No.	Date	Item
1	11/1/99	FCC Commences Rule Making to Consider Terrestrial DAB
2	5/10/99	AM BROADCAST CUT-OFF DATE NOTICE
3	10/25/99	NAB TechCheck, New Limits on Interference Conducted on AC Power
4	10/25/99	NAB TechCheck, Proposes Enhanced Interference Protection for AM
5	7/5/99	NAB TechCheck, Comments on Crossed-Field Antennas
6	6/14/99	memo re 93-177 w/o attachment
7	2/15/99	NAB TechCheck, Crossed-Field Antennas for AM Bcstg
8	12/6/79	FCC letter re AFCCE, AM directional broadcasting
9	8/9/99	Comments of AFCCE, 93-177
10	8/16/99	AM DA Patterns Proof-of-Performance
11	11/1/99	Email re AM DA Comments Revision 3, 11:41 PM
12	11/1/99	Email re AM DA Comments Revision 3, 3:25 PM
13	10/15/99	Office Memo, MM 93-177, NAB Sponsored Meeting
14	10/20/99	Discussion Summary and Attendees for 10/13/99 AM DA Meeting
15	9/12/99	Email re Response and Further Discussion on AM DA Rule Making
16	9/10/99	Email re Response and Further Discussion on AM DA Rule Making
17	8/20/99	Email re Further Thoughts on Rules Changes for AM Directionals
18	8/16/99	Email re AM Directional Patterns
19	6/11/99	CDE, Brian Marenco, 93-177, NPRM

A M

NEWS

News media Information 202 / 418-0500
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Internet: http://www.fcc.gov
ftp.fcc.gov

Federal Communications Commission
445 12th Street, S.W.
Washington, D. C. 20554

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 1974).

FOR IMMEDIATE RELEASE:
November 1, 1999

News Media contact:
David Fiske: (202) 418-0500

FCC COMMENCES RULEMAKING TO CONSIDER TERRESTRIAL DIGITAL AUDIO BROADCASTING

Washington D.C. – November 1: The FCC today began a rulemaking proceeding to consider methods for introducing digital audio broadcasting (DAB) to the public.

In a Notice of Proposed Rulemaking issued today, the Commission (1) reaffirmed its commitment to provide radio broadcasters with the opportunity to take advantage of DAB technology, (2) identified Commission public policy objectives for the introduction of DAB service, (3) proposed criteria for the evaluation of DAB models and systems, (4) stated its intention to evaluate models for providing DAB; (5) inquired as to whether or not there is a need for a mandatory DAB transmission standard, and (6) asked for comments on certain DAB system testing, evaluation and standard selection issues.

The Commission said that digital audio broadcasting has the potential to provide enhanced sound quality, greater robustness against interference and other impairments to the transmitted signal, and an array of new auxiliary services. DAB technology utilizes new and efficient audio compression techniques that reduce the amount of bandwidth required to transmit a high-quality audio signal.

In this Notice, the Commission proposed several goals for the proceeding: realizing the superior technical performance capabilities of DAB technology; creating DAB opportunities for existing radio broadcasters; ensuring that introduction of DAB does not weaken the vitality of free over-the-air broadcast service; approving DAB systems that are spectrally efficient; and fostering a rapid and non-disruptive transition to DAB for broadcasters and listeners.

The Commission described two alternative DAB system models that it wanted to evaluate in the proceeding: (1) the In-Band On Channel (IBOC) systems, currently under development by 3 companies, that would be designed to simultaneously broadcast both analog and digital radio signals on broadcasters' existing AM and FM frequencies without disrupting existing analog service, and (2) models based on allocating new radio spectrum on different frequency bands for terrestrial DAB.

According to the system proponents, IBOC technology would provide near CD-quality sound on FM channels and FM-quality on AM channels. Proponents envision a "hybrid" mode of operation during which radio stations could transmit analog and digital signals on their assigned frequencies, eventually followed by an all-digital mode of operations.

AM
2

PUBLIC NOTICE

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET N.W.
WASHINGTON, D.C. 20554

News media information 202/418-0500 Fax-On-Demand 202/418-2830 Internet: http://www.fcc.gov
ftp.fcc.gov

AM BROADCAST APPLICATIONS ACCEPTED FOR FILING AND NOTIFICATION OF CUT-OFF DATE

Report No. B-99 **Released: May 10, 1999**

CUT-OFF DATE: June 11, 1999

Notice is given that the following applications are accepted for filing and are subject to a cut-off date for petitions to deny. No application which would be in conflict with any of these applications will be accepted for filing.

Petitions to deny these applications must be on filed with the Commission not later than the close of business on the cut-off date.

BMP-990401AE WWRU, Elizabeth, New Jersey
Radio Unica of New York License Corporation
Has: 1660 kHz, 1.0 kW, 10 kW-LS, ND-1, U (Elizabeth, NJ)
Req: 1660 kHz, 9.0 kW, 10 kW-LS, DA-N, U (Jersey City, NJ)

BP-990409AA New, Moreno Valley, California
Delbert L. Van Voorhis
Req: 1670 kHz, 9.0 kW, 10 kW-LS, DA-2, U

-FCC-

PLEASE FORWARD TO THE ENGINEERING DEPARTMENT

National Association of Broadcasters NAB

TV TechCheck

The weekly newsfax for TV broadcast engineers *October 25, 1999*

AM 3

FCC PROPOSES NEW LIMITS ON INTERFERENCE CONDUCTED ON THE AC POWER LINES

On October 18, 1999, the FCC released a *Notice of Proposed Rule Making* (NPRM) in ET Docket 98-80 that proposes to modify the limits on the amount of RF energy that may be conducted onto the AC power lines by such things as computers and microwave ovens. The Commission said that, through this proceeding, it hopes to make its rules "more effective in controlling interference to communications services" and harmonize US limits with other international standards.

Limiting conducted interference emissions is important because the harmonics of these types of emission can enter a TV receiver and cause noticeable artifacts in the picture. The most common type of interference appears as black speckles on the TV screen and occurs mostly at low VHF frequencies.

ET Docket 98-80 began last year with a *Notice of Inquiry* that asked a number of questions about the FCC rules regarding RF energy that is conducted onto the AC power lines by various electronic devices. NAB hired the engineering consulting firm Carl T. Jones Corporation to test radio receivers and determine the degree to which they are susceptible to interference conducted through the AC power line. As a result of the data collected by Carl T. Jones, NAB filed comments with the FCC recommending that the conducted emission limits be tightened significantly.

The recently released NPRM proposes to change the amount of energy that may be conducted onto the AC power lines, between 150 kHz and 30 MHz, by computers, and other electronic devices used in the home from a fixed, 250 microvolts at all frequencies to a range of 200 to 631 microvolts (depending on frequency), as measured using an average detector. The FCC also proposes to impose a 200 microvolt (average detector) limit on AM-band emissions from microwave ovens. Currently, microwave ovens are not subject to any AC power line conducted emission limits.

The new limits proposed by the FCC are not as stringent as those recommended by NAB, but they do generally conform to the international standards for AC power line conducted emissions. These standards are published by the International Special Committee on Radio Interference (CISPR) as CISPR Publication 22 (for information technology equipment) and CISPR Publication 11 (for industrial, scientific and medical equipment).

The FCC said that it does not feel that further tightening of the emission limits is warranted because its standards are not intended "to control interference between the user's own devices, *e.g.*, from the user's personal computer to an broadcast receiver sitting on the same desk and connected to the same electrical outlet." It said that its standards "are designed to control interference from a user's device to other users of the spectrum, *e.g.*, from a user's personal computer to a neighbor's broadcast reception." And, it said that it has no "compelling evidence that devices complying with the FCC standards have caused interference from one user to another."

The FCC has separate technical standards for digital devices that are used in the home and those that are used in business or industrial environments. The emission limits for devices used in business or industrial environments are less restrictive because the FCC assumes that these devices will be located farther away from radios and televisions than is the case in the home. In our comments on the *Notice of Inquiry*, NAB argued that the distinction between home and business environments should be abolished because a significant amount of radio listening occurs in the workplace. We argued that a single conducted emission standard should be applied to all devices, no matter where they are used. In its NPRM, the Commission does not propose to make such a change. It cites once again the "different characteristics affecting interference in each environment, such as the wider separation distances between equipment that occur in business and commercial environments." It also cites the fact that it is trying to harmonize its rules with international standards, and that these standards draw a distinction between devices designed for use in residential environments, and those designed for use in non-residential environments.

The FCC also proposes to continue its existing policy of exempting certain digital devices from the AC power line conducted emission limits, including all digital devices used in appliances.

Comments on the FCC's NPRM will be due 75 days after it is published in the *Federal Register*, and reply comments will be due 30 days afterwards. Interested parties may download a copy of the NPRM from http://www.fcc.gov/e-file/ecfs.html (choose "search the ECFS system" and then search for proceeding number "98-80"). Instructions on how to file comments with the FCC may be downloaded from http://www.nab.org/MembersOnly/Legal/HowToFileFCC.asp (login as "nab member" with password "222").

CP APPLICATIONS FOR COMMERCIAL DTV STATIONS DUE THIS FALL

In its Fifth Report and Order (MM Docket 87-268), the FCC set a deadline for the filing of DTV construction permit (CP) applications. This deadline is November 1, 1999, for all commercial TV stations. The FCC's processing priority and evaluation of the CP applications will be done based on several categories in which the DTV application fits.

Courtenay S. Brown, Editor **Tel: +1 (202) 429-5341** **Fax: +1 (202) 775-4981**

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PLEASE FORWARD TO THE ENGINEERING DEPARTMENT

National Association of BROADCASTERS NAB

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National Association of Broadcasters NAB

Radio TechCheck ✓

The weekly newsfax for Radio broadcast engineers October 25, 1999

4

FCC PROPOSES ENHANCED INTERFERENCE PROTECTION FOR AM RADIO

On October 18, 1999, the FCC released a *Notice of Proposed Rule Making* (NPRM) in ET Docket 98-80 that proposes tighter limits on the amount of AM-band RF energy that may be conducted onto the AC power lines by such things as computers and microwave ovens. The Commission said that, through this proceeding, it hopes to make its rules "more effective in controlling interference to communications services."

ET Docket 98-80 began last year with a *Notice of Inquiry* that asked a number of questions about the FCC rules regarding RF energy that is conducted onto the AC power lines by various electronic devices. NAB hired the engineering consulting firm Carl T. Jones Corporation to test AM radios and determine the degree to which they are susceptible to interference conducted through the AC power line (see September 14, 1998, *Radio TechCheck*). As a result of the data collected by Carl T. Jones, NAB filed comments with the FCC recommending that the conducted emission limits be tightened significantly.

The recently released NPRM proposes to reduce the amount of AM-band energy that may be conducted onto the AC power lines by computers, television sets and other electronic devices used in the home from 250 microvolts to 200 microvolts, as measured using an average detector. If a quasi-peak detector is used to measure compliance then the proposed change in emission limit is from 1,117 microvolts to 631 microvolts. The FCC also proposes to impose a 200 microvolt (average detector) or 631 microvolt (quasi-peak detector) limit on AM-band emissions from microwave ovens. Currently, microwave ovens are not subject to any AC power line conducted emission limits.

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NAB2000: Call For Proposals

NAB Science & Technology is accepting proposals for presentations for NAB2000 until November 15. To submit a paper online, visit our website at http://www.nab.org/conventions/nab2000/papers_form.asp.

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AM

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The weekly newsfax for **Radio** broadcast engineers October 25, 1999

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AM 5

PLEASE FORWARD TO THE ENGINEERING DEPARTMENT

National Association of Broadcasters

Radio TechCheck

The weekly newsfax for **Radio** broadcast engineers July 5, 1999

FCC COMMENTS ON CROSSED-FIELD ANTENNAS

Last week's *Radio TechCheck* on crossed-field antennas (CFAs), noted that the FCC has an interest in identifying the performance data needed to determine if CFA's can be authorized for use by AM broadcasters in the U.S. As part of this ongoing effort, last week the FCC compiled a list of items that need to be addressed and presented this list to the developers of the CFA in a letter dated June 29, 1999.

Two of the CFA's developers, Dr. Brian Stewart and Dr. Fathi Kabbary, presented the theory behind the operation of the CFA and its use by the Egyptian Radio and TV Union for medium wave broadcast operations at the 1999 NAB Broadcast Engineering Conference (their paper is published in the BEC proceedings, available from the NAB store on the NAB website). A limited amount of measured performance data was included in this paper, however this data was not sufficient to satisfy the requirements of the FCC as described in their letter.

The items listed here are from the FCC's letter, with references to specific FCC rules (the rule citations can be found at http://www.access.gpo.gov/nara/cfr/cfr-retrieve.html):

- It must be demonstrated that the CFA can produce certain minimum effective radiated fields at 1 km depending on the class of station involved. The minimum field varies from 241 mV/m @ 1 km for a class "C" station, to 362 mV/m @ 1 km for clear channel class "A" stations. See 47 CFR 73.182(m) and 47 CFR 73.189.
- The efficiency of the CFA must be proven by a complete non-directional antenna proof-of performance as defined in 47 CFR 73.186 of the Rules. The measurements should be taken on eight (8) equally spaced radials using the number of measurements given in this section as a minimum only. It would be beneficial if the close-in measurements were taken at shorter intervals and also taken up to the perimeter of the ground system.
- When making the field intensity measurements, it is imperative that the power into the system be held constant.
- If the station is to operate nighttime, the FCC needs to have an equation for calculating the CFA's vertical plane radiation characteristic f(Θ). See 47.CFR 73.150.
- The FCC is required by the National Environmental Policy Act of 1969 to evaluate the effect of emissions from FCC regulated transmitters on the quality of the human environment. At the present time there is no federally mandated RF exposure standard. However, several non-government organizations, including the American National Standards Institute, the Institute of Electrical and Electronics Engineers, Inc., and the National Council on Radiation Protection and Measurements have issued recommendations for human exposure to RF electromagnetic fields. The potential hazards associated with RF electromagnetic fields are discussed in OET Bulletin No. 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* (available at http://www.fcc.gov/oet/info/documents/bulletins). Since the CFA radiates RF energy, the FCC needs to know the distance a fence must be placed to insure compliance with the OET 65 guidelines, or what other methods can be used to protect the public from the CFA's radiation.
- The FCC is also interested in the land and property requirements for the antenna system. What are the ground system requirements? Are buried ground radials utilized? Can the efficiency be further improved by using longer radials or more radials?

These items, while specifically addressing the required performance information for CFA's, also more generally describe the information needed on any antenna configuration proposed for use in the AM broadcasting service in the U.S. At this point, it is not clear exactly when or how the CFA developers will obtain the necessary information listed above. There are currently no CFAs under construction for use by licensed AM broadcasters in the U.S., however, it is not necessary that this data be obtained from a U.S. facility.

Continuing developments in this technology, and in the FCC's evaluation, will be followed closely by NAB and reported on in future editions of *Radio TechCheck*.

ENGINEERING CERTIFICATION WORKSHOPS AT THE NAB RADIO SHOW

Hone your skills in these intensive Engineering Certification workshops and receive a certificate signifying completion of each workshop. Attending these workshops may qualify as credit toward SBE re-certification.

Tuesday, August 31, 8:00 AM – 5:00 PM
NAB AM Directional Antenna (DA) Workshop

Wednesday, September 1, 8:00 AM – 5:00 PM
Digital Facilities Workshop

Thursday, September 2, 8:00 AM – 3:00 PM
AM/FM Transmitter Workshop

You can view exhibitor lists and program details, register and find housing for the NAB Radio Show by visiting the NAB website at www.nab.org/conventions/RADIOSHOW or by calling (732) 544-2888 from your fax handset.

Courtenay S. Brown, Editor **Tel: +1 (202) 429-5341** **Fax: +1 (202) 775-4981**

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- The FCC is required by the National Environmental Policy Act of 1969 to evaluate the effect of emissions from FCC regulated transmitters on the quality of the human environment. At the present time there is no federally mandated RF exposure standard. However, several non-government organizations, including the American National Standards Institute, the Institute of Electrical and Electronics Engineers, Inc., and the National Council on Radiation Protection and Measurements have issued recommendations for human exposure to RF electromagnetic fields. The potential hazards associated with RF electromagnetic fields are discussed in OET Bulletin No. 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* (available at http://www.fcc.gov/oet/info/documents/bulletins). Since the CFA radiates RF energy, the FCC needs to know the distance a fence must be placed to insure compliance with the OET 65 guidelines, or what other methods can be used to protect the public from the CFA's radiation.
- The FCC is also interested in the land and property requirements for the antenna system. What are the ground system requirements? Are buried ground radials utilized? Can the efficiency be further improved by using longer radials or more radials?

These items, while specifically addressing the required performance information for CFA's, also more generally describe the information needed on any antenna configuration proposed for use in the AM broadcasting service in the U.S. At this point, it is not clear exactly when or how the CFA developers will obtain the necessary information listed above. There are currently no CFAs under construction for use by licensed AM broadcasters in the U.S., however, it is not necessary that this data be obtained from a U.S. facility.

Continuing developments in this technology, and in the FCC's evaluation, will be followed closely by NAB and reported on in future editions of *Radio TechCheck*.

