 0.1 percent sample current ratio deviation shall be installed and continuously available to indicate the relative phase and magnitude of the sample currents of each element in the array to insure maintenance of the radiated fields within the standard pattern values of radiation.

Upon receipt of operating specifications and before issuance of a license, permittee shall submit the results of observations made daily of the base currents and their ratios, relative phases, sample currents and their ratios and sample current ratio deviations for each element of the array along with the final amplifier plate voltage and current, the common point current, and the filed strengths at each monitoring point for both the nondirectional and directional (both daytime and nighttime) operations for a period of at least thirty days, to demonstrate that the array can be maintained within the specified tolerances.

Prior to construction of the tower authorized herein, permittee shall notify AM Station _____ so that, if necessary that AM station: may determine operating power by a method described in Section 73.51(a)(1) or (d), and/or request temporary authority from the Commission in Washington, D.C. to operate with parameters at variance in order to maintain monitoring point field strengths within authorized limits. Permittee shall be responsible for installation and continued maintenance of detuning apparatus necessary to prevent adverse effects upon the radiation pattern of the AM station. Both prior to construction of the tower and subsequent to the installation of all appurtenances thereon, a partial proof of performance, as defined by Section 73.154(a) of

the Commission's Rules, shall be conducted to establish that the AM array has nsot been adversely affected and, prior to or simultaneous with the filing of the application for license to cover this permit, the results submitted to the Commission.

Prior to construction of the tower(s) authorized herein, permittee shall notify AM Station _____ so that station may determine operating power by a method described in Section 73.51(a)(1) or (d). Permittee shall be responsible for the installation and continued maintenance of detuning apparatus necessary to prevent adverse effects upon the radiation pattern of that station. Both prior to construction of the tower and subsequent to the installation of all appurtenances thereon, antenna impedance measurements of the AM station shall be made and sufficient field strength measurements, taken at a minimum of 10 locations along each of eight equally spaced radials, shall be made to establish that the radiation pattern is essentially omnidirectional. Prior to, or simultaneous with, the filing of the application for license to cover this permit, the results of the field strength measurements and the impedance measurements shall be submitted to the Commission in an application on FCC Form 302 notifying of the AM station's return to the direct method of power determination. (See Section 73.45(c), FCC Rules).

Before program tests are authorized, sufficient data shall be submitted to show that adequate filters, traps and other equipment has been installed and adjusted to prevent interaction, intermodulation and/or generation of spurious radiation products which may be caused by common usage of the same antenna system by Stations_____,_____,_____, and there shall be filed with the license application copies of a firm agreement entered into by the _____stations involved clearly fixing the responsibility of each with regard to the installation and maintenance of such equipment. In addition, field observations shall be made to determine whether spurious emissions exist and any objectionable problems resulting therefrom shall be eliminated. Following construction, and prior to authorization of program test under this grant, Stations _____,_____,_____,_____, shall each remeasure antenna resistance and submit Form 302 as application notifying the return to direct measurement of power.

Before program tests are authorized, permittee shall dismantle the unused antenna tower, or in lieu thereof, submit a proof of performance to establish that the proposed radiation pattern is essentially omnidirectional. The proof shall include at least eight approximately equally-spaced radials with sufficient close-in points that the inverse distance fields can be clearly

established.

Permittee shall assume responsibility for the elimination of interference due to external cross-modulation and for the installation and adjustment of filter circuits or other equipment in the antenna systems of the proposed operation and of Stations _____, _____, _____, _____, or any other stations which may be necessary, to prevent adverse effects due to internal cross-modulation and reradiation; and prior to the erection of the antenna towers and subsequent thereto, sufficient field strength measurements shall be made on these specified stations to establish that the radiation patterns have not been adversely affected due to reradiation. In addition, field observation shall be made to determine whether spurious emissions exist, and any objectionable interference problems resulting therefrom shall be eliminated.

Permittee shall accept such interference as may be imposed by other existing 250 watt Class IV stations in the event they are subsequently authorized to increase power to 1000 watts.

CONCLUSION:

It is recommended that the instant proposal be designated for hearing.

A grant of the instant proposal is recommended.

PENDING, CHECK LIST DATE

SIGNATURE OF ENGINEER DATE

SIGNATURE OF ATTORNEY DATE

ENGINEERING CONSIDERATIONS:

___ Complies with all engineering rules

___ There are no engineering objections, petitions or requests for waiver associated with this case.

ADDITIONAL COMMENTS:

OMNIDIRECTIONAL ANTENNA SYSTEM:

Coordinates: o ' " North; o ' " West.

Omnidirectional Antenna System described as:

Type of Tower:

Overall Height in Feet: ___ Height of Radiator: __Feet, ___ Wavelength

_____Buried Copper Wire Radials ____Feet.

Ground Screen:_____Feet by _____ Feet.

Type of Excitation: _____

Estimated Radiation Per One Kilowatt per one kM _____ mV/m

DIRECTIONAL ANTENNA SYSTEM

CALL: _____ FREQUENCY: _____

FILE NO: _____ POWER: _____

COORDINATES: _____ ' _____ " NORTH _____ ' ____ " WEST

1. DESCRIPTION OF DIRECTIONAL ANTENNA SYSTEM:

No. and Type of Elements: _____

_____

_____

_____

Height Above Insulators: _____

Overall Height: _____

Spacing and Orientation: _____

_____

_____

_____

Ground system: _____

_____

_____

_____

Nondirectional Antenna: _____

2. THEORETICAL SPECIFICATIONS:

PHASING	TOWER	
	NIGHT:	_____
	DAY :	_____
FIELD RATIO	NIGHT:	_____
	DAY :	_____

The inverse distance field strength at a distance of one kilometer from the above antenna in the directions specified shall not exceed the following values:

Azimuth	Radiation

THE AUTHORITY GRANTED IS SUBJECT TO THE FOLLOWING CONDITIONS:

A complete nondirectional proof of performance, in addition to a complete proof on the (day) and (night) directional antenna system, shall be submitted before program tests are authorized. The nondirectional and directional field strength measurments must be made under similar environmental conditions.