ENGINEERING CERTIFICATION WORKSHOPS AT THE NAB RADIO SHOW

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NAB AM Directional Antenna (DA) Workshop

Wednesday, September 1, 8:00 AM – 5:00 PM
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Courtenay S. Brown, Editor **Tel: +1 (202) 429-5341** **Fax: +1 (202) 775-4981**

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AM

PLEASE FORWARD TO THE ENGINEERING DEPARTMENT

National Association of Broadcasters NAB

Radio TechCheck

The weekly newsfax for **Radio** broadcast engineers July 5, 1999

FCC COMMENTS ON CROSSED-FIELD ANTENNAS

Last week's *Radio TechCheck* on crossed-field antennas (CFAs), noted that the FCC has an interest in identifying the performance data needed to determine if CFA's can be authorized for use by AM broadcasters in the U.S. As part of this ongoing effort, last week the FCC compiled a list of items that need to be addressed and presented this list to the developers of the CFA in a letter dated June 29, 1999.

Two of the CFA's developers, Dr. Brian Stewart and Dr. Fathi Kabbary, presented the theory behind the operation of the CFA and its use by the Egyptian Radio and TV Union for medium wave broadcast operations at the 1999 NAB Broadcast Engineering Conference (their paper is published in the BEC proceedings, available from the NAB store on the NAB website). A limited amount of measured performance data was included in this paper, however this data was not sufficient to satisfy the requirements of the FCC as described in their letter.

The items listed here are from the FCC's letter, with references to specific FCC rules (the rule citations can be found at http://www.access.gpo.gov/nara/cfr/cfr-retrieve.html):

- It must be demonstrated that the CFA can produce certain minimum effective radiated fields at 1 km depending on the class of station involved. The minimum field varies from 241 mV/m @ 1 km for a class "C" station, to 362 mV/m @ 1 km for clear channel class "A" stations. See 47 CFR 73.182(m) and 47 CFR 73.189.
- The efficiency of the CFA must be proven by a complete non-directional antenna proof-of performance as defined in 47 CFR 73.186 of the Rules. The measurements should be taken on eight (8) equally spaced radials using the number of measurements given in this section as a minimum only. It would be beneficial if the close-in measurements were taken at shorter intervals and also taken up to the perimeter of the ground system.
- When making the field intensity measurements, it is imperative that the power into the system be held constant.
- If the station is to operate nighttime, the FCC needs to have an equation for calculating the CFA's vertical plane radiation characteristic f(Θ). See 47.CFR 73.150.
- The FCC is required by the National Environmental Policy Act of 1969 to evaluate the effect of emissions from FCC regulated transmitters on the quality of the human environment. At the present time there is no federally mandated RF exposure standard. However, several non-government organizations, including the American National Standards Institute, the Institute of Electrical and Electronics Engineers, Inc., and the National Council on Radiation Protection and Measurements have issued recommendations for human exposure to RF electromagnetic fields. The potential hazards associated with RF electromagnetic fields are discussed in OET Bulletin No. 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* (available at http://www.fcc.gov/oet/info/documents/bulletins). Since the CFA radiates RF energy, the FCC needs to know the distance a fence must be placed to insure compliance with the OET 65 guidelines, or what other methods can be used to protect the public from the CFA's radiation.
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6

OFFICE MEMORANDUM

TO: All Engineers

FROM: Don Everist

TOPIC: MM Docket No. 93-177

DATE: June 14, 1999

This is of more than routine interest.

Attachment

PLEASE FORWARD TO THE ENGINEERING DEPARTMENT

National Association of Broadcasters NAB

Radio TechCheck ✓

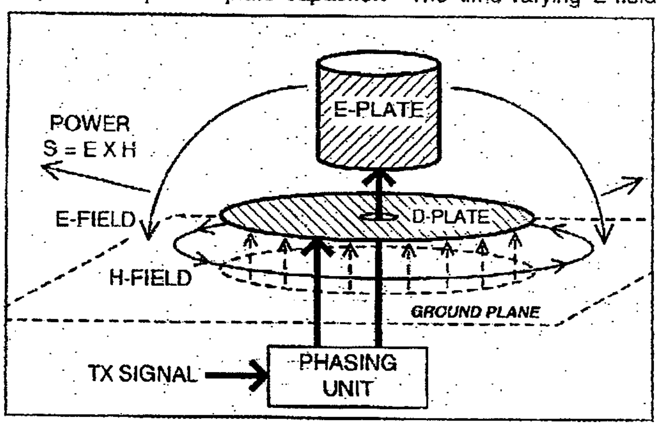
The weekly newsfax for Radio broadcast engineers FEBRUARY 15, 1999

Crossed-Field Antennas for AM Broadcasting

AM broadcasters may be on the verge of an antenna revolution, according to a paper to be presented at the 1999 NAB Broadcast Engineering Conference, with the advent of a new design known as a Crossed-field antenna (CFA). Currently in limited operation for the Egyptian Radio and Television Union (ERTU), the CFA represents a fundamentally different approach to medium wave (MW) antenna design.

The ERTU deployment of this new technology, as well as a description of its theory of operation, is highlighted in the paper "Four Egyptian MW Broadcast Crossed-Field Antennas," by F.M. Kabbary, M. Khattab, B.G. Stewart, M.C. Hatley, and A. Fayoumi. According to this paper, the key breakthrough which the CFA achieves is that it is able to establish a similar relationship between the electric and magnetic fields (the "E" and "H" fields, respectively) in the "near-field" region of propagation as that which exists in the "far-field" region, which improves the efficiency of the antenna, and has other beneficial effects. This is in contrast to traditional dipole or tower MW antennas, in which the strong E and H fields in the near-field region are 90° out of time-phase, resulting in wasteful reactive (non-radiated) power in the near vicinity of the structure.

The first figure shows the general concept of a ground plane (GP) CFA. Power from a transmitter is fed into a phasing unit from which two voltage feeds are taken to two separate field electrodes, the D-plate and the E-plate. The E-plate is a hollow metal cylinder which produces curved E-field lines to the GP. The D-plate is a circular metal disk which, in conjunction with the GP, forms a parallel-plate capacitor. The time-varying E-field

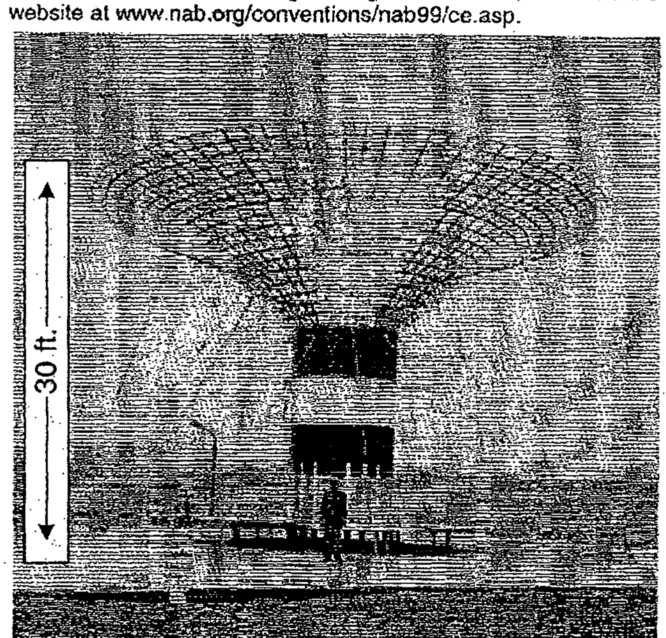


lines between the D-plate and the GP produce H-field lines surrounding the capacitor, which link with the E-field to produce significant power radiation.

This field behavior in the region immediately surrounding the antenna (called the *interaction zone* by the authors) is very different from what happens in the same region for a traditional AM antenna, primarily because the E and H fields are in time synchronism (due to precise adjustment of the phasing unit), and also because with a CFA the ratio of the E and H fields (called the wave impedance) matches the impedance of free space. As in circuit theory, a matched-impedance condition results in maximizing the useful power transfer (in this case, to the radiated fields) and minimizes the wasteful reactive power. Consequently, the inductive fields which normally surround an AM antenna are greatly reduced in the CFA, meaning increased safety for broadcast station personnel, and also that antennas operating at different frequencies can be located closer together without interference.

An enhancement to the basic CFA design shown in the figure involves adding conic sections to the cylindrically-shaped E-plate, resulting in an antenna configuration as shown in the photograph. (The pictured antenna operates at 100 kW with a center frequency of 603 kHz and a bandwidth of 48 kHz. Note that its height is only 1.8% of a wavelength, and that at this operating frequency, a conventional $\lambda/4$ tower would need to be about 400 ft. high.) The addition of the conic sections has the effect of confining the curved E-field lines in the interaction zone to low angles, producing a significant increase in ground-wave radiation and an accompanying decrease in sky-wave radiation.

In the paper's conclusion, the authors provide a list of the CFA's advantages, and note that the ERTU is planning to replace all of its conventional MW and LW broadcast antennas with CFA systems in the coming years. For more information about the 1999 NAB Broadcast Engineering Conference, visit NAB's website at www.nab.org/conventions/nab99/ce.asp.



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8

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

December 6, 1979

IN REPLY REFER TO:
8800-DW

COHEN AND DIPPELL
RECEIVED
DEC 7 1979
WASHINGTON, D.C.

Mr. Donald G. Everist, Chairman
FCC Processing and Procedure Committee
Association of Federal Communications
Consulting Engineers
1015 - 15th Street, N. W., Suite 703
Washington, D. C. 20005

Dear Mr. Everist:

I have your letter of October 22nd, written on behalf of your committee, requesting modification of certain Commission engineering practices used in assigning monitoring point limits to AM directional broadcast stations. Your letter formalizes suggestions developed in a series of meetings, begun well over a year ago, between your committee and members of the Broadcast Facilities Division's engineering staff concerning the policies and procedures governing the preparation and processing of various types of applications. The interest shown throughout this period by your committee in helping improve our processing procedures has been helpful and is greatly appreciated.

Specifically, your committee feels that, under the present policy, monitoring point limits are often assigned which are unnecessarily restrictive and urges the adoption of a policy whereby the assignment of these limits is based on the "direct ratio" method. The committee also urges the establishment of a policy whereby stations subject to seasonal conductivity changes can achieve relaxed limits upon submission of "seasonal proofs." Additionally, the committee requests that the Commission refrain from altering monitoring point limits based on partial proofs of performance if "substantial conformance" of the radiation patterns is demonstrated and the antenna parameters are either essentially unchanged or, if changed, adequately justified.

In response to your first suggestion, I am pleased to announce that we have, on an experimental basis, adopted the policy of assigning monitoring point limits using the direct ratio method. Under the direct ratio method, monitoring point limits are obtained by multiplying the measured field strength at a monitoring point by the ratio of the authorized maximum radiation divided by the unattenuated radiation established in the proof of performance. This method simply restricts unattenuated radiation to within its maximum authorized value whereas the traditional method, in many cases, restricted radiation much more severely. Theoretically, objectionable interference is not caused if antenna radiation is maintained below its maximum authorized value. Assuming, therefore, that changes in monitoring point field strength correspond directly to changes in antenna radiation, monitoring point limits determined by the direct ratio method should be adequate to avoid interference. However, since the assumption of a linear relationship between monitor point readings and antenna radiation becomes somewhat questionable with excessive changes, we do not intend to assign limits higher than 200% above proof values. In addition, because operation with monitoring point field strength in excess of the direct ratio limit could result in objectionable interference, we will continue to deny requests to exceed those limits.

Your second suggestion addresses a problem encountered in many areas of the country where complete proofs of performance are done during the summer months when ground conductivity is significantly lower than during the winter months. Often monitoring point limits resulting from such summertime proofs are not sufficient to accommodate higher readings encountered during winter. In such a case increased limits are obtained by collecting supplemental wintertime data in the form of a partial proof of performance consisting of at least 10 measurements on each radial established in the complete proof (see Section 73.154(a) of the Rules). You suggest that the Commission accept "seasonal proofs" for this purpose in lieu of partial proofs. A seasonal proof would consist of "at least 20 field strength measurements, both nondirectional and directional, on each of the radials specified in the construction permit and at least one radial in the major lobe."

In responding to this suggestion, it is helpful to understand the approach used by Commission engineers in analyzing complete proofs of performance. These generally consist of 20 or 30 measurements per radial (see Section 73.186(a)(1)) and serve as the reference for all subsequent partial proofs. As you know, the fundamental problem is distinguishing between the effects of conductivity and antenna radiation. In making this distinction, we consider it imperative to establish, as conclusively as possible, the size and shape of the nondirectional radiation pattern. The nondirectional radiating system is simpler (fewer variables) than the directional system and its RMS (size) can be more accurately determined since each measured radial is of more or less equal significance, particularly if the radials are evenly spaced. With a directional pattern, many of the minor-lobe and null radials do not contribute significantly toward defining the RMS, leaving the remaining main lobe radials with a disproportionate influence on the determination of the pattern size. For these same reasons, the Commission relies entirely on nondirectional measurement data in determining the extent of seasonal changes in conductivity.

Because of the crucial role played by the nondirectional pattern resulting from a complete proof of performance, extreme care is used in analyzing the measurement data. Experienced engineers who have been carefully trained are used in this work. All known external factors such as terrain features, reradiating structures, pipe lines, etc., are taken into account. Each radial is repeatedly weighed against the others with constant attention to the resulting pattern shape and RMS and the analysis is not considered complete until the importance of each element of data is understood from the perspective of the whole. Of course, the more extensive and "well behaved" the measurement data, the more precise and confident the engineer can be with his/her analysis. Once the nondirectional pattern is established, analysis of the directional data can usually be done mathematically, rather than graphically, using either arithmetic or logarithmic averages. Any subsequent nondirectional partial proofs which are submitted to the Commission for the purpose of documenting suspected conductivity changes are mathematically analyzed, point for point along each radial, against the complete proof nondirectional data (see Section 73.186(a)(5)). If the possibilities of distortion and changed RMS can be eliminated from the partial proof nondirectional pattern, then the extent of conductivity change along each radial can be determined and applied to the directional partial proof data revealing whether, in fact, observed changes in directional field strengths resulted from changes in the radiation pattern or simply from conductivity changes.

The notion of a seasonal proof, to the extent that some of the proof radials would be eliminated, strikes at the very heart of our approach which is an accurate determination of the nondirectional radiation pattern. Although, under the committee's suggestion, the minimum number of measurements on some radials would be raised from 10 to 20, we do not feel the value gained from additional data on these radials would be sufficient to offset the complete loss of data on the remaining radials. This is also the case for directional patterns where changes in radiation in some directions can affect radiation in other directions and assumptions of pattern symmetry are generally unreliable. The Commission encourages supplemental measurements in addition to the minimum of 10 per radial required by the Rules; this should not be accomplished, however, at the expense of fewer measurements on other radials.

Your last suggestion concerns the Commission's assignment of monitoring point limits in response to partial proofs of performance conducted following antenna repairs, refurbishment, construction or readjustment. Often such proofs result in a reduction in limits below those previously assigned because measurements were taken during periods of low conductivity or because antenna radiation in some directions was reduced. The committee suggests we not lower limits in such cases if the pattern remains in substantial conformance and the antenna parameters (phases and current ratios) are either essentially unchanged or, if changed, adequately justified. We believe this suggestion has merit and have, also on an experimental basis, ceased the practice of lowering limits based on partial proofs except when such limits would exceed measured values by more than 200%.

We feel that the current mandatory use of type-approved antenna monitors by directional stations and the widespread use of approved sample systems permit these changes in policy at this time without endangering in any way the technical integrity of our AM broadcasting system. Nonetheless, because of the significance of these changes, we intend to proceed on an experiemental basis for at least a year, gaining the benefit of practical experience, before permanently adopting them. In addition, cases clearly falling beyond the scope of these policies will continue to be handled on a case-by-case basis.

We are hopeful that the changes we have initiated in response to your suggestions will provide many stations with operating tolerances sufficient to accommodate variations which, under our old policy, would have required a proof of performance and the filing of an application with the Commission. Again, I would like to express my sincere appreciation for the work done by your committee in bringing forth these suggestions.

Sincerely,

Richard J. Shiben
Chief, Broadcast Bureau

Draft Comments on MM Docket No. 93-177, AM Directional Antenna Performance Verification

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

In the Matter of	)	
	)	
An Inquiry Into the Commission's	)	
Policies and Rules Regarding AM	)	MM Docket No. 93-177
Radio Service Directional Antenna	)	
Performance Verification	)	

COMMENTS OF THE ASSOCIATION OF FEDERAL COMMUNICATIONS CONSULTING ENGINEERS ON NOTICE OF PROPOSED RULEMAKING

Introduction

The Association of Federal Communications Consulting Engineers (AFCCE), celebrating 50 years, is an organization that includes approximately 90 full members who are Registered Professional Engineers engaged in the practice of consulting engineering before the Federal Communications Commission.

AFCCE supports and commends the Commission for its efforts to review and, where possible, simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas. However, as the Commission notes in paragraph 7, "Prevention of interference among AM broadcast station [sic] remains a core regulatory function of this Commission." While antenna proofs of performance impose a financial burden upon AM broadcasters, it is not a burden that has been concealed by Commission policy, rules, or regulations from station owners, nor is a service-specific burden unique to the AM service. We suspect that almost every broadcast service, when offered the possibility of relief, could identify costs that pose a greater burden for that service than for other broadcast services. The AFCCE can only support those changes in the rules which do not compromise the technical integrity of the broadcast spectrum.

Computer Modeling versus Proofs of Performance

If the Commission adopts the use of computer modeling as proof of compliance, the Commission's staff must be prepared to certify which computer programs and computers are permitted and which are not. Moreover, the Commission's staff must be prepared to replicate a given set of results in the event of disagreements. Both these requirements may take the Commission into controversial areas. However, as noted next, these possibilities are moot.

The use of computer modeling in lieu of field measurements has two fatal flaws. First, the inputs to any model are based on the engineer's beliefs concerning a specific antenna. Models are useful tools for achieving a desired antenna performance when designing or adjusting an array. However, unlike directional FM or TV antennas, which are measured on an antenna range before being shipped to a site and installed, AM arrays are built at the site. Only the on-site measurements can allow for variations in tower assembly, bonding of such items as critical joints, cables and appendages, and the effect of the surrounding environment.

The second fatal flaw in depending upon computer modeling is that it is unverifiable by external means. Only field strength measurements can be made by the station, by the FCC, and by other stations without local coordination. Computer models are only as good as the input parameters. Reliance upon computer modeling would be an invitation to fraud and corruption. The Commission's enforcement practices depend upon two principles; one, that most licensees try to abide by the rules, and two, that violators can be caught without undue effort. The second of these principles requires enforcement based on observed effect rather than claimed input. In the process, it would shift the present emphasis on self-policing by licensees to near continuous enforcement by the Commission's staff.

Directional Antenna Proofs of Performance

The Commission currently requires a minimum of eight radials, each with a minimum of 30 points between zero and 25 or 43 kilometers (zero and 15.5 or 20 miles) for a full proof. A partial proof currently requires at least 10 points between three and 16 kilometers (two and 10 miles) for each radial used in the last full proof. The Commission proposes to reduce the requirements for a full proof to a minimum of six radials, each with a minimum of 15 points between zero and 15 kilometers (zero and nine miles). The Commission proposes to reduce the requirements for a partial proof to a minimum of eight points per radial with no other changes in the partial proof.

Full Proof of Performance

The purpose of a full proof of performance is to establish the fundamental base line for showing antenna performance and compliance. A full proof is required when the antenna is first constructed and when any permanent changes are made in the location, height, or directional radiating characteristics of the antenna. A full proof of performance is a rare event in the life of an AM station. Many stations have been on for decades and have not had a full proof of performance since the ones that were made when they were constructed.

Because of the fundamental and infrequent nature of a full proof, we believe the Commission should look closely at the cost savings before using cost as a justification to reduce the requirements for a full proof. The cost difference between a full proof using the present rules and a full proof using the proposed rules is a small part of the engineering cost of building or modifying an AM array. The engineering costs include the design and adjustment of the array as well as the final proof measurements. While a consulting engineer usually designs and adjusts a new or modified array, it is common practice for the radial measurements to be taken by support personnel. The proposed reduction of 25 percent of the points for simple arrays, while it will reduce some of the time spent by support personnel in collecting data at the longer radial distances, may increase the time required by engineering personnel to analyze the data, since the relative spread in the data will be greater.

With regard to nondirectional stations which are required to conduct a full proof due to the proximity of reradiating structures, etc., the Commission proposes reducing the number of evenly spaced radials from eight to six. We oppose this reduction for a full proof for the same reasons as noted above. However, in those cases where measurements are required for a nondirectional antenna because of the impending construction of a new tower nearby and a previous full proof does not exist, we would support requiring a minimum of six radials for a partial proof, provided that at least four are on the side facing the proposed construction at no more than 45 degree spacing symmetrical about the bearing to the new construction, while the side opposite the new construction has a minimum of two radials at no more than 75 degrees spacing.

Partial Proof of Performance

The purpose of a partial proof of performance is to verify that the array is still in compliance. As noted in the NPRM, many things can trigger the need for a partial proof. If the monitoring point or antenna monitor reading limits are exceeded, if the antenna system is altered by attaching or replacing items such as guy wires, cables, isocouplers, other antennas, etc., or if the station has been dark for more than six months, a partial proof is needed to determine that the array is still functioning as intended. If the partial proof and the antenna monitor readings indicate compliance, there is a high degree of probability that a full proof would also show compliance.

Because of the diagnostic nature of a partial proof, a directional station can anticipate many partial proofs in the course of its existence. For this reason, reducing the cost of a partial proof is more important than reducing the cost of a full proof. Reducing the cost of a partial proof also increases the likelihood that station management will authorize the measurements when the need is indicated. A partial proof typically utilizes a much higher ratio of support personnel to engineering personnel and the proposed reduction of 20 percent or more in the number of points would be a more significant reduction in the partial proof cost than the 25 percent reduction proposed for a full proof.

We support reducing the number of required points per radial for a partial proof from the present 10 to the proposed eight because the cost savings may outweigh the increased engineering risk. The Commission should make clear its ability to require a full proof if a partial proof does not seem to agree with interference measurements or other indications of noncompliance. In addition, the Commission should increase substantially the fine for noncompliant operation to provide more incentive for partial proofs when the need is indicated.

Monitoring Points

If partial proofs are the verification of compliance, then monitoring point measurements are the warning system that a problem may exist. However, monitoring points are based on the full proof, not the partial proof. If a monitoring point needs to be changed because of construction or other factors, then the full proof data should be used rather than a radial partial proof. We agree with the Commission's proposal to assign limits to new monitoring points based on the last full proof of performance.

The Commission proposes eliminating the requirement for maps and directions for applicants using differential GPS-determined coordinates. This precludes the use of coordinates determined by survey or by techniques that may be developed in the future. We recommend that the Commission accept coordinates as a means of locating monitoring points but specify the required accuracy rather than the method.

Finally, regarding augmentation of radials which involve a required monitoring point, 47 C.F.R. 73.152(c)(2)(iv)(B) allows 120 percent augmentation of the actual measured inverse field value if the measured inverse field exceeds the value permitted by the standard pattern. If the data for a monitoring point radial is analyzed and found to be 99 percent of the standard pattern, the field strength limit for the monitoring point will be set at essentially the standard pattern value, leaving no room for drift or seasonal variations. If the data for a monitoring point radial is analyzed and found to be 101 percent of the standard pattern, the field strength limit can be set significantly above the standard pattern by augmenting the radial.

This is an incentive to analyze the data on monitoring point radials where the result is near the standard pattern value as above the standard pattern value. Since analyzing field strength data involves judgment as well as engineering, there is an inherent conflict. We recommend the Commission eliminate this conflict as part of the present NPRM by allowing a positive 10 percent adjustment to monitoring point values for monitoring point values between 90 and 100 percent of the standard pattern value.

AM Station Equipment & Measurements

We agree with the Commission's proposal to delete the requirement for base current ammeters or toroidal transformers for those directional stations employing approved antenna sampling systems.

Antenna Monitors

We agree that 47 C.F.R. 73.53(c) can be moved to 47 C.F.R. 73.69. We are puzzled as to why the other requirements of 47 C.F.R. 73.53, with the possible exception of 47 C.F.R. 73.53(b)(1), impede the development of antenna monitor systems using advanced technology. These requirements are minimum requirements that a monitor should pass for it to be used to verify and maintain array compliance on a day-to-day basis. A monitor that can not pass these requirements will be of limited value to the station licensee or to an FCC field inspector.

We agree that voltage sampling devices are appropriate as alternatives to sampling transformers and pick-up loops and can be used to feed antenna monitors for towers with electrical lengths of 130 degrees or less.

Impedance Measurements Across a Range of Frequencies

We agree with the proposal to delete the requirement to measure impedance across a range of frequencies. The Commission presently imposes no requirements on the audio quality of AM stations, which is the reason for measuring impedance across the signal bandwidth. However, we note in passing the Commission's statement that "...we have no reason to believe that audio and video quality of broadcast stations has been lessened by deletion of those requirements [15 years ago]." (paragraph 35) We have observed several AM stations in rural areas with audio quality so poor as to be almost unintelligible. Some of these stations have eventually gone dark. Others remain on the air as the only station in a small town. We are unsure as to whether this type of deregulation is in the public interest.

Common Point Impedance Measurements

We agree with the proposal to delete the requirement that the common point reactance should be adjusted to zero ohms. We recommend that this requirement be replaced with a requirement that the common point reactance be adjusted to between zero and minus 20 percent of the common point resistance.

Critical Arrays

We agree with the proposal to discontinue specifying the use of special precision monitors, provided that the monitor requirements continue to require stability over the present range of environmental and electrical parameters and that the monitor installed has sufficient accuracy and precision to assure compliance with the license requirements.

The Commission's computer code for determining array stability has not been available long enough for a detailed evaluation. We request that the Commission's proposals regarding reclassifying critical arrays be postponed until the computer code has received more extensive review. As a practical matter, this may best be achieved by staying the effective date of these rule changes for a period of six months.

REVISION 1 Draft Comments on MM Docket No. 93-177, AM Directional Antenna Performance Verification

Before the
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Washington, D.C. 20554

In the Matter of)
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An Inquiry Into the Commission's)
Policies and Rules Regarding AM) MM Docket No. 93-177
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AFCCE supports and commends the Commission for its efforts to review and, where possible, simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas. However, as the Commission notes in paragraph 7, ▓ Prevention of interference among AM broadcast station [sic] remains a core regulatory function of this Commission.▓ While antenna proofs of performance impose a financial burden upon AM broadcasters, it is not a burden that has been concealed by Commission policy, rules, or regulations from station owners, nor is a service-specific burden unique to the AM service. We suspect that almost every broadcast service, when offered the possibility of relief, could identify costs that pose a greater burden for that service than for other broadcast services. The AFCCE can only support those changes in the rules which do not compromise the technical integrity of the broadcast spectrum.

However, it is equally true that the Commission should simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas (as well as all other licensees) when the cost benefits are substantial and the risk of technical compromise can be eliminated by adequate safeguards. The challenge for the Commission is to enact rule changes that reduce costs without eliminating the ability of the broadcaster to verify both his own and his competitors' compliance.

Computer Modeling versus Proofs of Performance

If the Commission adopts the use of computer modeling as proof of compliance, the Commission's staff must be prepared to know and provide public notification as to which computer programs are acceptable. Moreover, the Commission's staff must be prepared to replicate a given set of results in the event of disagreements. Both these requirements may take the Commission into controversial areas. It will be important for the Commission to provide the necessary staff resources to prepare for the use of computer modeling before accepting such proofs.

For directional FM or TV antennas every effort is made to duplicate during design the near field conditions for the antenna including tower shape, cables, and other appurtenances. The antenna is then measured on an antenna range rather than on site because of the unpredictable effects of multipath and reflections on the measurement process. The antenna is then shipped to a site and installed. Restrictions are placed on the local environment around the antenna so that the pattern will not be distorted by the environment but will stay as measured on the test range.

AM arrays are built at the site. Only on-site measurements can allow for variations in tower assembly, bonding of such items as critical joints, cables and appendages, and the effect of the surrounding environment. These on-site measurements have historically consisted of field strength measurements. As computer models have become more elaborate, more accurate representations of the array and the impact of the local environment on the array have become possible. The method of moments model in many cases can predict array performance at least as well as can be measured using traditional field measurements. Models have been useful tools for several years for achieving a desired antenna performance when designing or adjusting an array.

The use of computer modeling in lieu of field measurements has two critical problems. First, the inputs to any model are based on the engineer's beliefs concerning a specific antenna. For example, tower height is an important parameter in predicting performance. Survey measurements on existing towers often reveal heights up to several feet different than claimed on the available documentation. Tower spacings and array orientation also must be accurately verified to avoid errors in the modeling process. Tower integrity can be a serious problem on older towers as well as on new towers assembled by inexperienced personnel.

The second critical problem in depending upon computer modeling is that it is unverifiable by external means. Only field strength measurements can be made by the station, by the FCC, and by other stations without local coordination. Reliance upon computer modeling exclusively would be an invitation to fraud and corruption. The Commission's enforcement practices depend upon two principles; one, that most licensees try to abide by the rules, and two, that violators can be caught without undue effort. The second of these principles requires enforcement based on observed effect rather than claimed input.

We recommend that the use of computer modeling be permitted as an alternative to field measurements except in cases of dispute and that field measurements continue to be the final authority in cases of dispute. This approach is similar to the Commission's policy on the use of topographic data files in lieu of maps (see 47 C.F.R. 73.312(d)). Cases of dispute would include disagreements between broadcast stations and between a broadcast station and a communications tower owner, for example.

Those stations using computer modeling should be required (1) to install the necessary antenna monitoring system to monitor absolute current or voltage and phase rather than relative current and phase, (2) to have a professional surveyor certify the physical parameters of the array, and (3) to have tower integrity certified by a recognized tower inspection firm at least every three years.

Directional Antenna Proofs of Performance

The Commission currently requires a minimum of eight radials, each with a minimum of 30 points between zero and 25 or 43 kilometers (zero and 15.5 or 20 miles) for a full proof. A partial proof currently requires at least 10 points between three and 16 kilometers (two and 10 miles) for each radial used in the last full proof. The Commission proposes to reduce the requirements for a full proof to a minimum of six radials, each with a minimum of 15 points between zero and 15 kilometers (zero and nine miles). The Commission proposes to reduce the requirements for a partial proof to a minimum of eight points per radial with no other changes in the partial proof.

Full Proof of Performance

The purpose of a full proof of performance is to establish the fundamental base line for showing antenna performance and compliance. A full proof is required when the antenna is first constructed and when any permanent changes are made in the location, height, or directional radiating characteristics of the antenna. A full proof of performance is a rare event in the life of an AM station. Many stations have been on for decades and have not had a full proof of performance since the ones that were made when they were constructed.

Because of the fundamental and infrequent nature of a full proof, we believe the Commission should look closely at the cost savings before using cost as a justification to reduce the requirements for a full proof. The cost difference between a full proof using the present rules and a full proof using the proposed rules is a small part of the engineering cost of building or modifying an AM array. The engineering costs include the design and adjustment of the array as well as the final proof measurements. While a consulting engineer usually designs and adjusts a new or modified array, it is common practice for the radial measurements to be taken by support personnel. The proposed reduction of 25 percent of the points for simple arrays, while it will reduce some of the time spent by support personnel in collecting data at the longer radial distances, may increase the time required by engineering personnel to analyze the data, since the relative spread in the data will be greater.

With regard to nondirectional stations which are required to conduct a full proof due to the proximity of reradiating structures, etc., the Commission proposes reducing the number of evenly spaced radials from eight to six. We oppose this reduction for a full proof for the same reasons as noted above. However, in those cases where measurements are required for a nondirectional antenna because of the impending construction of a new tower nearby and a previous full proof does not exist, we would support requiring a minimum of six radials for a partial proof, provided that at least four are on the side facing the proposed construction at no more than 45 degree spacing symmetrical about the bearing to the new construction, while the side opposite the new construction has a minimum of two radials at no more than 75 degrees spacing.

As noted in the previous section, we recommend that the use of computer modeling be permitted as an alternative to field measurements except in cases of dispute and that field measurements continue to be the final authority in cases of dispute.

Partial Proof of Performance

The purpose of a partial proof of performance is to verify that the array is still in compliance. As noted in the NPRM, many things can trigger the need for a partial proof. If the monitoring point or antenna monitor reading limits are exceeded, if the antenna system is altered by attaching or replacing items such as guy wires, cables, isocouplers, other antennas, etc., or if the station has been dark for more than six months, a partial proof is needed to determine that the array is still functioning as intended. If the partial proof and the antenna monitor readings indicate compliance, there is a high degree of probability that a full proof would also show compliance.

Because of the diagnostic nature of a partial proof, a directional station can anticipate many partial proofs in the course of its existence. For this reason, reducing the cost of a partial proof is more important than reducing the cost of a full proof. Reducing the cost of a partial proof also increases the likelihood that station management will authorize the measurements when the need is indicated. A partial proof typically utilizes a much higher ratio of support personnel to engineering personnel and the proposed reduction of 20 percent or more in the number of points would be a more significant reduction in the partial proof cost than the 25 percent reduction proposed for a full proof.

We support reducing the number of required points per radial for a partial proof from the present 10 to the proposed eight because the cost savings may outweigh the increased engineering risk. The Commission should make clear its ability to require a full proof if a partial proof does not seem to agree with interference measurements or other indications of noncompliance. In addition, the Commission should increase substantially the fine for noncompliant operation to provide more incentive for partial proofs when the need is indicated.

As noted in a previous section, we recommend that the use of computer modeling be permitted as an alternative to field measurements except in cases of dispute and that field measurements continue to be the final authority in cases of dispute. For computer modeling, the concept of a partial proof does not apply. All proofs using computer modeling are, by definition, full proofs, and the requirements for a full proof using computer modeling must apply when the need for a partial proof is indicated and computer modeling is used to satisfy the need.

Monitoring Points

Monitoring points are based on the full proof, not the partial proof. If a monitoring point needs to be changed because of construction or other factors, then the full proof data should be used rather than a radial partial proof. We agree with the Commission's proposal to assign limits to new monitoring points based on the last full proof of performance.

The Commission proposes eliminating the requirement for maps and directions for applicants using differential GPS-determined coordinates. This precludes the use of coordinates determined by survey or by techniques that may be developed in the future. We recommend that the Commission accept coordinates as a means of locating monitoring points but specify the required accuracy rather than the method.

As noted in a previous section, we recommend that the use of computer modeling be permitted as an alternative to field measurements except in cases of dispute. We recommend that monitoring point measurements continue to be established and routinely measured whether the antenna proof is performed via field strength measurements or via computer modeling. The use of monitoring points remains a simple and relatively inexpensive way to verify externally the actual performance of an array and of the antenna monitoring system.

Finally, regarding augmentation of radials which involve a required monitoring point, 47 C.F.R. 73.152(c)(2)(iv)(B) allows 120 percent augmentation of the actual measured inverse field value if the measured inverse field exceeds the value permitted by the standard pattern. If the data for a monitoring point radial is analyzed and found to be 99 percent of the standard pattern, the field strength limit for the monitoring point will be set at essentially the standard pattern value, leaving no room for drift or seasonal variations. If the data for a monitoring point radial is analyzed and found to be 101 percent of the standard pattern, the field strength limit can be set significantly above the standard pattern by augmenting the radial.