A partial proof of performance on the (day) and (night) directional antenna system made in accordance with Section 73.154(a) of the Rules, shall be submitted before program tests are authorized.

Operation by remote control authorized.

If remote control authorization is desired, necessary to file complete FCC Form 301-A.

Painting and lighting of the proposed antenna tower(s) in accordance with paragraphs _____of FCC Form 715.

Antenna obstruction markings not required.

Permittee shall install a type accepted transmitter, or submit application (FCC Form 301) along with data prescribed in Section 73.1660(b) should non-type accepted transmitter be proposed.

Before program tests are authorized, permittee shall submit a complete nondirectional proof of performance to establish that the efficiency is at least _____mV/m/kW at one kilometer, as proposed. The proof shall include at least eight approximately equally-spaced radials with sufficient close-in points such that the inverse distance field can be clearly established. (See Section 73.186 FCC Rules).

The proposed antenna shall be excited with a symmetrical folded unipole feed, utilizing a minimum of three folds.

A request must be submitted in accordance with Section 73.99 of the Rules if a Pre-Sunrise (PSRA) and/or a Post-Sunset Authorization (PSSA) is desired using the facilities specified in this authorization.

The license application to cover this authorization may refer to and rely upon the technical data contained in the engineering report filed _____to establish that the array is adjusted to within the pattern authorized

herein.

Before program tests are authorized, permittee shall submit sufficient current distribution measurement data to establish clearly that the current distribution approximates that of an antenna with electrical height of _____, as proposed.

Before program tests are authorized, permittee shall submit sufficient data to establish that the inverse distance field at one kilometer is essentially _____mV/m/kW, as proposed.

This authorization is subject to the condition that the permittee shall accept overlap from grant of the proposal of_____ ( ), _____.

An antenna monitor of sufficient accuracy and repeatability, and having a minimum resolution of 0.1 degrees phase and 0.1 percent sample current ratio deviation shall be installed and continuously available to indicate the relative phase and magnitude of the sample currents of each element in the array to insure maintenance of the radiated fields within the standard pattern values of radiation.

Upon receipt of operating specifications and before issuance of a license, permittee shall submit the results of observations made daily of the base currents and their ratios, relative phases, sample currents and their ratios and sample current ratio deviations for each element of the array along with the final amplifier plate voltage and current, the common point current, and the filed strengths at each monitoring point for both the nondirectional and directional (both daytime and nighttime) operations for a period of at least thirty days, to demonstrate that the array can be maintained within the specified tolerances.

Prior to construction of the tower authorized herein, permittee shall notify AM Station _____ so that, if necessary that AM station: may determine operating power by a method described in Section 73.51(a)(1) or (d), and/or request temporary authority from the Commission in Washington, D.C. to operate with parameters at variance in order to maintain monitoring point field strengths within authorized limits. Permittee shall be responsible for installation and continued maintenance of detuning apparatus necessary to prevent adverse effects upon the radiation pattern of the AM station. Both prior to construction of the tower and subsequent to the installation of all appurtenances thereon, a partial proof of performance, as defined by Section 73.154(a) of

the Commission's Rules, shall be conducted to establish that the AM array has nsot been adversely affected and, prior to or simultaneous with the filing of the application for license to cover this permit, the results submitted to the Commission.

Prior to construction of the tower(s) authorized herein, permittee shall notify AM Station _____ so that station may determine operating power by a method described in Section 73.51(a)(1) or (d). Permittee shall be responsible for the installation and continued maintenance of detuning apparatus necessary to prevent adverse effects upon the radiation pattern of that station. Both prior to construction of the tower and subsequent to the installation of all appurtenances thereon, antenna impedance measurements of the AM station shall be made and sufficient field strength measurements, taken at a minimum of 10 locations along each of eight equally spaced radials, shall be made to establish that the radiation pattern is essentially omnidirectional. Prior to, or simultaneous with, the filing of the application for license to cover this permit, the results of the field strength measurements and the impedance measurements shall be submitted to the Commission in an application on FCC Form 302 notifying of the AM station's return to the direct method of power determination. (See Section 73.45(c), FCC Rules).

Before program tests are authorized, sufficient data shall be submitted to show that adequate filters, traps and other equipment has been installed and adjusted to prevent interaction, intermodulation and/or generation of spurious radiation products which may be caused by common usage of the same antenna system by Stations_____,_____,_____, and there shall be filed with the license application copies of a firm agreement entered into by the _____stations involved clearly fixing the responsibility of each with regard to the installation and maintenance of such equipment. In addition, field observations shall be made to determine whether spurious emissions exist and any objectionable problems resulting therefrom shall be eliminated. Following construction, and prior to authorization of program test under this grant, Stations _____,_____,_____,_____, shall each remeasure antenna resistance and submit Form 302 as application notifying the return to direct measurement of power.

Before program tests are authorized, permittee shall dismantle the unused antenna tower, or in lieu thereof, submit a proof of performance to establish that the proposed radiation pattern is essentially omnidirectional. The proof shall include at least eight approximately equally-spaced radials with sufficient close-in points that the inverse distance fields can be clearly

established.

Permittee shall assume responsibility for the elimination of interference due to external cross-modulation and for the installation and adjustment of filter circuits or other equipment in the antenna systems of the proposed operation and of Stations _____, _____, _____, _____, or any other stations which may be necessary, to prevent adverse effects due to internal cross-modulation and reradiation; and prior to the erection of the antenna towers and subsequent thereto, sufficient field strength measurements shall be made on these specified stations to establish that the radiation patterns have not been adversely affected due to reradiation. In addition, field observation shall be made to determine whether spurious emissions exist, and any objectionable interference problems resulting therefrom shall be eliminated.

Permittee shall accept such interference as may be imposed by other existing 250 watt Class IV stations in the event they are subsequently authorized to increase power to 1000 watts.

CONCLUSION:

It is recommended that the instant proposal be designated for hearing.

A grant of the instant proposal is recommended.

PENDING, CHECK LIST DATE

SIGNATURE OF ENGINEER DATE

SIGNATURE OF ATTORNEY DATE

AM 26.

OFFICE MEMORANDUM

TO: ALL ENGINEERS AND AM PI
FROM: DON
SUBJECT: Facilities Authorized Under Part 22 of FCC Rules - AM FAcilities
DATE: January 28, 1988

The following is of interest.

DON

Attachment C

RECEIVED
OCT 2 8 1987
COHEN AND DIPPELL, P.C.
WASHINGTON, D.C.

PUBLIC NOTICE

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET N.W.
WASHINGTON, D.C. 20554

4396

News media information 202/632-5050. Recorded listing of releases and texts 202/632-0002.

Recorded cellular information 202 653-5858

August 11, 1987

COMMON CARRIER PUBLIC MOBILE SERVICES INFORMATION

STANDARD BROADCAST RERADIATION AND TOWER CONSTRUCTION AUTHORIZED UNDER PART 22 OF THE RULES

Recently the Mobile Services Division of the Common Carrier Bureau has received a number of complaints from AM Broadcasters concerning the construction of Cellular Radio towers near their AM facilities that modify the authorized pattern of the AM facilities.

The Mobile Services Division is hereby reminding Part 22 licensees and permittees of their responsibility to protect existing licensees. The Commission's policy is clear. Whether by imposition of specific conditions or by operation of law, a licensee building a new facility is obligated to take all the necessary steps, including the financial burden, to correct interference problems caused by new or modified construction. See e.g. Sudbrink Broadcasting of Georgia, 65 F.C.C 2d 691 (1977); Athens Broadcasting Co., 68 F.C.C. 2d 920 (1978); Midnight Sun Broadcasting Co., 11 F.C.C.119 (1947); B & W Truck Service, 15 F.C.C. 2d 769 (1986).

Licensees and permittees planning to construct or modify a tower within 2 miles of a directional AM array or within 1/2 mile of a non-directional AM tower should take certain precautions.

If construction is planned within 1/2 mile of a nondirectional AM tower the licensee should, prior to construction of the proposed tower, notify the AM station so that the station may commence determining operating power by the indirect method (See Section 73.51 (e)&(f)). The common carrier shall be responsible for the installation and continued maintenance of any detuning apparatus necessary to prevent adverse affects upon the radiation pattern of the AM station. Measurements shall be taken both prior to the construction of the tower and subsequent to the installation of all appurtenances thereon. Antenna impedance measurements of the AM station shall be made and sufficient field strength measurements taken at a minimum of ten locations along each of eight equally spaced radials to establish that the AM radiation pattern is essentially omnidirectional. The results of the field strength and impedance measurements should be reported to the

Commission in an application for the AM station to return to the direct method of power determination.

If construction is planned within 2 miles of a directional AM array the licensee should notify the AM station so that, if necessary, the AM station may determine operating power by the indirect method and request temporary authority from the Commission in Washington, DC to operate with parameters at variance in order to maintain monitoring point field strengths within authorized limits (See Section 73.51 (e)&(f)). The common carrier shall be responsible for the installation and continued maintenance of detuning apparatus necessary to prevent adverse affects upon the radiation pattern of the AM station. Both prior to construction of the tower and subsequent to the installation of all appurtenances thereon a partial proof of performance, as defined by Section 73.154(a) of the Commission's Rules, shall be conducted to establish that the AM array has not been adversely affected. Prior to or simultaneous with the filing of the FCC 489 notification, the results of the measurements must be submitted to the Commission.

For further information contact Jay O'Connor at (202) 653-5560.

-FCC-

AM 27.

(1) The interstate portion of deferred taxes (Accounts 4100 and 4340).

(2) The interstate portion of customer deposits (Account 4040).

(3) The interstate portion of liabilities related to compensated absences (Account 4120) to the extent of the difference between the interstate portion of the deferred charge related to compensated absences (Account 1439) and the interstate portion of the corresponding liability.

(4) The interstate portion of unfunded accrued pension costs (Account 4310).

(5) The interstate portion of other deferred credits (Account 4360) to the extent they arise from the provision of regulated telecommunications services. This shall include deferred gains related to sale-leaseback arrangements.

(b) The interstate portion of deferred taxes, customer deposits compensated absences and other deferred credits shall be determined by multiplying the sum of such funds by the interstate plant factor. (The interstate plant factor shall be computed by dividing interstate plant in service by total plant in service); except that the interstate portion of customer deposits may be determined by special study when use of the interstate plant factor would yield distorted results.

(c) The interstate portion of unfunded accrued pension costs shall bear the same proportionate relationship as the interstate/intrastate expenses which give rise to the liability.

[FR Doc. 88-509 Filed 1-14-88; 8:45 am]
BILLING CODE 6712-01-M

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47 CFR Part 73

[MM Docket No. 87-131; FCC 87-356]

Radio Broadcasting Services; Unlimited-time Operation by Existing AM Daytime-Only Radio Broadcast Stations; Discontinuance of Authorization of Additional Daytime-only Stations; and Minimum Power of Class III Stations

AGENCY: Federal Communications Commission.