This is an incentive to analyze the data on monitoring point radials where the result is near the standard pattern value as above the standard pattern value. Since analyzing field strength data involves judgment as well as engineering, there is an inherent conflict. We recommend the Commission eliminate this conflict as part of the present NPRM by allowing a positive 10 percent adjustment to monitoring point values for monitoring point values between 90 and 100 percent of the standard pattern value.

AM Station Equipment & Measurements

We agree with the Commission's proposal to delete the requirement for base current ammeters or toroidal transformers for those directional stations employing approved antenna sampling systems.

Antenna Monitors

We agree that 47 C.F.R. 73.53(c) can be moved to 47 C.F.R. 73.69. We are puzzled as to why the other requirements of 47 C.F.R. 73.53, with the possible exception of 47 C.F.R. 73.53(b)(1), impede the development of antenna monitor systems using advanced technology. These requirements are minimum requirements that a monitor should pass for it to be used to verify and maintain array compliance on a day-to-day basis. A monitor that can not pass these requirements will be of limited value to the station licensee or to an FCC field inspector.

We agree that voltage sampling devices are appropriate as alternatives to sampling transformers and pick-up loops and can be used to feed antenna monitors for towers with electrical lengths of 130 degrees or less. The use of voltage sampling devices for towers with electrical lengths of more than 130 degrees should require specific approval of the Commission based on a case by case basis.

Impedance Measurements Across a Range of Frequencies

We agree with the proposal to delete the requirement to measure impedance across a range of frequencies. The Commission presently imposes no requirements on the audio quality of AM stations, which is the current reason for measuring impedance across the signal bandwidth. However, we note in passing the Commission's statement that "...we have no reason to believe that audio and video quality of broadcast stations has been lessened by deletion of those requirements [15 years ago]." (paragraph 35) We have observed several AM stations in rural areas with audio quality so poor as to be almost unintelligible. Some of these stations have eventually gone dark. Others remain on the air as the only station in a small town. We are unsure as to whether this type of deregulation is in the public interest.

Common Point Impedance Measurements

We agree with the proposal to delete the requirement that the common point reactance should be adjusted to zero ohms. We recommend that this requirement be replaced with a requirement that the common point reactance be adjusted to between zero and minus 20 percent of the common point resistance.

Critical Arrays

We agree with the proposal to discontinue specifying the use of special precision monitors, provided that the monitor requirements continue to require stability over the present range of environmental and electrical parameters and that the monitor installed has sufficient accuracy and precision to assure compliance with the license requirements.

The Commission's computer code for determining array stability has not been available long enough for a detailed evaluation. We request that the implementation of the Commission's proposals regarding reclassifying critical arrays be postponed until the computer code has received more extensive review. As a practical matter, this may best be achieved by staying the effective date of these rule changes for a period of six months.

AM DIRECTIONAL ANTENNA PATTERNS
PROOF OF PERFORMANCE

The FCC is currently reviewing its rules regarding AM radio service directional antenna performance verification, in MM Docket No. 93-177 (RM-7594). This paper is intended to provide background information regarding AM proofs-of-performance. It is written for engineers having an open mind. For others, it is designed to perhaps let in a ray of light.

AM directional antennas were first used in the United States in the 1932. Although directional antenna theory was well known and directional patterns could be mathematically calculated, it was a difficult and tedious process. Trigonometric tables along with a slide rule or a mechanical calculator were the tools of the designer.

Early directional antenna systems were commissioned without actual knowledge of the phase angle of the tower currents; however, the magnitude of the current could be measured. The dilemma of the early directional antennas was "proof" that the signal was reduced or enhanced in the desired directions. Field strength meters were employed to first measure the field from a single tower, and with the assumption that the radiation from this tower was uniform on all azimuths, compare the measured directional field strength to determine pattern shape. Very early proofs were conducted simply by taking a series of measurements around the transmitter site (ratio measurements). Existing proof-of-performance requirements were established in the 1950's, including radial field strength measurements.

In recent years, the ability to measure current amplitude and phase angle in each tower was made possible by reliable electronic equipment. However, the most dramatic event affecting AM directional antennas was the computer, which gave a designer the ability to develop a myriad of directional patterns, "fine-tuning" to the ultimate pattern. More importantly, with available computing techniques, the proper antenna parameters needed to produce the desired radiated field from the antenna system can be very accurately determined.

There is no question that modern computer techniques can provide the antenna parameters needed to produce the desired radiation pattern. With proper use, all designers will obtain identical results. Those who are knowledgeable DO NOT get different answers. As a case in point, when the FCC adopted the "standard pattern" it did not take a long period of time for all pattern designers to arrive at the same answer.

The question begging an answer is why knowledgeable engineers have not embraced the computer aided adjustment of directional antenna systems. Among the many reasons are "... why change what we have been doing for over 50 years", or "If it ain't broke..."

Let's review existing proof procedures. With NEC modeling, the proper currents and phase angles to produce the desired radiation pattern are predetermined. At the station, the antenna system is carefully adjusted to produce the desired parameters. The desired pattern has thus been developed and the project should be complete. At this point however, the tedious process of comparing fields measured from the directional antenna with field from what we believe is an omni-directional pattern begins. Based on this information, the engineer proceeds to **MISADJUST** the antenna system to take into account the impact of the local environment. AM directional antenna are probably the only antenna systems which are intentionally misadjusted to make them fit the local environment, and unfortunately this procedure is looked upon by some engineers as an acceptable practice.

Consider further the directional antenna pattern designed for nighttime use that has very specific radiation requirements at a specific vertical angle. What happens to these precise fields at vertical angles after having intentionally misadjusted the antenna system to "fit" the local environment?

Compare AM directional antennas with antennas used in the other broadcast services. In television, we consider an antenna to be "omni" if the radiation is within plus or minus 2 or 3 decibels of being circular. In FM service an "omni" antenna is side-mounted on a tower, with resulting pattern distortion of many decibels, yet the FCC is satisfied that the pattern is "omni". The FM service allocations, formerly based solely on distance separations, also employs contour protection in numerous instances, making the FM broadcast service allocation scheme quite similar to the AM service.

It is often difficult to change our way of thinking; however, a rational engineer, when confronted with proven analysis techniques, should come to the conclusion that it is a disservice to the AM directional antenna broadcasters by continuing the current proof-of-performance ritual.

Louis R. du Treil, Sr.

August 16, 1999

Thanks for your work on the AFCCE comments.

As you mentioned, there were several things which I thought were consensus or near consensus at the meeting that I would like to bring out:

re: Moment Method - there seemed to be a consensus that Moment Method Modeling is the preferred method of verifying the performance of a wide class of arrays. The caveats and limitations of the applicable arrays need to be worked out, as well as the definition of what must be modeled off site. There was a consensus the old method of field readings must remain an option for those who choose to proof an antenna by that means.

re: Partial vs Full Proofs - there seemed to be a consensus that there was no longer a need for partial proofs at all if the requirements for full proofs were suitably reduced.

re: Magnitude of proofs - There seemed to be a consensus that directional proofs only required pattern minima and minor lobes below pattern RMS. The magnitude of the main lobe was subject to competitive pressures, and if a licensee wanted to add radials, it is free to do so. (My note) The licensee could also require any entity building structures near the array to measure radials in the main lobe. ie: recommendation that 73.151(a)(1)(ii) and (iii) - where the CP would specify maxima below pattern RMS and pattern minima

re: Monitor points - you captured the sense I got from the meeting about coordinates. The augmentation point we did not discuss, but it makes sense.

re: base ammeters and base toroidal ammeters. - you might just change the toroidal transformer to toroidal linked ammeter.

re: Re Antenna monitor specs - One problem comes when the antenna monitor is not connected to the samplers by coax. The specs do not permit the use of lasers or microwaves or other methods to transmit the samples to the transmitter building. The consensus was to change the specifications of the monitor to performance and environmental specifications only. additionally, it is possible to give a total "indication of correctness" with a monitor, instead of a bunch of numbers that people in a station can't understand. If there were three lights - OK, Drifting, and Out of Spec - that could be the whole display. We would just hook our laptops to the serial or USB port and adjust with that. Think how much manufacturing cost could come out of the monitor!

re: Voltage sampling - Appropriate for 130-190 degrees, towers less than 90 degrees are the problematic ones, where you are only measuring reactive voltage.

re: Sweep : Consensus was yes, however connecting data points on either side of carrier should still be permitted (Did you ever try to bridge 900 kHz in Philadelphia at night with CHAM blowing 300 kW ERP at you?)

re: Critical Arrays - The consensus of the meeting was to propose 1) no longer designating any antenna systems as critical 2) offering licensees with designated critical arrays an escape by demonstrating that the array is functioning properly (proof) and that an approved sampling system is installed, and a current antenna monitor is installed - manufactured after a specific date.

I hope that these notes are helpful in developing yet another draft!

Sincerely
Ted Schober

At 15:25 11/1/1999 -0500, Louis A. Williams, Jr. wrote:
>Thank you all for your many e-mails and for your patience in waiting for
>me to get back to this subject. The following is the third revision of
>the draft proposed AFCCE comments on the AM DA docket. Comments are due
>by November 9th, so any changes or deletions must be made in the next
>few days.
>
>The comments have been modified to include the results of the ad hoc
>meeting on October 13th, as I have gleaned from the several versions of
>the meeting that have been provided to me. Different people hear
>different things, as any psychologist will tell you. We agree that
>resolution of the computer modeling question should be deferred until
>the rest of the docket is put to bed but that it should not be taken off
>the table.
>
>Concentrate on the remainder of the NPRM. If there is a problem with
>our proposed comments, speak up. It would be better for the AFCCE not
>to submit comments than to submit comments that disagree with comments
>submitted by several members. Of course, there is room for members to
>expand on their pet topics or to have minority opinions, but we should

>have a fairly broad consensus before we file this as AFCCE or we will
>have failed in our mission.
>
>If you say nothing, it is a form of tacit agreement, so do not hesitate
>to say, "Lou, you really missed the mark on this one." For this near
>final round, you do not even have to provide constructive criticism -
>although an explanation or suggested revision would be nice. I would
>rather hear an unqualified "NO" than sniping afterwards. I doubt if one
>or two "no's" will kill it, but it will not take many for me to get the
>message.
>
>The attachment is in rich text format (rtf). If you do not receive it
>successfully, let me know what format you need.
>
>Thanks again
>
>Lou
>

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The attachment is in rich text format (rtf). If you do not receive it successfully, let me know what format you need.

Thanks again

Lou

REVISION 3 Draft Comments on MM Docket No. 93-177, AM Directional Antenna Performance Verification

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

In the Matter of)		
	)	
An Inquiry Into the Commission's	)	
Policies and Rules Regarding AM	)	MM Docket No. 93-177
Radio Service Directional Antenna	)	
Performance Verification)		

COMMENTS OF THE ASSOCIATION OF
FEDERAL COMMUNICATIONS CONSULTING ENGINEERS
ON NOTICE OF PROPOSED RULEMAKING

Introduction

The Association of Federal Communications Consulting Engineers (AFCCE), celebrating 50 years, is an organization that includes approximately 90 full members who are Registered Professional Engineers engaged in the practice of consulting engineering before the Federal Communications Commission.

AFCCE supports and commends the Commission for its efforts to review and, where possible, simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas. Antenna proofs of performance impose a financial burden upon AM broadcasters, although it is not a burden that has been concealed by Commission policy, rules, or regulations from station owners. However, as the Commission notes in paragraph 7, "Prevention of interference among AM broadcast station [sic] remains a core regulatory function of this Commission." The AFCCE agrees that any changes in the rules must not compromise the technical integrity of the broadcast spectrum. The challenge for the Commission is to enact rule changes that reduce the burden on licensees while maintaining a reasonable ability to verify compliance.

Computer Modeling versus Proofs of Performance

Antenna proofs to verify performance of AM directional antenna systems have a long history in AM broadcasting. Field strength measurements are made at many points along several radials to show that the array is properly adjusted. A substantial amount of labor is required. The development of accurate monitoring equipment that measures the relative phases and amplitudes of the RF signal in each tower, along with computer modeling techniques, offers a significant potential for verifying array performance at lower cost.

The problems with field strength measurements to prove array performance are well known to the Commission and to the engineering community. The accuracy of field strength measurements can depend significantly on the experience of the person(s) making the measurements and reducing the data. The field environment can affect the readings, as can seasonal variations.

The use of computer modeling has its own set of problems. First, the inputs to the model assume the validity of the data about the physical parameters of the array such as tower height, spacing, and orientation. Second, verification of the results is as yet unresolved. Are field measurements or modeling the final authority in cases of dispute? Third, what are the limits that should be set on our ability to model an array and to include the effects of the environment. Under what conditions is the probable error in modeling larger or smaller than the probable error in field measurements?

Because of the complexity of the topic, AFCCE supported the request by the NAB and others to extend the comment period deadline so that an ad hoc meeting could be held on October 13, 1999 to discuss the use of computer modeling, as well as the other issues in the NPRM. This meeting has been held with several AFCCE members in attendance.

It is the consensus of the AFCCE members and others at the meeting that the use of computer modeling should be the subject of a Further Notice of Proposed Rulemaking under the present docket. The topic is too important to ignore and too complex to address as a secondary issue. Making the topic a Further Notice keeps the issue on the table while allowing the other items in the NPRM to proceed.

Directional Antenna Proofs of Performance

The Commission currently requires a minimum of eight radials, each with a minimum of 30 points between zero and 25 or 43 kilometers (zero and 15.5 or 20 miles) for a full proof. A partial proof currently requires at least 10 points between three and 16 kilometers (two and 10 miles) for each radial used in the last full proof. The Commission proposes to reduce the requirements for a full proof to a minimum of six radials, each with a minimum of 15 points between zero and 15 kilometers (zero and nine miles). The Commission proposes to reduce the requirements for a partial proof to a minimum of eight points per radial with no other changes in the partial proof.

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The cost difference between a full proof using the present rules and a full proof using the proposed rules can be a small part of the engineering cost of building or modifying an AM array. However, the proposed changes, as minimum acceptable requirements, may in some cases reduce the cost burden associated with a full proof and do not appear to materially degrade the value of the proof measurements.

With regard to nondirectional stations which are required to conduct a full proof due to the proximity of reradiating structures, etc., the Commission proposes reducing the number of evenly spaced radials from eight to six, the same as the minimum number of radials proposed for any other full proof. In those cases where measurements are required for a nondirectional antenna because of the impending construction of a new tower nearby and a previous full proof does not exist, a full proof should also be required, provided the full proof requirements are simplified as proposed. The technical requirements are the same whether a previous full proof exists or not.

Partial Proof of Performance

The purpose of a partial proof of performance is to verify that the array is still in compliance. As noted in the NPRM, many things can trigger the need for a partial proof. If the monitoring point or antenna monitor reading limits are exceeded, if the antenna system is altered by attaching or replacing items such as guy wires, cables, isocouplers, other antennas, etc., or if the station has been dark for more than six months, a partial proof is needed to determine that the array is still functioning as intended. If the partial proof and the antenna monitor readings indicate compliance, there is a high degree of probability that a full proof would also show compliance.

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Finally, regarding augmentation of radials which involve a required monitoring point, 47 C.F.R. 73.152(c)(2)(iv)(B) allows 120 percent augmentation of the actual measured inverse field value if the measured inverse field exceeds the value permitted by the standard pattern. If the data for a monitoring point radial is analyzed and found to be 99 percent of the standard pattern, the field strength limit for the monitoring point will be set at essentially the standard pattern value, leaving no room for drift or seasonal variations. If the data for a monitoring point radial is analyzed and found to be 101 percent of the standard pattern, the field strength limit can be set significantly above the standard pattern by augmenting the radial.

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AM 13

OFFICE MEMORANDUM

TO: All Engineers

FROM: Don Everist

TOPIC: MM Docket 93-177–NAB Sponsored Meeting

DATE: October 15, 1999

Morning

Presentation by Ron Rackley.

a. Questions current distribution by classical methods that Method of Moments "MOM" can solve.

b. Questions monitoring methods in some systems.

  1. Do open/short impedance for DA's to determine stray capacitance. Make corrections to MOM program to account for stray capacitance. Example in Fullerton, California, where MOM program derived parameters that obtained pattern, but standard sample system found operating parameters substantially different than theoretical parameters.

Summary He believes that MOM modeling does not work everywhere, but desires to have MOM be used if appropriate conditions prevail. He does not feel confident with MOM in large section towers (i.e. self-supporting), top loaded towers, sectionalized tower, or folded unipole. In instances of uniform, cross-section, equal height with no external reradiators then MOM modeling can achieve accurate data. He also believes voltage sampling can be used to reliably predict array performance.

Ben Dawson claims to have sent out e-mail several days ago (did not receive) on change method of monitoring due to near field.

John Marino a. How do we establish method that can be used that will achieve reasonable results in the field at initial tune-up?

b. How can Commission be satisfied with the information filed?

c. Wants to establish the questions that will permit the use of internal array monitoring.

NAB question "How are the two questions posed by the FCC be addressed?" Briefly, the Commission has two main concerns about adopting a methodology for array adjustments based solely on computer models. First, the Commission is concerned that NEC programs may not always accurately predict the radiation being emitted in critical directions toward the stations. Second, the Commission is concerned about extending AM regulations into new technical areas. The Commission rules do not currently regulate the design of internal circuitry of antenna systems or the methodology employed in the adjustment of antenna systems. Therefore, the Commission feels that basing proofs of performance solely on computer models could create controversial issues relating to the adequacy of adjustment programs and procedures.

Dave Harry Asks the question if the array is adjusted and licensed based on MOM and under certain assumptions, what happens when it is found the assumptions are incorrect or how do you confirm if assumptions are correct? No response.

Discussion	Rackley has used NEC3, but says he relies on MININEC1. He says differences between two are that one analyzes pulse at the end of the segment and the other analyzes the center of the segment. Note: CDE has primarily used NEC3.
Ben Dawson	Discussed how Commission would review data. He believes issues to be addressed are the burdens to Commission staff.
Rackley	Cites difference between NEC3 (Kirschner) and MININEC (Rackley) and 500 kW facility, but drive voltages (3 element DA) were in agreement.
Everist	Asked question if DA licensed according to MOM has a 20-story building built later across the street, how and what does the Commission require? No response.
Tom Jones	Suggests adopt one or two models with procedures (cites segment length, etc.) for FCC review.
Rackley	Antenna monitoring needs to be specified.
Ted Shober	Cites Canadian sampling by surrounding folded unipole.
Glen Clark	a. Standard program needed. b. What does industry standardize on? c. Says Penn. State folks believes MININEC gives better impedance results
Hatfield	Buy source code and give to Commission. (EM Scientific?)

John Marino What questions needs to be asked? Suggestion setup separate Committee to address MOM and let MM Docket 93-177 go forward without MOM issue. General consensus recommends having FCC split rule making into two parts.

Afternoon

<u>Radial</u>	Eliminate main lobe measurements--general agreement
<u>Reduce Number and Length of Measurement Radials</u>	
Ted Shober	Number of radials with measurements and analyze with standard deviation
Rackley	10 ND and DA measurements if ND analysis within 10% of ND efficiency otherwise additional measurements to be made
Partial Proofs	
Rackley	Remove partial proof requirements–make it same as full proof
Antenna sample system change above base	Use substitution method to determine no effect–Dave Harry indicates that some critical arrays have problem with this requirement if old special monitor needs to be repaired
Dave Harry	Suggests documentation of full sample system. Ed Dela Hunt suggests FCC will be using electronic filing
Two-way antenna added or something added above base insulator	Do substitution method similar to antenna monitor change

Monitoring Point Change	Eliminate partial proof
Map and monitoring point route description	Still retain point description
Base current ammeters and toroid ammeters in the case of approved sample system	Eliminate
Antenna monitor specification in FCC Rules	Dave Harry wants an antenna monitor baseline specification which meets minimum requirement and certified by manufacturer
Impedance measurements across band	Eliminate, but with provision if cannot make on channel measurement, sweep method be permitted
Set common point reactance to zero	Eliminate
Antenna monitor for critical arrays and eliminate critical arrays	Eliminate
Existing critical arrays	Release critical arrays from conditions upon filing certification that it can meet 3° and 5 percent tolerance criteria
Other issues	
Electronic Filing	Maps (?)
Calibration of measurement devices and traceable calibrations	Internal versus External–Undecided

Please find attached a summary of the discussion from last week's AM DA meeting (Microsoft Word 97 document). Also, I have included the list of attendees (below). Thank you all for participating.

Sometime within the next month or so I will be in touch with those of you who expressed an interest in participating on an ad hoc committee that would formulate further proposals for computer modeling of AM DAs.

Dave Wilson
Manager, Technical Regulatory Affairs
National Association of Broadcasters
dwilson@nab.org

Attendees at 10/13/99 Meeting

Broadcast Engineers

ABC, Bert Goldman
AMFM Inc., Jeff Littlejohn
Clear Channel Radio, Al Kenyon
Clear Channel Radio, Bill Suffa
Clear Channel Radio, John Warner
Infinity Broadcasting, Raymond C. Benedict
Susquehanna Radio, Charlie Morgan

Broadcast Engineering Consultants

Carl T. Jones Corporation, Herman Hurst
Carl T. Jones Corporation, Tom Jones
Cavell Mertz & Davis, Inc., Garrison C. (Gary) Cavell

Cohen, Dippell and Everist, Donald Everist
Denny & Associates, J. M. "Bix" Bixby
Denny & Associates, Susan Crawford
Denny & Associates, Robert Mallery
duTreil, Lundin & Rackley, Ron Rackley
Engineering Consultant, Larry Will
Glen Clark & Associates, Glen Clark
Hatfield & Dawson, James Hatfield
Hatfield & Dawson, Ben Dawson
Kaye, Scholer, Fierman, Hays & Handler LLP, James Weitzman
Moffett, Larson & Johnson, John Kean
Mullaney Engineering, Alan E. Gearing
Radiotechniques, Ted Schober
T.Z. Sawyer Technical Consultants, Timothy Z. Sawyer

Equipment Manufacturers

Delta Electronics, Bill Fox
Delta Electronics, Tom Wright
Kintronic Labs, Tom King
Potomac Instruments, Clifford C. (Cliff) Hall
Potomac Instruments, David G. (Dave) Harry

FCC Engineers

Federal Communications Commission, William Ball
Federal Communications Commission, Ann Gallagher
Federal Communications Commission, Ben Halprin
Federal Communications Commission, Keith Larson
Federal Communications Commission, Ed DeLaHunt

NAB Staff

David Layer
John Marino
Dave Wilson
Ann Zuvekas

MM Docket 93-177 NPRM Ad Hoc Meeting

An Inquiry Into the Commission's Policies and Rules Regarding AM Radio Service
Directional Antenna Performance Verification

October 13, 1999
10:00 AM – 4:00 PM
Conference Room A
National Association of Broadcasters
1771 N Street, NW
Washington, DC 20036-2891

Summary of Discussion

Computer Modeling vs. Proofs of Performance

Points made during discussion included the following:

Magnetic field measurement methods are sufficiently ambiguous to allow for introduction of many errors in reported data.

Towers that are the same height, and which have the same cross section, and which are sitting over flat land, can all be accurately modeled using moment method techniques.

Can folded unipoles be moment method modeled? (One person says yes.) Can sectionalized towers be accurately modeled? Can top-loaded towers be accurately modeled? How accurately can moment method modeling predict reradiation from buildings and other objects that cannot be modeled as wire antennas?

Are different implementations of MININEC able to provide repeatable results? MININEC is just a simplified version of NEC so it should provide repeatable results provided the input parameters match.

If we are going to permit modeling to be used we should select a model, or select a group of models, that must be used. Also, a procedure for using the models should be identified. A good way to do it would be for the FCC to identify a particular procedure and model that it will use, and let everyone use whatever they want with the understanding that that is what the FCC will be using.

There is an industry consensus that we want to have a moment method procedure identified not because we want to, but because we have to, in order to have enough people available who can maintain AM transmission facilities.

How do we want FCC to proceed?

Unanimous concern from broadcasters about need for others to be able to accurately monitor and maintain AM transmission facilities as existing core of engineering consultants retire.

General agreement that Commission should split off the issue of computer modeling and allow about six months for a smaller ad hoc group of engineering consultants and broadcast engineers to come up with some recommendations for a Further Notice of Proposed Rule Making concerning computer modeling.

Discussion concerning other agenda items is summarized below, by agenda item.

2.a. Agreement that we can generally get rid of requirement to measure main lobe since maintaining appropriate signal strength in main lobe is a competitive issue that licensees will be inclined to meet.

2.b. Agreement that there should not be maximum distance limit on location of measurement points.

3.a. Suggestion that partial proofs should be abolished, full proofs simplified, and all proofing requirements should be for full proofs. Agreement that, if full proofs can be scaled back, it would be worthwhile looking into elimination of partial proofs.

3.b. General agreement that Commission proposal is good. Thoughts that sampling system changes may be addressed in Further Notice of Proposed Rule Making because they relate to computer modeling

4.a. Agreement with Commission proposal

4.b. General agreement that some description (GPS, maps, whatever) should be on file at station.

5.a. General agreement that Commission proposal is good.

6.a. General agreement that manufacturers should be required to confirm that antenna monitors meet certain accuracy and environmental requirements

7.a. General agreement that using the sweep method should be permitted, but not required.

8.a. General agreement with Commission proposal.

9.a. General agreement that new antenna monitors are capable of doing the things that former specially designed monitors could do, and therefore specially designed monitors should not be required provided that station's monitor was manufactured after a certain date.

General agreement that critical arrays, of which there are approximately 24-28 total, are no longer of much use and the critical array designation should be abolished. General agreement that existing critical arrays should be released from their critical status provided they meet certain tolerance criteria.

Additional non-agenda item:

Suggestion that group should think about whether there should be a recalibration requirement for monitoring equipment. Agreement that this can be discussed in smaller ad hoc meetings regarding computer modeling.

Ted Schober wrote:

> One premise that Glen takes is that the entire RF environment is the
> responsibility of the licensee.
> Ron's premise may be to remove some of this responsibility from the licensee.
> There may be some justification for this.

Please elaborate on the latter point. I'd like to know what's behind thattantilizing comment.

My thoughts come in the form of a question. "If it should no longer be the licensee's responsibility, whose responsibility *should* it become?"

True, it wasn't WMEX's responsibility (now WNRB) that they built an apartment complex in front of the array. But it wasn't WLAC's either. (WLAC is the Class A on that channel that WNRB protects.) WLAC was powerless to do anything about the building. At least WNRB had some control over the situation and were able to counter-tune the array. (Yes, I concede that counter-tuning fixes the horizontal pattern at the expense of the high-angle integrity. Fortunately, most of the zenith's toward WLAC are less than 10 degrees)

Also, counter-tuning doesn't always solve the problem. Then what?

Timken Bearings built a steel plant right in the main bang of the WHBC (1480 kHz) array. The old site was simply not salvagable. WHBC rebuilt down the road and dismantled the original site. Sure, it put a dent in WHBC'searnings. But what other viable alternatives were there? No one elsecould fix the problem. It's hard enough to try to serve large cities like Philadelphia and New York City on a high-end channel like 1480 kHz. Should New York and Philly accept the higher NIF as unavoidable bad luck and just live with it?

Take it one step further...

The 1160 kHz in Chicago used to be 10 kW at night. So did the 1170 kHz in San Diego. The Commission cut them both back to lower night power because they weren't able to maintain the night MP's. [See MO&O adopted May 4, 1987, FCC 87-173 for the San Diego case. I can't put my hands on the Chicago case.] Under a new set of rules, what would have happened in these two specific cases?

Perhaps the easy answer is that protecting the 0.5 mV/m skywave contour of Class A stations no longer serves a real purpose for anyone except long-haul truckers. And maybe that is a realistic answer too. But that is a 301 issue. And this is a 302 proceeding.

> Daytime, everyone knows that M-3 bears only a passing resemblance to the actual

> groundconductivity, and the fact that day propagation shows up to a 10 db

> variation summer to winter in New England.

This is a very slippery slope you're going down.

> If we are willing to ignore these effects, and other little things - like Cuban
> stations, how much should we be concerned with the other effects in the
> vicinity of the towers, as long as the array itself does its job?

Errr... Ahhhh.... If there are significant "other effects" in the vicinityof the towers, the fact that "the array itself does its job" is completely irrelevant. To satisfy a criteria which is not directly tied to the *net* arriving skywave at a distant point is a meaningless, empty gesture.

> Can we change the discussion from whether or not to use MOM for verification of
> performance - to discussing where we can get a consensus on those cases where
> MOM is clearly appropriate, and discussing the areas where it is clearly
> inappropriate to cover the whole situation. After that is done we can start to
> hash out those situations that are a grey area.

Yes. I like that idea. Bill Suffa made a nearly-identical suggestion a few hours ago. Since you and Bill both made the suggestion, it is only fair that the two of you lead off. Do you have a first-cut at a definition of where MOM is clearly appropriate and where it is not?

Glen Clark
Pittsburgh, PA

Jeepers Ron...

It's clear that you feel strongly about this. I don't disagreee with much of what you've said. There was obviously a LOT of thought and time which went into it. Where I differ from your conclusion, it is not because I come to a different conclusion while looking at the same data. I come to a different conclusion because I am including concerns which were missing from your wonderful discertation.

Let me specifically agree with some of the points that you've made and then later talk about why I disagree with your conclusion. The choice to order it that way doesn't have anything to do with trying to toss and olive branch and then go in a different direction. It's just that I'm following the order in your missive and I don't know how to (with a high degree of confidence) cut and paste things into a different order.

Ron Rackley wrote:

> Although this message "thread" is a little unconventional, I think that a
> lot of good points have been raised and discussed in a very constructive
> way.

I believe in the process. This is not much different from the NRSCdeliberations which were held an the NAB building in about 1987.
Ken Brown, Chris Payne, Greg Buchwald, Glynn Walden, John Marino, Carlie Morgan and many others all brought important ideas to the table. And the group thrashed through it all. And while sometimes it got heated, I happen to think that the end result really was very good.

I just look at this NPRM discussion as the modern-day, cyberspace equivalent of the NRSC meetings. I believe strongly that good things will come from this.

> We are certainly not motivated in
> this matter by a desire to denigrate the importance of field work. Rather,
> we understand the need to reform the requirements for proofing DAs from
> first-hand experience.

I think the earlier inference that this is a battle between "field guys"and "office wonks" was off the mark. I don't think that many readers believe that characterization. Certainly, you recitation of the original proponents disproves the theory.

> THE IMPACT OF MOM
>
> The impact of MOM on antenna adjustment and proofing is nothing short of
> earth shaking. The big disadvantage of using current distribution
> "assumptions" is that you assume that every element of an array has the same
> form of current distribution.

I agree. People have though for years that the reason that the numberson the Nems-Clarke.... err Potomac Instruments monitor didn't agree with the theoretical fields (when equal height towers were used) was that, despite great care, they had somehow ended up with a sample system that had errors in it. Even a perfect sample system would not have shown theoretical values on the panel for the reasons you cite in the paragraph below.

> In reality, the
> current distributions vary significantly in the various elements of an array
> because each tower functions in both the radiating and receiving (from
> mutual coupling) modes simultaneously and its current distribution is
> actually the superposition of the two.

Yep. And trying to stumble on those correct values empiricallyby banging on the phasor while four guys are out in the field with FIM's is a very expersive way to do empirical science.

> Furthermore, the current
> distributions of the towers of an array change whenever the parameters are
> adjusted.

One of the first thgings that Neil Smith told me when I went towork for him out of college was that "Mutt-and-Jeff arrays will always have more RMS than the hemispheric integrations says they will have". (A Mutt-and-Jeff array is one where there is a very short tower and a very tall tower.) The specific case he used to illustrate it was KABC(AM), 790 kHz in Los Angeles. NEC bears this out.

The sinusoidal assumption (which, as you say, was not picked for accuracy, but because it was a function that could be easily integrated in the days before computers) was never accurate. But it becomes even further from the truth when the towers are of unequal heights.

> The software was fine, it just
> didn't have any built-in feature to solve for the drive volages required to
> produce a desired set of antenna field parameters. It would give correct
> results for the array geometry and drive voltages that you put into it, it
> just didn't help find the voltages to use if you only knew the field
> parameters of the pattern. I believe that this is why several experienced
> and respected consulting engineers stated in their earlier Notice of Inquiry
> comments that their experience was that MOM techniques could not be reliably
> used to model AM DAs.

This was the biggest problem. NEC (and its predecessor "AMP")let you specify driving voltages, not currents. And, because you did not have "a priori" knowlege of what the dirving points were, you had no idea what the voltages needed to be. You had to know the answer to properly ask the question. A crude workaround was to build a Thevenin-equivalent current source with a 1 Meg resistor in series with each tower base. If you wanted 2 amps in the tower base, you specified a driving voltage of 2 megaVolts. There was no danger of arc-over because it was all in software. No one would ever build it that way. The array efficiencies were hideously low, but it got you in the ball park on drive points and you could start seeing how the array wanted to work. It was an iterative process from there to "walk it in". Still, this gave you current ratios, not far-field field ratios.

> Those of us who were successfully using MOM techniques back then had a
> "secret" weapon. The technique
> involved inverting large matrices filled with complex numbers - something
> that is not particularly easy for most people to intuitively understand -
> and apparently few people ever "tried it at home."

Doctor Metker from Penn State wrote a Genetic Algorithm optimizerwhich got to the same place through empirical means. But it was much later than the Hatfield breakthrough.

> Fortunately, programs
> that do the complete job of modeling AM DAs are available today from several
> sources - the user only has to learn how to set up the array geometry using
> appropriate assumptions to be in the "MOM business."
>
> I suggest that, before we attempt to address the issues that will have to be
> dealt with before we can write new Rules, we pause to let more of our fellow
> consulting engineers become experienced with MOM techniques.

Here's where we begin to disagree. While it is probably true thatmany people had

bad early experiences with MOM and were left
with a sour taste in their mouths, I don't think that my objection
to a MOM-world has to do with a presumption that I couldn't get
it to work. It has to do with the incompleteness of the model.

> I refer to using MOM techniques to proof an antenna pattern as an "internal"
> process, since the system is adjusted to produce the correct internal array
> parameters. Likewise, I call the conventional field strength measurement
> proof process an "external" one, since it relys on field strength
> measurements made external to the array.

That seems a useful terminology for us to adopt in this discussion.