ACTION: Final rule.

SUMMARY: The FCC has amended its Rules to (1) permit unlimited-time operations for existing daytime-only AM radio broadcast stations on the AM regional channels, and on two clear channels: 940kHz and 1550 kHz; (2) discontinue the authorization of new daytime-only stations; and (3) reduce the generally applicable minimum power of Class III AM radio broadcast stations from 0.5 kW to 0.25 kW. This action is needed to relieve daytime-only stations and the listening public from the disadvantages of limitations on their hours of operation under present rules. The revised rules will make possible unlimited-time operation by qualifying daytime-only stations on the above-noted channels.

EFFECTIVE DATE: The rule amendments enter into effect December 1, 1987.

ADDRESS: Federal Communications Commission, Washington, DC 20554.

FOR FURTHER INFORMATION CONTACT: Vicki Assevero or Louis C. Stephens, Policy and Rules Division, Mass Media Bureau, (202) 632-7792, or (202) 632-7792, respectively.

SUPPLEMENTARY INFORMATION: This is a summary of the Commission's *Report and Order* in MM Docket No. 87-131, adopted November 18, 1987, and released December 1, 1987. This *Report and Order* may be consulted and will be available for coying during normal business hours in the FCC Dockets Branch (Room 230), 1919 M Street NW., Washington, DC. The complete text of this *Report and Order* may also be purchased from the Commission's copy contractor, International Transcription Services, Inc., (202) 857-3800, 2100 M Street, NW, Washington, DC 20037.

Summary of Report and Order:

1. Having previously opened the way for unlimited-time operation for most daytime-only AM radio broadcast stations operating on the 14 foreign clear channels, the FCC took similar action for those assigned to the regional AM channels and to 940 kHz and 1550 kHz. Pursuant to the newly adopted rule amendments, the Commission has calculated and informed, each qualifying daytime-only station the power, within a range of .001 kW (1 watt) to 0.5 kW, that it may use for broadcasting during nighttime hours with the antenna systems they are licensed to start using at sunrise. The authorized power was set at levels calculated to provide required interference protection to foreign and comestic stations.

2. Daytime-only stations authorized to operate during nighttime hours with power sufficient to enable them to provide a field strength of at least 141 mV/m at 1 kilometer from their transmitters will be reclassified as Class II-B stations if on 940 kHz or 1550 kHz or as Class III if on any of the 41 regional channels.

3. None of the stations permitted to operate during nighttime hours are required to provide interference protection to each other. They are, however, required to protect: (1) Foreign stations, (2) existing unlimited-time stations, and (3) new and changed unlimited-time stations for which construction permits had been issued or applications tendered no later than December 1, 1987. The reclassified stations may apply, under regular procedures, for nighttime power increases, up to the maximum generally permitted for the class of channel occupied, consistent with requisite protection against interference to other stations.

4. Stations reclassified as Class II-S or III-S are not required to provide the generally required minimum signal to their principal cities nighttime, nor are they be required to meet the requirement generally applicable to stations that regularly operate during nighttime hours, that they broadcast at least 4 hours between 6 p.m. and midnight. Stations reclassified as Class II-B, II-C, or III are required to meet the latter requirement, but, so long as their nighttime powers are limited to those initially authorized by the Commission, they would be exempted from the minimum city signal requirement.

5. The minimum power of stations on regional channels was reduced from 0.5 kW to 0.25 kW. The few Class IV stations assigned to regional channels that already, exceptionally operate at 0.25 kW without interference protection, will be reclassified as Class III stations, entitled to protection.

6. Individual stations have been notified of the powers they may use during nighttime hours and the date when nighttime operations may start, in Orders to Show Cause why the station's license should not be modified to permit such operations.

7. Finally, the assignment of additional daytime-only AM stations on 940 kHz, 1550 kHz, and the 41 regional AM channels, has been discontinued.

8. With reference to the Regulatory Flexibility Act of 1980, 5 U.S.C. 603, the revised rules will have a beneficial impact on small daytime-only AM stations that are enabled, through more extended hours of operation, to provide enhanced services to the public, and thereby compete more effectively with existing unlimited-time AM and FM stations.

9. The Secretary of the Commission is directed to send a copy of the *Report and Order* in this proceeding to the Chief Counsel for Advocacy of the Small Business Administration in accordance with the Regulatory Flexibility Act.

10. *Paperwork Reduction Act Statement:* The rule changes have been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified norm.

information, collection and/or record keeping, labeling, disclosure, or record retention requirements; and will not increase or decrease burden hours imposed on the public.

11. Authority for the rule changes is contained in sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

List of Subjects in 47 CFR Part 73

Radio broadcasting.

Federal Communications Commission.

H. Walker Feaster III,

Acting Secretary.

Part 73 of Title 47 of the Code of Federal Regulations is amended as follows:

PART 73—[AMENDED]

1. The authority citation for Part 73 continues to read as follows:

Authority: 47 U.S.C. 154 and 303.

2. Section 73.21 is amended by adding a new sentence at the end of paragraphs (a)(2)(ii) and (a)(2)(iv), revising paragraphs (a)(2)(v) and (b)(1), and adding a new paragraph (b)(3), to read as follows:

§ 73.21 Classes of AM broadcast channels and stations.

(a) * * *

(2) * * *

(ii) * * * A former Class II–D station operating on 940 or 1550 kHz that is authorized to operate during nighttime hours will be reclassified as Class II–B notwithstanding the fact that its authorized nighttime power is less than 0.25 kW, if it RMS field strength at 1 kilometer is 141 mV/m or higher.