> Accepting the amount of
> uncertainty inherent in the external proofing process was the thing to do
> before MOM came along,

And here's where the trains collide. That sentence presumes, as aforegone
conclusion, that we have established that MOM is more accurate
than field readings. I disagree strongly with that premise. And I will
bifurcate my disagreement into two parts:

1) Your points about cumulative error and standards
make a push in that direction. But I think that Dave Harry and his people
do a pretty darn good job. I've done enough "Amish barn buildings"
(where 10 Amish men come together and build a barn in one day or,
in this case, where 10 engineers show up with 10 meters and run 10
radials on a DA in 1 day) where we compared 10 FIM's to each other
at sunrise for me to trust the FIM's. Given the differing ages of the
meters and the fact that one engineer brought one in from Minneapolis,
one came from Boston, one came from St. Louis and etc, it was unusual
for there to be more that about a +/- 5% spread. Even the 120E's
agreed well with the FIM-21's and 41's.
I don't see the measurement process having more than 10% error in
it most of the time and I won't fight you over 10%

2) But my bigger objection has to do with the completeness of the
model. You can model the elements all day long but, if you don't
include the Brendan Byrne Arena (a large sports arena in suburban
New York, for those of you not familiar with the Meadowlands) in
the model, you do not have a clue what NET signal from WINS(AM)
is ending up in the Toronto area, affecting the would-be listeners of
CFRB(AM). When you build a significant building inside the 3 V/m
contour of a DA, there are consequences.

Similarly, there is a high-voltage catenary that goes right through
the main bang of the of the WKNR(AM) array. (The old WGAR,
Cleveland.) Several of the power towers are detuned. If one of the detuning
networks takes a lightning hit and blows the cap at the base of the
catenary support, the MP's toward Mexico (1220 is a Mexican I-A)

go up by 300%. (Yes I know that some people will pounce on this as proof that the present system has problems and needs to be jettisoned. That also is an illogical argument. Until someone proves that MOM is better, and I haven't seen that yet, acknowledging a weakness is not proof that the alternative is an improvement). The fact that the MP's move (drastically!) when the detuning fails is proof that the power towers are part of the "system". Bill Suffa agreed it was part of the system and said we should simply model it also. Could we ever agree on what the NEC model should look like for a 200-foot-tall catenary support with two tiers of arms, with each tier supporting 3 conductors? Could we ever agree what the NEC model should look like for the Brendan Byrne Arena?

WPAT v. WBEN shows Earl Cullum at his best, arguing that an apartment building in Patternson, New Jersey (near WPAT) was actually part of the array and should be included as a 5th tower in the Commission's Standard Pattern definition. He even went so far as to specify the spacing orientation, cruuent and phase that should be assigned to this 5th tower. This battle has been argued before, at great length. Agreed, we did not have the tools then that we do now.

But the catenaries and the arena are the easy ones. These are grounded conductive structures (GCS's). If we could agree on how to model them, could we ever .... take a deep breath everybody... agree on what to do about the Meadowlands? We watched the MP's on the 620 array in the Meadowlands move by 200% on a day by day basis as Carl Jones's people were adjusting the new 1190 kHz nighttime array, which is less than a mile in front of the 620 array. We went on an STA, not because our array was drifting, but because it was in a dynamic environment. [Note to all: the Jones people on the 1190 kHz array weren't doing anything wrong. They were just doing what they were paid to do, bring in the 1190 kHz array.]

Here, the physical geometry of the system has not changed (even if you included the 1190 kHz towers in the model), but the fields changed, drastically. Because the 1190 kHz towers were not grounded conductive structures, rather, they go to ground through a complex impedance, their effect on the 620 array moves when you move the tap on a coil or turn a crank on the phasor. Remember also that the 1190 kHz array has traps for 620 and 1010 kHz (I'm not sure if it also has traps for 710 kHz). If we were to try to NEC-model the 620 kHz array, including the 1190 steel as a geometry file with a passive, complex impendance between the base of the tower and earth, what j-value would you assign to the passive reactance at the base of each tower?

I said above that I wouldn't fight over 10%. But, here we have

3 examples of MP's which are off by more that 100% (sometimes 200%) due to structures outside of the model:

1) a sports arena
2) high-tension catenaries, and
3) another array

Remember that the receivers of the listeners in Toronto who are trying to receive CFRB will not be selectively listening to only the 4 vectors which correspond to the 4 towers in the WINS array, which will all cancel to zero. The receivers will be responding to ALL vectors leaving the Meadowlands, and that includes the Brendan Byrne arena.

I agee that the present definition of a full proof is more work than should be required for maybe 30% of the arrays out there, and that certainly includes the 1-kW nighttime which you designed for WGST. And this passes because there is no defensible argument one could advance that would make a reradiator change the net polar pattern envelope. Of course, this is because the deepest null isn't much more than 9 dB belowe the pattern maxima (if memory serves me right). Silimar logic applies to the WTIC and KRLD arerays. I would give them over to MOM right now and sleep like a baby.

But when the pattern minima are less that 10% of pattern RMS, the model has to include external factors, and I don't think we can model buildings and nearby arrays with an accuracy that does something meaningful to the underlying engineering problem. I do not think that MOM will ever get the WDFN night array (which you tuned up) into a configuration where it protects WBBR and KWKH as well as it does now. Yes, you may get it within 2 or 3 degrees. But, on the WDFN night array, (and unlike the WGST, WTIC and KRLD arrays) 2 or 3 degrees makes a BIG difference in the field in the nulls.

I like to think of tuning an array as being like a game of golf. I need a 2 wood to get it from the tee to the green. And I need a putter to get it in the hole. Before MOM, we were using the putter the whole way from the tee. And it was an awful waste of time and money. Today, MOM gets the array close (on to the green, if you will). But I don't think that MOM is the answer for the final adjustment any more than a 2 wood is a good tool for a 6-inch putt. For arrays which cannot stay within standard pattern with a +/- 5 degree permutation of all parameters, I think radials are still required to feel good about what we have done. (Shorter radials, though. 20 points between 2 and 5 km).

Can we talk about stratification of arrays? I agree that it is not fair to make the many suffer for the sins of the few. But I also don't think it is responsible to turn loose a few egregious accidents-waiting-to-happen on the argument that MOM is adequate for "most" arrays.

I don't like to travel. And 302's force a lot of travel. A family of 5 did four end-for-end flips of their Toyota minivan on I-79 about noon today, less than 3 miles from here. Four were thrown from the van. There was one fatality and two more are in bad shape. USAir flight 427 augered in less than 5 miles from here. If you keep spinning the cylinder on the revolver in the game of Russian Roulett, the law of large numbers will eventually bite you. That's why I drive a pick-up with a diesel engine between be and the outside world . I don't ask myself IF my number will come up. I ask what will happen WHEN it comes up. I don't like being in the field any more.

I need to sleep in another hotel like a fish needs a bicycle. Please, find a way that MOM will work for all situations, and I will send you and your wife to Hawaii for a week in gratitude. But, so far, I have resigned myself to the presumption that we can stratify arrays and eliminate (or shrink in scope, time and cost) maybe half of the 302's that we do now. I do not see a scientifically-defensible way that we can use MOM only for the remaining half.

Glen Clark
Pittsburgh, PA

Glen:

As another MOM proponant, I will gladly step up and say that 1) we should retain some form of field strengh measurement proof in the rules, and 2) that we should not accept MOM/sample system proofs where MOM cannot describe the complete array, including other pertinant objects in the surrounding environment.

Assuming that you agree, can we work on defining those situations where MOM should/should not apply (and hopefully do it in a manner that will not require a new rulemaking in the future when the models are sufficiently improved to allow almost ALL arrays to be modeled)?

bill

At 01:29 PM 9/11/99 -0400, Glen Clark wrote:
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>> form of current distribution.
>
>I agree. People have though for years that the reason that the numberson the
>Nems-Clarke.... err Potomac Instruments monitor didn't agree
>with the theoretical fields (when equal height towers were used) was
>that, despite great care, they had somehow ended up with a sample
>system that had errors in it. Even a perfect sample system would not
>have shown theoretical values on the panel for the reasons you cite
>in the paragraph below.
>
>> In reality, the
>> current distributions vary significantly in the various elements of an
array
>> because each tower functions in both the radiating and receiving (from
>> mutual coupling) modes simultaneously and its current distribution is

>> actually the superposition of the two.
>
>Yep. And trying to stumble on those correct values empiricallyby banging
on the
>phasor while four guys are out in the field with FIM's
>is a very expersive way to do empirical science.
>
>> Furthermore, the current
>> distributions of the towers of an array change whenever the parameters are
>> adjusted.
>
>One of the first thgings that Neil Smith told me when I went towork for
him out
>of college was that "Mutt-and-Jeff arrays will
>always have more RMS than the hemispheric integrations says they
>will have". (A Mutt-and-Jeff array is one where there is a very
>short tower and a very tall tower.) The specific case he used to
>illustrate it was KABC(AM), 790 kHz in Los Angeles. NEC
>bears this out.
>
>The sinusoidal assumption (which, as you say, was not picked for
>accuracy, but because it was a function that could be easily
>integrated in the days before computers) was never accurate.
>But it becomes even further from the truth when the towers are
>of unequal heights.
>
>> The software was fine, it just
>> didn't have any built-in feature to solve for the drive volages required to
>> produce a desired set of antenna field parameters. It would give correct
>> results for the array geometry and drive voltages that you put into it, it
>> just didn't help find the voltages to use if you only knew the field
>> parameters of the pattern. I believe that this is why several experienced
>> and respected consulting engineers stated in their earlier Notice of
Inquiry
>> comments that their experience was that MOM techniques could not be
reliably
>> used to model AM DAs.
>
>This was the biggest problem. NEC (and its predecessor "AMP")let you specify
>driving voltages, not currents. And, because you did not have
>"a priori" knowlege of what the dirving points were, you had no idea what
>the voltages needed to be. You had to know the answer to properly
>ask the question. A crude workaround was to build a Thevenin-equivalent
>current source with a 1 Meg resistor in series with each tower base.
>If you wanted 2 amps in the tower base, you specified a driving voltage
>of 2 megaVolts. There was no danger of arc-over because it was all in
>software. No one would ever build it that way. The array efficiencies were
>hideously low, but it got you in the ball park on drive points and you could
>start seeing how the array wanted to work. It was an iterative process from
>there to "walk it in". Still, this gave you current ratios, not far-field

field
>ratios.
>
>> Those of us who were successfully using MOM techniques back then had a
>> "secret" weapon. The technique
>> involved inverting large matrices filled with complex numbers - something
>> that is not particularly easy for most people to intuitively understand -
>> and apparently few people ever "tried it at home."
>
>Doctor Metker from Penn State wrote a Genetic Algorithm optimizerwhich got to
>the same place through empirical means. But it was much
>later than the Hatfield breakthrough.
>
>> Fortunately, programs
>> that do the complete job of modeling AM DAs are available today from
several
>> sources - the user only has to learn how to set up the array geometry using
>> appropriate assumptions to be in the "MOM business."
>>
>> I suggest that, before we attempt to address the issues that will have
to be
>> dealt with before we can write new Rules, we pause to let more of our
fellow
>> consulting engineers become experienced with MOM techniques.
>
>Here's where we begin to disagree. While it is probably true thatmany
people had
>
>bad early experiences with MOM and were left
>with a sour taste in their mouths, I don't think that my objection
>to a MOM-world has to do with a presumption that I couldn't get
>it to work. It has to do with the incompleteness of the model.
>
>> I refer to using MOM techniques to proof an antenna pattern as an
"internal"
>> process, since the system is adjusted to produce the correct internal array
>> parameters. Likewise, I call the conventional field strength measurement
>> proof process an "external" one, since it relys on field strength
>> measurements made external to the array.
>
>That seems a useful terminology for us to adopt in this discussion.
>
>> Accepting the amount of
>> uncertainty inherent in the external proofing process was the thing to do
>> before MOM came along,
>
>And here's where the trains collide. That sentence presumes, as aforegone
>conclusion, that we have established that MOM is more accurate
>than field readings. I disagree strongly with that premise. And I will
>bifurcate my disagreement into two parts:

>
>1) Your points about cumulative error and standards
>make a push in that direction. But I think that Dave Harry and his people
>do a pretty darn good job. I've done enough "Amish barn buildings"
>(where 10 Amish men come together and build a barn in one day or,
>in this case, where 10 engineers show up with 10 meters and run 10
>radials on a DA in 1 day) where we compared 10 FIM's to each other
>at sunrise for me to trust the FIM's. Given the differing ages of the
>meters and the fact that one engineer brought one in from Minneapolis,
>one came from Boston, one came from St. Louis and etc, it was unusual
>for there to be more that about a +/- 5% spread. Even the 120E's
>agreed well with the FIM-21's and 41's.
>I don't see the measurement process having more than 10% error in
>it most of the time and I won't fight you over 10%
>
>2) But my bigger objection has to do with the completeness of the
>model. You can model the elements all day long but, if you don't
>include the Brendan Byrne Arena (a large sports arena in suburban
>New York, for those of you not familiar with the Meadowlands) in
>the model, you do not have a clue what NET signal from WINS(AM)
>is ending up in the Toronto area, affecting the would-be listeners of
>CFRB(AM). When you build a significant building inside the 3 V/m
>contour of a DA, there are consequences.
>
>Similarly, there is a high-voltage catenary that goes right through
>the main bang of the of the WKNR(AM) array. (The old WGAR,
>Cleveland.) Several of the power towers are detuned. If one of the detuning
>networks takes a lightning hit and blows the cap at the base of the
>catenary support, the MP's toward Mexico (1220 is a Mexican I-A)
>go up by 300%. (Yes I know that some people will pounce on this as
>proof that the present system has problems and needs to be jettisoned.
>That also is an illogical argument. Until someone proves that MOM
>is better, and I haven't seen that yet, acknowledging a weakness
>is not proof that the alternative is an improvement). The fact that the
>MP's move (drastically!) when the detuning fails is proof that
>the power towers are part of the "system". Bill Suffa agreed it was
>part of the system and said we should simply model it also. Could
>we ever agree on what the NEC model should look like for a 200-
>foot-tall catenary support with two tiers of arms, with each tier
>supporting 3 conductors? Could we ever agree what the NEC model
>should look like for the Brendan Byrne Arena?
>
>WPAT v. WBEN shows Earl Cullum at his best, arguing that an
>apartment building in Patternson, New Jersey (near WPAT) was
>actually part of the array and should be included as a 5th tower
>in the Commission's Standard Pattern definition. He even went
>so far as to specify the spacing orientation, cruuent and phase
>that should be assigned to this 5th tower. This battle has
>been argued before, at great length. Agreed, we did not have the
>tools then that we do now.

>
>But the catenaries and the arena are the easy ones. These are
>grounded conductive structures (GCS's). If we could agree on
>how to model them, could we ever .... take a deep breath
>everybody... agree on what to do about the Meadowlands?
>We watched the MP's on the 620 array in the Meadowlands
>move by 200% on a day by day basis as Carl Jones's people
>were adjusting the new 1190 kHz nighttime array, which is less
>than a mile in front of the 620 array. We went on an STA, not
>because our array was drifting, but because it was in a dynamic
>environment. [Note to all: the Jones people on the 1190 kHz array
>weren't doing anything wrong. They were just doing what they
>were paid to do, bring in the 1190 kHz array.]
>
>Here, the physical geometry of the system has not changed
>(even if you included the 1190 kHz towers in the model), but
>the fields changed, drastically. Because the 1190 kHz towers
>were not grounded conductive structures, rather, they go to
>ground through a complex impedance, their effect on the 620
>array moves when you move the tap on a coil or turn a crank
>on the phasor. Remember also that the 1190 kHz array has
>traps for 620 and 1010 kHz (I'm not sure if it also has traps for
>710 kHz). If we were to try to NEC-model the 620 kHz array,
>including the 1190 steel as a geometry file with a passive,
>complex impendance between the base of the tower and earth,
>what j-value would you assign to the passive reactance at the
>base of each tower?
>
>I said above that I wouldn't fight over 10%. But, here we have
>3 examples of MP's which are off by more that 100% (sometimes
>200%) due to structures outside of the model:
>
>1) a sports arena
>2) high-tension catenaries, and
>3) another array
>
>Remember that the receivers of the listeners in Toronto who are
>trying to receive CFRB will not be selectively listening to only the 4
>vectors which correspond to the 4 towers in the WINS array, which
>will all cancel to zero. The receivers will be responding to ALL
>vectors leaving the Meadowlands, and that includes the Brendan
>Byrne arena.
>
>I agee that the present definition of a full proof is more work than
>should be required for maybe 30% of the arrays out there, and that
>certainly includes the 1-kW nighttime which you designed for WGST.
>And this passes because there is no defensible argument one could
>advance that would make a reradiator change the net polar pattern
>envelope. Of course, this is because the deepest null isn't much
>more than 9 dB belowe the pattern maxima (if memory serves me right).