* * * * *

(vi) *Class II–D Stations.* * * * No application will be accepted for new Class II–D (daytime-only) stations.

(v) *Class II–S Stations.* Class II–S stations are former Class II–D stations that have been authorized to operate nighttime on the 14 channels listed in § 73.25(c) or on 940 kHz or 1550 kHz, at powers that are less than 0.25 kW; provided that, if the nighttime power of such a station on 940 or 1550 kHz, although less than 0.25 is sufficient to enable its RMS field strength at 1 kilometer to attain the level of 141 mV/m or more, it shall be classified as a Class II–B station. Class II–S stations operate without protection from interference at night, but do receive protection from interference during the daytime.

(b) *Regional Channel.*

* * * * *

(1) *Class III stations.* A station designated as Class III operates unlimited-time on a regional channel, and is designed to render service B primarily to a principal center of population and in the rural area contiguous thereto. Except as provided in paragraph (b)(2) of this section, a Class III station operates with a power not more than 5 kW and not less than 0.25 kW; provided that, an unlimited-time station that operates on a regional channel during nighttime hours with a power of less than 0.25 kW will nevertheless be classified as Class III station if its RMS field strength is 141 mV/m or more at 1 kilometer.

* * * * *

(3) *Class III–S Station.* A Class III–S station is a former daytime-only station that operates on a regional channel with a nighttime power that is both less than 0.25 kW and insufficient to enable the station to attain an RMS field strength of at least 141 mV/m or more at 1 kilometer.

* * * * *

3. Section 73.24 is amended by revising the second sentence of paragraph (j) of this section to read as follows:

§ 73.24 Broadcast facilities; showing required.

* * * * *

(j) * * * The following categories of stations need not demonstrate the ability to provide such coverage during nighttime operation: (1) Daytime-only AM stations; and (2) former daytime-only stations that were reclassified as Class II–B or II–S on 940 or 1550 kHz or as Class II–C of II–S on the 14 frequencies listed in § 74.25(c) or as unlimited-time Class III or III–S stations or regional channels, and have not since been authorized to increase nighttime power.

* * * * *

§ 73.25 [Amended]

4. Section 73.25 is amended by removing the second sentence from paragraph (c).

5. Section 73.26 is amended by revising the text of paragraph (a) up to the colon, and adding a new paragraph (c), to read as follows:

§ 73.26 Regional channels; Class III stations.

(a) The following frequencies are designated as regional channels and are assigned for use by Class III and Class III–S stations: * * *

* * * * *

(c) No application for new daytime-only stations will be accepted on the channels listed in paragraph (a) of this section.

6. Section 73.29 is revised to read as follows:

§ 73.29 Class IV stations on regional channels.

No license will be granted for the operation of a Class IV station on a regional channel.

7. Section 73.31 is amended by revising the table in paragraph (a) to read as follows:

§ 73.31 Rounding of nominal power specified on applications.

(a) * * *

Nominal power (kW)	Rounded down to nearest figure (kW)
Below 0.25	0.001
0.25 to 0.99	0.01
1 to 9.9	0.1
10 to 50	1

* * * * *

8. Section 73.99 is amended by adding a new paragraph (l), as follows:

§ 73.99 Presunrise service authorization (PSRA) and Postsunset service authorization (PSSA).

* * * * *

(l) The authorization of unlimited-time operation by daytime-only stations that are reclassified as Class II–S or Class III–S stations will not affect their right to operate during prescribed presunrise and postsunset hours in accordance with PSRA's and PSSA's issued pursuant to this section.

9. Section 73.182 is amended by revising the second sentence of paragraph (a)(3) up to the semicolon, to read as follows:

§ 73.182 Engineering standards of allocation.

(a) * * *

(3) * * * They operate with powers not less than 0.25 kW and not more 5 kW, and are normally protected to the 1500 uV/m groundwave contour nighttime and the 500 uV/m groundwave contour daytime; * * *

10. On the line in the table in § 73.182(s) which starts with the entry "III" in the first column, the entry in the third column that now reads "0.5 kW to 5 kW" is revised to read "0.25 kW to 5 kW."

11. Footnote [2] to the table in § 73.182(s) is revised to read as OB follows:

* * * * *

[2] For adjacent channel, see paragraph (t) of this section.

* * * * *

12. Immediately preceding the last line of the table in § 73.182(s) a new line is added as follows:

Class of station	Class of channel used	Permissible power	Signal strength contour of area protected from objectionable interference [1]		Permissible interfering signal on same channel [2]	
			Day [3]	Night	Day	Night [4]
*	*	*	*	*	*	*
III-S	do	0.25 kW to 5kW (daytime) less than 0.25 kW nighttime.	500 uV/m	not prescribed	do	Not prescribed.
*	*	*	*	*	*	*

[1] When a station is already limited by interference from other stations to a contour of higher values than that normally protected for its class, this contour shall be the established standard for such station with respect to interference from all other stations.
[2] For adjacent channel, see paragraph (t) of this section.
[3] Groundwave.
[4] Skywave field strength for 10 percent or more of the time.

* * * * *

13. Section 73.1740(a)(1)(i) is revised to read as follows:

§ 73.1740 Minimum operating schedule.

(a) * * *

(1) * * *

(i) Daytime-only AM stations and former daytime-only AM stations that have been reclassified as Class II-S or III-S need comply only with the minimum requirements for operation between 6 a.m. and 6 p.m., local time.

* * * * *

14. Section 73.3571 is amended by adding a new paragraph (d)(5), to read as follows:

§ 73.3571 Processing of AM broadcast station applications.

* * * * *

(d) * * *

(5) The following special procedures will be followed in authorizing Class II-D daytime-only stations on 940 and 1550 kHz, and Class III daytime-only stations on the 41 regional channels listed in § 73.26(a), to operate unlimited-time.