>Silimar logic applies to the WTIC and KRLD arerays. I would give
>them over to MOM right now and sleep like a baby.
>
>But when the pattern minima are less that 10% of pattern RMS,
>the model has to include external factors, and I don't think we
>can model buildings and nearby arrays with an accuracy that
>does something meaningful to the underlying engineering problem.
>I do not think that MOM will ever get the WDFN night array
>(which you tuned up) into a configuration where it protects
>WBBR and KWKH as well as it does now. Yes, you may
>get it within 2 or 3 degrees. But, on the WDFN night array,
>(and unlike the WGST, WTIC and KRLD arrays) 2 or 3
>degrees makes a BIG difference in the field in the nulls.
>
>I like to think of tuning an array as being like a game of golf.
>I need a 2 wood to get it from the tee to the green. And I
>need a putter to get it in the hole. Before MOM, we were
>using the putter the whole way from the tee. And it was an
>awful waste of time and money. Today, MOM gets the array
>close (on to the green, if you will). But I don't think that MOM
>is the answer for the final adjustment any more than a 2 wood
>is a good tool for a 6-inch putt. For arrays which cannot stay
>within standard pattern with a +/- 5 degree permutation of all
>parameters, I think radials are still required to feel good about
>what we have done. (Shorter radials, though. 20 points between
>2 and 5 km).
>
>Can we talk about stratification of arrays? I agree that it is not
>fair to make the many suffer for the sins of the few. But I also
>don't think it is responsible to turn loose a few egregious accidents-
>waiting-to-happen on the argument that MOM is adequate for
>"most" arrays.
>
>I don't like to travel. And 302's force a lot of travel. A family
>of 5 did four end-for-end flips of their Toyota minivan
>on I-79 about noon today, less than 3 miles from here. Four
>were thrown from the van. There was one fatality and two more
>are in bad shape. USAir flight 427 augered in less than 5 miles
>from here. If you keep spinning the cylinder
>on the revolver in the game of Russian Roulett, the law of large
>numbers will eventually bite you. That's why I drive a pick-up with
>a diesel engine between be and the outside world . I don't ask
>myself IF my number will come up. I ask what will happen
>WHEN it comes up. I don't like being in the field any more.
>
>I need to sleep in another hotel like a fish needs a bicycle. Please,
>find a way that MOM will work for all situations, and I will send
>you and your wife to Hawaii for a week in gratitude. But, so far,
>I have resigned myself to the presumption that we can stratify
>arrays and eliminate (or shrink in scope, time and cost) maybe

>half of the 302's that we do now. I do not see a scientifically-
>defensible way that we can use MOM only for the remaining
>half.
>
>
>Glen Clark
>Pittsburgh, PA
>
>
>
>
>

Hi Glen and Ron!

You know the old saw about two people looking at the same thing and seeing something
completely different? I use a series of three pictures in a leadership training course I teach,
the first a line art picture of a young woman dressed in finery which I give to half the class,
the other half I give a picture of an old hag dressed rags. After a while,
I hand out an ambiguous picture which, depending on preconditioning can be interpreted either way. The people in the class have a fight over which it is.

Let me summarize:

Most of us agree that MOM works and adequately predicts what the array itself does when;

1) the sampling system does not introduce unreasonable errors.
2) The array has the correct physical geometry.
3) The towers are properly modelled (particularly Non-Uniform towers, tall Unipoles and elevated grounds)

Glen feels that the externals are a major issue when in an urban environments or where there are additional arrays in the vicinity of the array. In these cases MOM of the subject array is inadequate.

Ron feels that in most cases (not those where Glen sees big problems) MOM is adequate to describe the performance of arrays for verification purposes.

Maybe what we need to determine what cases we all agree are beyond the scope of MOM - maybe this can be done.

One premise that Glen takes is that the entire RF environment is the responsibility of the licensee.

Ron's premise may be to remove some of this responsibility from the licensee. There may be some justification for this.

I am presently doing a proof where one radial wags with the movement of a 100 degree tall crane located 500 meters from the array. The crane will be there for two years.

Another example is how WMEX (old days on 1510) could not have its array retuned when they built an apartment building in the main lobe that was taller than the towers and only a few hundred meters off the end of the array.

Of course I remember the stories of a crane during a WWRL tune up which shifted array parameters by several degrees every time a construction crane moved.

Where should these classes of problems fall? One could say that protection is absolute, however night propagation is highly variable and only described by a statistical model which ignores such parameters as sea gain, east -west propagation asymmetry are conveniently ignored for administrative convenience. Sea gain can provide 6 to 10 db gain - why else would WNIS, Norfolk, VA have better signals in Bermuda at night than any of the clears? How about nighttime arrays over poor soil, where the radiation is mostly 15 degrees up, with greatly reduced field on the ground, especially in high RSS to RMS arrays. A null on the ground has much more signal above the horizon.

Daytime, everyone knows that M-3 bears only a passing resemblance to the actual ground conductivity, and the fact that day propagation shows up to a 10 db variation summer to winter in New England.

If we are willing to ignore these effects, and other little things - like Cuban stations, how much should we be concerned with the other effects in the vicinity of the towers, as long as the array itself does its job?

Can we change the discussion from whether or not to use MOM for verification of performance - to discussing where we can get a consensus on those cases where MOM is clearly appropriate, and discussing the areas where it is clearly inappropriate to cover the whole situation. After that is done we can start to hash out those situations that are a grey area.

We can discuss what supplementary field measurements are needed, and in what cases.

One thing that I believe is essential, IMHO, if we are to use MOM to verify performance, is that we can first verify that the hardware is as planned.
I recently took over a very stinky two tower array which would not tune anywhere we expected. (2 tall towers at 60 degree spacing with unipoles part way up) The drive points were messy, and the sample voltages from the loops above the unipoles were low. It tuned up on field readings about 130 degrees phase from where it should, and the efficiency stunk.
We discovered that the unipoles had never been connected at the top! If we had just put the numbers on the monitor as predicted by NEC, then we would have had

no protection of the other guys! - in fact the main lobe would have been the wrong way!

Once we connected the unipoles correctly it came in just as expected. One non-obvious from the ground error can foul everything up. There needs to be some method of assuring that you have before you the physical plant that was designed.

Hopefully this helps center the discussion - perhaps we can define the conditions where MOM is adequate to completely assure conformance with the requirements of administration, and actual protection of other stations. Maybe we can come up with some proposals which foster actual protection of other stations instead of meeting some regulatory benchmark.

Just my 2 cents.

+++

dedAt 13:29 9/11/1999 -0400, Glen Clark wrote:
>Jeepers Ron...
>
>It's clear that you feel strongly about this. I don't disagreee with
>much of what you've said. There was obviously a LOT of thought
>and time which went into it. Where I differ from your conclusion,
>it is not because I come to a different conclusion while looking at
>the same data. I come to a different conclusion because I am
>including concerns which were missing from your wonderful discertation.
>

Ted Schober

OFFICE MEMORANDUM

TO: Warren Powis and Sid Khanna

FROM: Donald Everist

TOPIC: AM Rule Making

DATE: September 13, 1999

Your thoughts.

MOM if MAX to NULL RATIO < 6dB ?

OTHERWISE FULL PROOF

Sent: Friday, September 10, 1999 11:16 AM
Subject: Response and Further Discusion on AM DA Rulemaking

The FCC has extended the comment period deadline of the AM DA proof rulemaking by 60 days. This should relieve the sense of urgency in these deliberations. I believe that the proposed NAB meeting should go a long way toward reaching an industry concensus on these controversial issues. I intend to participate in the meeting, but would like to go ahead and make another contribution to the written discussion that has been underway for a while.

Although this message "thread" is a little unconventional, I think that a lot of good points have been raised and discussed in a very constructive way. I would like to clairify some of my opinions, make certain suggestions of a philosophical nature, and offer some additional information that I would like to see considered in this rulemaking process. For sake of brevity and to make it easier for the reader to digest in stages, I'm writing on my series of topics in "stand alone" fashion and presenting everything under topical headings. Following the convention that was set by someone else earlier in this discussion, I will refer to method of moment computer modeling as "MOM."

By the way, I love MOM. I was one of the original petitioners who requested that the FCC open a rulemaking on this subject back in 1989. I was disappointed to see that the FCC had rejected the request to consider MOM techniques for proofing AM DAs in the rulemaking out-of-hand, for what I believed were illogical reasons (see my section on "avoiding logical fallacy"), and that it appeared to be because MOM was so poorly understood in the AM engineering community. After some "soul-searching," I realized that it had been a mistake for us to go to the FCC with the rulemaking request in the first place without better informing the remainder of the engineering community of our reasons and encouraging others to share in our experiences. I wish to apologize for this. I hope that I am able to rectify that mistake with the information provided herein.

I know that this message is very long. I've tried to be succinct, but there was a lot to say. I suggest that anyone wishing to read what I have to say here go ahead and print these pages so that it will be easier to read in parts.

A LITTLE HISTORY ABOUT THIS RULEMAKING

As someone who was there from the beginning, please let me dispel the notion that the movement to have MOM recognized by the FCC for proofing AM DAs is something being promoted by young office workers who prefer the company of their computers to that of RF measuring instruments. The signers were, in alphabetical order, Ben Dawson, Wally Johnson, Karl Lahm, myself, and Bob Silliman. All of us were working as consulting engineers at the time. I haven't done the research necessary to calculate it precisely, but I know that the average age of the group has to be over 60 years today. Bob Silliman, who designed and supervised the adjustment and proofing of a very large number of AM DAs during the 50 or so years that he was in practice and was a MOM pioneer late in his career (and who I regard as the dean of antenna engineering in the broadcast field) is now retired. So is Wally Johnson, who had a very distinguished career at the FCC before leaving government service to become a private-sector consulting engineer. Karl Lahm was very active in tuning and proofing AM DAs, as well as computer software development, before he left consulting a few years ago. Ben Dawson and I are both still "at it." I don't think that you can find any other pair of engineers practicing today who have adjusted and proofed more AM DAs than Ben and I have in the last 20 years. We are certainly not motivated in this matter by a desire to denigrate the importance of field work. Rather, we understand the need to reform the requirements for proofing DAs from first-hand experience.

A LITTLE HISTORY ABOUT ANTENNA MODELS

MOM uses modern computer technology to solve for the actual current distributions of array elements so that their radiating properties can be related to their drive currents and voltages using generally accepted, and empirically proven, laws of electromagnetics. This was not possible before MOM, because antenna analysis was based on current distributions that were chosen for their mathematical simplicity instead of their real-world reliability. It had to be done that way back then, as it was not humanly possible to integrate the complicated functions that have to be used to replicate real-world conditions using the techniques of classical mathematics.

The most common current distribution assumption is sinusoidal current distribution. Most textbook analysis of linear antennas uses the sinusoidal current distribution assumption, as do the FCC's procedures for calculating radiation patterns. Even though it is easy to demonstrate that no antenna that is radiating can have purely sinusoidal current distribution, it has long been held to be "good enough" as far as calculating far-field radiation is concerned. I agree. The improvement in far-field radiation accuracy with MOM may be significant in some instances, but I don't believe of a

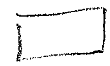
Proofs reqd to confirm validity of theoretical or MOM computed antenna systems.

- Surveyors can create errors in azimuth & location.
- Canadian station QRM to U.S. reqd move of US station to another frequency (990 KHz?)
- Should all old arrays be MOM'ed & readjusted? (Old arrays assume sinusoidal current distributions)

9/10/99

magnitude sufficient to "upset the apple cart" and redo all of the FCC Rules and international agreements that now rely on time honored sinusoidal current distribution assumptions at this time.

• What about structures within 3.22 km ?
+ Bridge overpasses
+ HV lines



Loops!

THE IMPACT OF MOM

The impact of MOM on antenna adjustment and proofing is nothing short of earth shaking. The big disadvantage of using current distribution "assumptions" is that you assume that every element of an array has the same form of current distribution. In other words, the relationships of the tower currents to their corresponding far-field pattern contributions are all assumed to be the same - leading to the conclusion that, with a perfect sampling system, you should see parameters on the antenna monitor equal to the field parameters for the desired DA pattern if verification ny internal measurement is valid. This is far from being the case. In reality, the current distributions vary significantly in the various elements of an array because each tower functions in both the radiating and receiving (from mutual coupling) modes simultaneously and its current distribution is actually the superposition of the two. Furthermore, the current distributions of the towers of an array change whenever the parameters are adjusted. This is why it has almost always been necessary to adjust the ratios and phases of the tower currents in an array to values differing from its DA field parameters in order to produce the correct radiation pattern, even with carefully constructed antenna monitor sampling systems.

Although the fact of non-uniform array current distribution has commonly been ignored, since it is not recognized in the FCC Rules, those who are inclined to reason from first principles have been aware of it for a long time - Earl Cullum was doing research on the phenomenon back in the 1940s - but we were unable to treat it as much more than a curiosity until modern computing equipment made such problems solvable through numerical techniques. It was impossible to calculate the actual current distributions of DA array elements before the advent of MOM, so it was impossible to relate the required far-field pattern paremeters to quantities that could be measured on-site. This is why we proof antennas the way we do now, relying on an external field strength measurement process that itself has a large amount of uncertainty, especially in the important null region of a pattern where field strength measurtement scatter can easily span a range of 10 dB along the length of a measurement radial. I believe that it is time to get rid of that uncertainty and the great expense that is required for the process that produces it.

• Averaging!

TO MOM OR NOT TO MOM

Although MOM techniques are almost "old hat" by now to the larger antenna engineering community (you can find them discussed in just about any IEEE Antennas and Propagation Society periodical published in the last fifteen or twenty years), their use has been retarded in the AM broadcast field by the fact that the Rules in this country require that the techniques that were developed long ago employing the sinusoidal current distribution assumption still be used. I also believe that the old problem with relating the current and field parameters of the elements of AM DAs is responsible for much negative thinking among the ranks of U.S. consulting engineers today. They have simply had so many experiences where very careful antenna monitor system design and installation still did not produce the correct pattern shape with the paramaters adjusted to the "theoretical" values determined by the old methods that they are incredulous when told that a computer program can now let them do it.

Monitors not intended to replicate theoretical parameters.

Another major cause of misunderstanding and disagreement is that many consulting engineers purchased the MOM software that was available "off the shelf" ten or more years ago and were never able to achieve satisfactory results when attempting to model AM DAs. The software was fine, it just didn't have any built-in feature to solve for the drive volages required to produce a desired set of antenna field parameters. It would give correct results for the array geometry and drive voltages that you put into it, it just didn't help find the voltages to use if you only knew the field parameters of the pattern. I believe that this is why several experienced and respected consulting engineers stated in their earlier Notice of Inquiry comments that their experience was that MOM techniques could not be reliably used to model AM DAs. The first time I started MININEC intending to model an AM DA many years ago, I felt like I did the first time I went into an Asian restaurant while very hungry and was handed nothing but a pair of chop sticks when my meal was served - I understand their frustration!

Those of us who were successfully using MOM techniques back then had a "secret" weapon. [Actually, we did not mean for it to be a secret at all - Jim Hatfield, for one, published several papers describing how to do it but they were apparently not well understood.] We had figured out how to modify the software that was available at the time to convert desired field parameters to required voltage drives for the MOM programs. The technique involved inverting large matrices filled with complex numbers - something that is not particularly easy for most people to intuitively understand - and apparently few people ever "tried it at home." Fortunately, programs that do the complete job of modeling AM DAs are available today from several sources - the user only has to learn how to set up the array geometry using appropriate assumptions to be in the "MOM business."

I suggest that, before we attempt to address the issues that will have to be dealt with before we can write new Rules, we pause to let more of our fellow consulting engineers become experienced with MOM techniques. A Further Notice of Proposed Rulemaking would be a good vehicle for accomplishing this without interrupting the process that is currently underway to simplify the requirements for proofs that employ field strength measurements.

i.e., MOM is outside the terms of reference for THIS PRM.

INTERNAL VS EXTERNAL PROOFING

I refer to using MOM techniques to proof an antenna pattern as an "internal" process, since the system is adjusted to produce the correct internal array parameters. Likewise, I call the conventional field strength measurement proof process an "external" one, since it relys on field strength measurements made external to the array. Accepting the amount of uncertainty inherent in the external proofing process was the thing to do before MOM came along, since we were not able to correlate any internal measurable quantity to the far-field pattern parameters of an array. External measurements were superior to internal measurements for determining that an antenna pattern was correct. An uncertain process focused on reality was superior to an uncertain process (even if the degree of uncertainty could be decreased with a high quality antenna monitoring system) focused on the unknown. Once the proof was completed with field strength measurements, the internal parameters were useful for maintenance purposes. Antenna monitor systems are presently designed for that use and the parameters observed at the time of an external proof are placed by the FCC on station licenses for maintenance purposes.

Now that we can make the correlation between antenna element currents and actual field parameters, we have the opportunity to clean up the process by deciding how we can monitor internal array parameters with sufficient precision to overcome the disadvantages that are imposed by real-world conditions on external field strength measurements. It will likely require that more money be spent on antenna monitoring equipment, but the savings in time and expense for proofing patterns will far outweigh the increase.

BETTER LIVING THROUGH COMPUTING

Now that it is possible to model actual array element current distributions, I believe that it should be possible to determine that a DA system is operating properly by observing that the element currents or voltages are correct. A proof-of-performance under this scenario would focus on a very thorough validation of the sampling system. Sampling systems would be constructed to higer standards than they are today, and might include self-calibrating or self-testing features.

I believe that it should be possible in most cases to proof DAs with MOM techniques and get better results, in terms of the actual objective of interference avoidance, than we realize today with the thousands of arrays out there that have been proofed with the procedures required by the present Rules. [See my section on "Leaving Shangri-La?"] Having said that, I also believe that there are some systems out there that, because of their electromagnetic environments or inherent characteristics, are not candidates for MOM analysis. We should review the present requirements for field strength measurement proofs to see how they can be streamlined for those arrays and others that might otherwise qualify for MOM analysis but have licensees that choose to do otherwise. We can have Rules that allow great flexibility for conducting proofs by recognizing the advantages of the latest technology where it can reasonably be applied. The uncertainty of the external proof process can be reduced or at least traded for a level of uncertainty that is no greater with an internal proof process at a great overall cost savings in most cases. It is good engineering practice to find the most cost-effective solutions to problems. Need I say more?