(i) Each eligible daytime-only station in the foregoing categories will receive an Order to Show Cause why its license should not be modified to specify operation during nighttime hours with the facilities it is licensed to start using at local sunrise, using the power stated in the Order to Show Cause, that the Commission finds is the highest nighttime level—not exceeding 0.5 kW—at which the station could operate without causing prohibited interference to other domestic or foreign stations.

(ii) Stations accepting such modifications shall be reclassified. Those authorized in such Show Cause Orders to operate during nighttime hours with a power of 0.25 kW or more, or with a power that, although less than 0.25 kW, is sufficient to enable them to attain RMS field strengths of 141mV/m or more at 1 kilometer, shall be redesignated as Class II-B stations if they are assigned to 940 or 1550 kHz, and as unlimited-time Class III stations if they are assigned to regional channels.

(iii) Stations accepting such modification that are authorized to operate during nighttime hours at powers less than 0.25 kW, and that cannot with such powers attain RMS field strengths of 141 mV/M or more at 1 kilometer, shall be redesignated as Class II-S stations if they are assigned to 940 or 1550 kHz, and as Class III-S stations if they are assigned to regional channels.

(iv) Applications for new stations may be filed at any time on 940 and 1550 kHz and on the regional channels. Also, stations assigned to 940 or 1550 kHz, or to the regional channels, may at any time, regardless of their classifications, apply for power increases up to the maximum generally permitted. Such applications for new or changed facilities will be granted without taking into account interference causes to Class II-S or Class III-S stations, but will be requred to show interference protection to other classes of stations, including stations that were previously classified as Class II-S or Class III-S, but were later reclassified as Class II-B or Class III unlimited-time stations as a result of subsequent facilities modifications that permitted power increases qualifying them to discontinue their "S" subclassification.

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BILLING CODE 6712-01-M

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 565

[Docket No. 88-02; Notice 2]

Vehicle Identification Number—Content Requirements

AGENCY: National Highway Traffic Safety Administration (NHTSA), DOT.

ACTION: Final rule.

SUMMARY: This notice amends 49 CFR Part 565, *Vehicle Identification Number—Content Requirements*, by simplifying vehicle identification information coding requirements for trailer manufacturers. Specifically, this rule amends Table I, § 565.4 by deleting the requirement that trailer manufacturers include in the VIN code a "series" designation for trailers, and by changing vehicle attributes for incomplete trailers. The amendment will bring VIN requirements for trailers in line with actual trailer manufacturing practices, thereby facilitating VIN information retrieval, and increasing the accuracy and efficiency of vehicle defect recall campaigns.

DATE: February 16, 1988.

FOR FURTHER INFORMATION CONTACT: Mr. Kenneth Rutland, Office of Vehicle Safety Standards, National Highway Traffic Safety Administration, 400 Seventh St., SW., Washington, DC 20590 (202-366-5267).

SUPPLEMENTARY INFORMATION:

Introduction. Under Standard 115, *Vehicle Identification Number—Basic Requirements*, a motor vehicle manufacturer must assign a 17-character vehicle identification number (VIN) to

PIKE & FISCHER

ROUTE TO:

1988 AM 28.

RADIO REGULATION

RECEIVED JAN 11 1988 COHEN AND DIPPELL, P.C. WASHINGTON, D.C.

REPORT 41-1

JANUARY 4, 1988

MORE RELIEF PROVIDED TO AM DAYTIMERS; NEW RULES AUTHORIZE NIGHTTIME SERVICE

AM daytime-only broadcast stations operating on Regional Channels and on the 940 kHz and 1550 kHz Domestic Clear Channels have been given authority to operate at night with a maximum power of 500 watts, reduced as necessary to avoid prohibited interference to existing full-time stations and foreign stations. Although this action will cause some interference to existing stations that is not cognizable under the Rules, the effect of this minor interference is outweighed by the public interest in enabling more than 1,200 stations to provide a nighttime service for the first time, the Commission holds.

The Commission declines, however, to extend nighttime authority to AM daytime-only stations operating on Domestic Clear Channels other than 940 kHz and 1550 KHz. While no U.S. Class I station currently broadcasts on 940 kHz or 1550 kHz, nighttime operations by AM daytimers on the other Clear Channels could cause interference to the 0.5 mV/m 50 percent skywave contours of Class I stations; thus, the Commission holds, conferring nighttime authority would be premature. The Commission notes further that protection to Class I stations' skywave signals is currently based on evaluations of the interference impact of individual signals; a blanket authorization of new nighttime operations on these channels raises important issues involving the impact of cumulative interference, and further studies should therefore be undertaken before additional relief can be provided to daytime stations on the Clear Channels other than 940 kHz and 1550 kHz.

Eligible AM daytime-only stations will be reclassified on the basis of the nighttime powers for which they have been authorized. A daytime-only station operating on one of the Regional Channels will be designated as Class III (unlimited-time) if its authorized nighttime power is high enough to produce a field strength at one kilometer of 141 mV/m; a Regional Channel station unable to attain such a field strength level will be classified as Class III-S. Similarly, former daytime-only stations operating on 940 kHz and 1550 kHz will be reclassified as Class II-B or Class II-S, respectively. Daytime-only stations reclassified as unlimited-time Class II-B or Class III stations will be entitled to the full interference protection provided to other stations of these classes. Former daytime-only stations reclassified as Class II-S or III-S will not receive interference protection unless they increase their facilities to attain the higher status.

The nighttime operations of former daytime-only stations reclassified as unlimited-time Class II-B, II-S, III or III-S stations will be exempt from the principal city signal requirement. However, this exemption will not be extended to stations that seek authorization to modify their facilities to use nighttime powers greater than their initial nighttime authorization; there is no reason, the Commission finds, to provide upgrading stations with an automatic exemption from the minimum principal city coverage requirement equivalent to that available with initial unlimited time authorizations. All former AM daytime-only stations reclassified as unlimited-time Class II-S and Class III-S stations will also be exempt from the §73.1740(a)(1) minimum operating schedule requirement during nighttime hours.

In a related amendment of the Rules, the minimum required nighttime power for Class III AM stations is reduced from 500 watts to 250 watts. The Commission notes that the 500-watt minimum had been adopted at a time when the development of AM radio was relied upon to extend aural service to areas completely lacking such service. Such reliance is no longer necessary since most areas can receive numerous stations, the Commission reasons, adding that economics, not engineering, is usually the principal factor where an area continues to be without service. Concluding that retention of the 500-watt minimum would serve only to block otherwise beneficial proposals to use the remaining capacity on underused channels, the Commission also observes that the lowering of the minimum power requirement to 250 watts makes it possible to reclassify the few Class

IV stations on the Regional Channels as Class III, providing these stations with nighttime interference protection.

As a final measure, the Commission announces that it will no longer process applications for new AM daytime-only stations on the Regional Channels and the 940 kHz and 1550 kHz Clear Channels. New daytime-only authorizations would have a substantial preclusive effect on the potential assignment of unlimited-time stations on seven channels: the channel occupied by the daytime-only station and the three adjacent channels higher and lower in frequency. Moreover, authorization of new daytime-only stations would also block opportunities for existing stations to improve their nighttime service to the public and would prevent the Commission from providing relief (in the form of additional unlimited-time authorizations) to existing daytime-only stations. The existing "freeze" on the acceptance of new daytime-only proposals for the other Domestic Clear Channels remains in effect. **AM Daytime-Only Broadcast Stations (Unlimited Time Operations)**, 64 RR 2d 17 *[December 1]*.

TECHNICAL STANDARDS ESTABLISHED FOR BROADCAST/CABLE INPUT SELECTOR SWITCHES

Technical regulations for broadcast/cable television input selector switches have been instituted by the Commission through amendments to Part 15 of the Rules.

The significance of the new technical standards is somewhat muted by the subsequent Court of Appeals decision invalidating the Commission's must-carry regime. The Commission has petitioned the Court to clarify whether its must-carry opinion invalidated the input selector switch and consumer education requirements imposed on cable operators as well as the mandatory signal carriage requirements. In any event, it remains that the new technical standards will govern voluntarily installed switches.

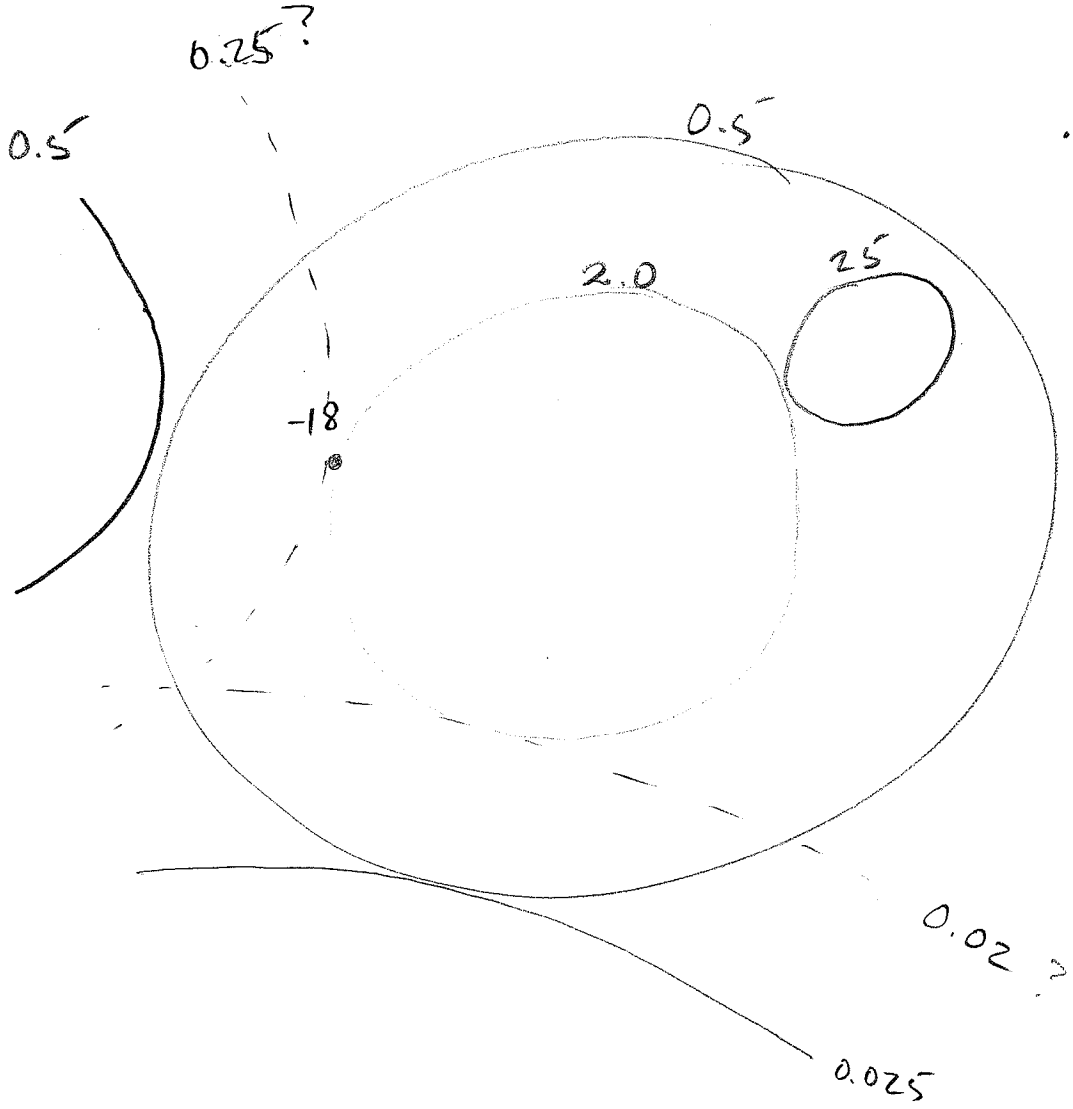
Under the new standards, both external, stand-alone switches and switches built into television receivers will be required to provide at least 80 dB of isolation in the 54 to 216 MHz range and 60 dB of isolation in the 216 to 550 MHz range between the antenna and the cable inputs. These levels of isolation are necessary to prevent leakage of wideband cable signals that may cause interference to other radio services and to television receivers outside the switch-user's premises, the Commission determines. Moreover, because the isolation provided by such switches could be defeated by the direct coupling of cable signals to a premises antenna system where unshielded transformers or wiring are used or the switch is installed improperly, the must-carry consumer education obligations of cable operators, if they have survived the must-carry court decision, will be augmented to require the provision of explicit instructions to subscribers for installing the switches so as to minimize the potential for signal leakage. Cable operators will also be required to include a section of coaxial cable at least four feet in length between the switch terminal and lead wires in all installations they perform themselves.

All input selector switches that use A/C power will have to be designed so as to maintain the capability to comply with minimum isolation standards in the event of an A/C power failure or other power interruption. The method used to maintain the required isolation will be left to the discretion of the switch manufacturers.

External, stand-alone input selector switches will be subject to the verification procedures of Subpart J of Part 2 of the Rules. In addition, all stand-alone input selector switches and all devices with built-in switches that are sold or distributed to a final user will have to be labeled to indicate that they comply with the technical requirements of §15.64 or §15.606(d) of the Rules.

An additional amendment to the Rules clarifies that, in conjunction with the installation of input selector switches, cable operators may charge their subscribers, including new subscribers, for any additional labor or materials needed to install a proper ground system for an outside antenna. Finally, the application of existing cable terminal device interference monitoring standards is extended to the input selector switches; cable operators can discharge their responsibilities under this Rule through normal systematic performance checks of their plant and equipment pursuant to §76.601 of the Rules.

The new Rules are slated to take effect on January 28. However, all existing input selector switches installed in customers' premises or included in manufacturer', distributors', and retailers' inventories as of January 28 will be exempt



1 WIDE-BAND

Present	2 mV/m	Protection, present power.
CO-CH	-40 dB	u/D
1-ADJ	-18 dB	u/D
2-ADJ	+22 dB	u/D

2 Newer (10KHz) wide band recvrs will magnify noise problem & may be that noise limited contour also lies. Here 0.5 mV/m. Particularly compared to present 2.5KHz receivers.

3 Does ATSC (FSD, SD) or (FSD, 10) 26 dB or 40 dB Signal to Atmos. Noise ratio?

NEW KENTLAND INDIANA 640 KHZ II N LAT 40-46-01 W LONG 87-29-35 880406
APP .25 KW-LS DA-D U PSA .00000KW
(DAY) 871207AG (NIGHT) 871207AG
RAD(MV/M/KW): NIGHT 281.60 THEO RMS(MV/M): DAY 143.73
AMDED 870507 & 871007-870330AH RET 871104-RESUBMITTED
AMDED 870507-870330AH RET 871104-RESUBMITTED

WKVI KNOX INDIANA 1520 KHZ II-D N LAT 41-19-20 W LONG 86-36-17 880511
APP 1.80 KW-LS ND-D D
(DAY) BP870821AE
RAD(MV/M/KW): DAY 365.22
870821AE RECN DEN, APP RET 1/87-RECN 880201, AMDED 880329-ACCPTD NPT 880428

WKVI KNOX INDIANA 1520 KHZ II-D 880520
APP ND-D D
BP870821AE

870821AE RECN DEN,APP RET 1/87-RECN 880201, AMDED 880329-ACCEPTED NPT 880428

WIMS LA PORTE INDIANA 1420 KHZ III 880301
APP .05 KW DA-2 U
(NIGHT) 880217AF
THEO RMS(MV/M): NIGHT 63.00
EXPERIMENTAL SYNCHRONOUS OPERATION N LAT 41-36-36 W LONG 86-43-14 (NIGHT)

NEW LAWRENCE INDIANA 600 KHZ III N LAT 39-40-08 W LONG 86-00-33 870422
APP .50 KW-LS DA-2 U PSA .00000KW
(DAY) BP860728AA (NIGHT) BP860728AA
THEO RMS(MV/M): DAY 199.30 NIGHT 204.26
HEARING D87-108

WJJN NEWBURGH INDIANA 1180 KHZ II-D N LAT 37-57-16 W LONG 87-25-07 880701
APP 1.00 KW-LS ND-D D
(DAY) BP880407AE
RAD(MV/M/KW): DAY 282.00
AMENDMENT 880527AA

WNDI SULLIVAN INDIANA 1550 KHZ II-D N LAT 39-05-36 W LONG 87-26-38 880511
APP .22 KW-LS ND-D D
(DAY) BP880325AE
RAD(MV/M/KW): DAY 302.50
FOLDED UNIPOLE-AMENDED 880419 & 880509