MOTIVATION FOR CHANGE

It has been suggested that the motive for modernizing the Rules on proofing AM DAs is to allow those of us who work on them to spend more time at home. While it is true that it can be frustrating spending days or weeks (and tens-of-thousands of clients' dollars) doing work that one believes is unnecessary, there is, in my opinion, a much more important consideration: there are not enough qualified engineers to take care of the stations that now need help.

I can choose what percentage of my personal time is devoted to the field tuning of AM directional arrays and what percentage I spend in the office; there is certainly no shortage of office work for communications engineers these days. With the recent renaissance in AM radio broadcasting, however, radio station owners don't have much choice when it comes to finding competent consulting engineers to come out and work on their directional antennas.

Think about it. How many engineers do you know that are competent, experienced antenna specialists who thoroughly understand antenna theory, RF network analysis, and the nuances of the present FCC regulations for directional antennas and are available for the laborious field work that is required to proof them? In other words, how many engineers could you in good conscience recommend to sort out and deal with the problems of a multi-tower directional antenna with damaged phasing equipment, parameters at variance, monitor points "out," and reradiators across the street? I run out of engineers before I run out of fingers when I try to count them, and I think that I know just about every practitioner in the business. The sad fact is that very few of the engineers who designed, adjusted, and proofed the thousands of directional antennas that we have today are still in practice and only a scant number of new experts have come along to replace them.

AM RADIO'S ENGINEERING CRISIS

I don't believe that it is overstatement to say that the AM radio industry is in an engineering crisis. If 1,000 of the directional antenna systems in the United States are seriously out of adjustment (which I believe to be a low estimate based on my experience) and there are 10 engineers who really understand what they are doing left to work on them (which I believe to be a high estimate), each engineer will have 100 DA systems to troubleshoot, adjust, and proof. If the directional antennas require an average of one month of engineering work to be brought into compliance and proofed, each engineer will have over 8 years worth of work to do. This does not include any work for stations wishing to make changes in their authorized patterns.

I know that there was a period this summer when my firm was turning away a prospective new AM field work client approximately every 1 1/2 days. We simply cannot schedule any more field projects at this time and are running something like a one year backlog. I suspect that the other qualified AM directional antenna engineers who still do field work in this country are in a similar situation. This is not acceptable. It is a stumbling block for stations that need work to be restored to legal operation. It will also impede facility improvements that would reduce interference and improve service within the AM band.

The obvious solution of training new engineers to do the required hands-on antenna system work is easier said than done, I'm afraid. The work can be divided into two distinct phases: Phase One deals with adjusting the equipment to a specified set of parameters while Phase Two deals with simultaneously finding the operating parameters and analysis assumptions necessary to allow the hundreds of field strength measurements that are required for an FCC-type proof to be analyzed to show satisfactory performance. Both phases involve much more complicated and theoreticallly rigorous work than is normally required of the engineers who do the office work in this business, performing allocation studies and preparing the exhibits required for construction permit applications. My experience is that an engineer with an interest in antennas and RF networks, fresh out of college, can be sufficiently trained to do Phase One work, which is fairly scientific in nature, in one to two years. Phase Two work, which typically has to deal with much more complicated matters related to the electromagnetic environment within the region where field strength measurements must be made, by its nature involves much more engineering judgement and, to a large degree, can be described as an art form. My experience is that it takes a special person with exceptional abstract reasoning skills and a strong interest in mastering AM directional antennas to perform well in Phase Two, with several years of experience necessary before working independently.

I think that it is legitimate to question to what extent the requirements of the present FCC Rules might be contributing to this crisis. I believe that the answer is A LOT, and that the situation can be eased significantly if the Rules are changed to allow analysis techniques that can be demonstrated to be scientifically valid but that were not available when the Rules started out on their present course. MOM techniques can eliminate Phase Two work completely for many, if not most, stations. That would go a long way toward solving the AM radio's engineering crisis. Young engineers will be able to enter the market and reach the level of knowledge necessary to become experts in AM DA work much more expeditiously than is now the case.

AVOIDING LOGICAL FALLACY

I don't wish to sound like Dr. Spock of the TV series Star Trek, who only understood things when they were stated logically, or, for that matter, pretend that our government's processes for making rules and establishing policies always adhere to sound formal logic. [After all, I remember the famous quote from a hearing on the clear channel rulemaking many years ago suggesting that the laws of physics be "amended" to eliminate interference.] I particularly don't want to sound haughty or quibble with anyone over minor infractions of formal logic that I might unintentionally violate myself. I think that we do, however, have to agree to use valid logical thinking as we approach the question of what data should be required to demonstrate that an AM directional antenna is working properly. This means that we must avoid granting decisional significance to illogical arguments.

One common logical fallacy that those on both sides of the MOM question need to avoid is CHRONOLOGICAL SNOBBERY : X is old/new, therefore X is good/bad or bad/good. Another is AD IGNORATIUM argument: I don't know if X is true or false, so X is therefore false. Another is AD BACULUM argument: an undesirable side effect is possible if X is true/false, therefore X is false/true. Another is AD POPULUM argument: most people presently believe X is true/false, therefore X is true/false. Another is BULVERISM: you believe X is true because of who you are, therefore X is false. And an important one is AD HOMINEM argument: P says X, I disagree with P about Y, therefore P is wrong about X. FALSE DICHOTOMY can be very misleading: X and Y are valid separately or together, you must choose between X and Y.

"We have to change the Rules because they were written many years ago," and "we should not change the Rules because they have stood the test of time" are both examples of CHRONOLOGICAL SNOBBERY. Neither alone is a reason to change or not change the Rules. "I haven't experienced success with moment method modeling, so it should not be considered" is an AD IGNORATUM argument. Maybe you should get some experience, or share someone else's. "The FCC should not stop requiring base current readings because they might stop making base current meters" is an example of an AD BACULUM argument. If there is no need for that type of meter, why make them? If there remains some need, it will be up to the law of supply and demand to set the price at which new ones can be made or old ones rebuilt. "Most people will still want to make field strength measurements, so the rules should not be changed" is an example of an AD POPULUM argument. Why should measurements that are not scientifically necessary be required because of the opinions of some individuals? "You just like moment method modeling because you are a computer jockey" is an example of BULVERISM. "You like moment method modeling but I think you are just too lazy to make field strength measurements like I've always made them, so you are wrong" is an AD HOMINEM argument. "We are at a crossroads where we have to choose whether DAs will be proven with computer modeling or field strength measurements" presents a FALSE DICHOTOMY. Allowing MOM proofing of some stations will not prohibit others from being proofed with field strength measurements.

Just for fun this time: "we are at a crossroads where we must decide whether to let computer jockeys who are too lazy to make field strength measurements change everything to make everybody use techniques that I have my doubts about and maybe, in the process, destroy AM radio, or to continue proofing antennas the old fashioned way that everyone knows works" is an example of a FALSE DICHOTOMY containing CHRONOLOGICAL SNOBBERY; AD IGNORATIUM, AD

BACULUM, AD POPULUM and AD HOMINEM arguments; and BULVERISM. Toss the same
ingredients from the other direction and you can get "we have to decide whether or not we are going to let the guys who don't understand modern developments in antenna engineering, either because they are too lazy to keep up or because they want to keep charging their clients more than is really necessary for proofing antennas, use their outmoded thinking to keep us from ushering in modern technology that will possibly avoid the downfall of AM radio and make everybody happy in the long run." Such argument might be amusing to both write and read, as long as people don't take themselves too seriously, but it doesn't solve anything.

The discussion should not turn sterile or formal. Using logical fallacy in ordinary language is not unusual. It is not a crime. In fact, it is often used to convey one's feelings. It happens very easily when emotional controversy is involved as is obviously the case for the present discussion. I'm sure that I do it myself more than I realize. I'm just saying that, when we get down to the process of evaluating the possibilities for changing the Rules on DA performance verification and the reasons that might justify doing so, we should go about it in a scientifically valid and logical way. We might find the logical fallacies entertaining, we might have fun stating them, but we must filter them out when it comes to the decision making process. There must be sound reasons for what we decide to do and to not do.

WILLIAM THOMSON AND WILLIAM OF OCKHAM

I believe that we would do well to be illuminated by the thinking of two gentlemen who, in my opinion, long ago stated principles that are fundamental to science and the practice of engineering even today. They are William Thomson, a.k.a. Lord Kelvin, who lived in the nineteenth and into the early twentieth century and William of Ockham, a.k.a. William Ockham, William Occam, or simply Occam, who lived in the thirteenth century and into the fourteenth century.

William Thomson made a statement that is always near and dear to the hearts of empiricists such as myself. It is usually quoted this way: "When you can measure what you are speaking about and express it in numbers, you know something about it; when you cannot measure it, when you cannot express it in numbers, your knowledge is of the meager and unsatisfactory kind." These words, from a man who some call the father of modern science, could seem to suggest that field strength measurements are the only basis for defining a directional antenna pattern. He did not mean it that way.

It helps to understand what Lord Kelvin was talking about when the quote is completed by including the last sentence that is often omitted: "It may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science." Taken in its entirety, the statement simply says that it is necessary to be able to verify with measurements and quantify what you are talking about before you are "doing" science. It does not say that exhaustive and redundant measurements are necessary for scientific analysis. Indeed, Lord Kelvin himself developed the system of temperature measurement that bears his name to simplify thermodynamic analysis based on what was known about the behavior of gases in the nineteenth century, even though it would be decades before scientists could make temperature measurements anywhere close to the zero entropy point, or "absolute zero" temperature, upon which his scale was based. I think that he would heartily approve of the use of modern computational methods that, employing empirically derived or empirically verified scientific principles like Ampere's Rule, Faraday's Law, the Biot-Savart Law, and Maxwell's Equations, can greatly simplify the work of antenna analysis. [This goes for arrays of linear elements because they have been proven many times over to obey these laws - believe me, I'm not going to accept the claims of the Crossed Field Antenna's developers without very thorough field strength measurements.]

William of Ockham laid a very important "stone" for the foundation of modern science with the doctrine of simplicity expressed in his Law of Economy, otherwise known as "Ockham's Razor": "NON SUNT MULTIPLICANDA ENTIA PRAETER NECESSITATEM"; i.e., "entities are not to be multiplied beyond necessity", or, in more common english, "it is vain to do with more what can be done with less." The history of science is the history of a search for simplicity in explaining and analyzing the properties of the world and universe around us. An example of how Ockham's Razor has helped our understanding of science might be worded "it is a waste of effort to calculate the relative motion of the Sun and every body in our Solar System around the earth when calculations using the Sun as the reference point can be correct with much less computational complexity." [You can make yourself unpopular when you use Ockham's Razor to challenge emotionally-held beliefs, as Copernicus learned the hard way when he published roughly the same statement in the early sixteenth century.] The proper application of Ockham's Razor to the question of AM directional antenna performance verification would be to avoid accumulating data beyond what is necessary to demonstrate acceptable DA performance because additional information is meaningless for that purpose.

IT ALL STARTED AT BAYVIEW

I think that a brief review of the early history of AM DAs would probably be of good use in this discussion. The first DA built in the United States was tuned up in April of 1932 at the site in Bayview, Florida that was used by stations WFLA in Clearwater and WSUN in St. Petersburg on a shared-time basis. It was a two-tower array on 620 kHz, with a quarter wavelength spacing between the towers that were oriented on a line toward co-channel station WTMJ in Milwaukee. The feed system was designed by Dr. Raymond Wilmotte to have the north tower lead the south tower in phase by 90 degrees so that a cardoid pattern with a null toward WTMJ would be produced. He had gone to great lengths in designing the RF networks and transmission lines to achieve the necessary phase shifts to produce the desired pattern, since there was no way to measure the phase relationship between the currents in the two towers in 1932.

The plan was for Dr. Wilmotte and the other consulting engineer on the project, Commander T.A.M Craven (who later served as Chairman of the FCC), to adjust everything theoretically, by setting the network branches to the values they calculated for the required phase shifts, and then let the Federal Radio Commission's engineers decide whether the technology was valid by making nighttime skywave signal observations at WTMJ. The plan didn't work. They discovered something unexpected - mutual impedance - when they configured the system for DA operation. In other words, the base impedances of the towers changed to values that they were unable to mathematically predict when both towers were driven, so the RF networks that had been so carefully designed and the transmission lines that had each been routed to be exactly a quarter wavelength long were not working together to produce the required parameters. They did not have time for a research project on mutual impedance, so they came up with Plan B to get the job done: they put someone a few miles out in the direction of WTMJ and changed the reactances of network branches experimentally until they found out what they had to do to get the field strength down at the observation point. [Sound familar?]

Every DA pattern that has been built since has been proofed with field strength measurements. I think that everyone will agree that it was the right thing for them to do in 1932. I think that we will all even agree that it was the right thing to do 50 years later in 1982, even though some of us were experimenting with a new technology that showed promise for returning us to Plan A by then. Yes, MOM was emerging at that time as a possible solution to the problem that had always made it impossible to rely on internal array parameter measurements to verify correct pattern adjustment: the inability to predict actual current distributions.

LEAVING SHANGRI-LA?

[Shangri-La, memorialized in 1960s song, was a mythical Tibetan land where life approached perfection in James Hilton's 1933 novel LOST HORIZON.]

I sense that there is a lot of opposition to MOM because many consulting engineers are happy with things in Shangri-La. Life approaches perfection when you can know that AM stations are always protected from interference to the "Nth degree" because every directional antenna has been measured with field strength meters. It is a comfortable life for an engineer when you can always use familar techniques to get exact results in an ideal world.

I hate to be the bearer of bad news, but we aren't anywhere near Shangri-La. The following five illustrations immediately come to my mind:

1. THE FIELD STRENGTH MEASUREMENT PROCESS IS FAR FROM PERFECT

To start with, just get out the calibration certificate that came with one of your field strength meters. Start reading where it explains the tracability of the calibration from the original standard source. You will see words that describe how the various intermediate standards are believed to be within certain percentages of the original standard and each other and then the percentages that your meter indication can vary from the final lab standard that was used to calibrate it on different scales. If you add up all the percentages, you will see that the meter is only stated to be capable of reading within about 8 1/2% of the true field value. That is 0.7 dB right there. I know that it is highly improbable that all of the errors will fall in the same direction and that field strength meters are generally more accurate than that, but this is just the "tip of the iceberg."

Take that field meter out and make some readings. You should know, first of all, that you are writing down numbers in mV/M of electric field that were read from a meter that is actually sensing magnetic field and doing the conversion by the scale on its meter face. This process assumes the characteristic impedance of free space. Look around - see the various configurations of conductors that can have currents induced in them all around you; realize that conductors that you can't see, because they are underground, can carry currents too and that localized field disturbances can result from changes in soil characteristics, terrain features, and land/water boundaries. I think the expression I'm looking for in the modern vernacular is GIMME A BREAK!

Take out a proof-of-performance report and look at the graph of the DA readings that were made on a null radial, where the critical protection requirements are typically found. In the majority of cases, you will see that the measured field strengths are scattered over a span of several dB - in the best of cases the scatter will be centered above and below the conductivity curve that was drawn through them. If the radial was run over complicated terrain, the span might be well over 10 dB. The word "proof" might appear in the title of the report, but when you look at the data and think about field strength meters and how they are used you have to realize that all that has been proven for some of the measured radials is that the measured field numbers given in the report are probably within several dB of being correct.

Wait a minute, you might say, the probable error is small because randomness assures that they are +/- errors. This is the principle that underlies the kind of statistical analysis done on data such as is acquired by a surveyor laying out a straight line on a fixed azimuth from a reference point. He determines his azimuth reference within an acceptable +/- tolerance when sighting back to the reference point and the line will be quite accurately portrayed with several observations owing to the randomness of the errors. This is not what is going on with errors in measured field that result from influences external to the array. I believe that the situation is much closer to the one where errors are introduced in a poorly placed ship's compass which is "pulled" off azimuth by nearby magnetic field disturbances. Successive observations will have the familar +/- error, and maybe even scatter due to the changing influence of the magnetic disturbance at different headings, but the errors will not be centered on the correct azimuth. Hence, statistical analysis of many observations might let you gain high confidance in defining some central value but it will not mean that the value is correct. You might solve for something like the mean erroneous value of field strength along a measurement radial in a proof-of-performance that way, but trying to relate it to the actual performance of the array is a process akin to trying to unscramble eggs. We do the best we can to get good data and get help from the standard pattern assumptions, but we are really not "proving" what many people like to think we are proving - the exact values of unattenuated field stated out to several decimal places - with external proofs.

2. PARTIAL PROOFS ARE SUBJECT TO CUMULATIVE ERROR

Most AM stations in operation today have had partial proofs run since the original full proof measurements were made. The analysis technique required for partial proofs involves a comparison of present measured field strength data to the measurements that were included in the original proof report. This process is subject to error from two major sources - the inability to make readings at precisely the same locations after many years have passed and changing propagation characteristics. These errors are cumulative, because the required analysis technique makes them add to the error already present in the original proof-of-performance.

Anyone who has made field strength measurements for a partial proof-of-performance knows that you can often get at least 25% more or less field than you first measure by walking around in the area covered by the dot that was placed on the measurement map in the original proof-of-performance report to indicate the measurement location. When faced with the task of running a partial proof that must be accepted by the FCC, engineering judgement comes into play. Since the engineer running the partial proof cannot be expected to use exactly the same judgement as the one who ran the last full proof many years, or even decades, earlier, errors are bound to occur.

The matter of propagation conditions changing over time is a major and pervasive form of error resulting from the partial proof process. This happens in two ways: seasonal variation and long-term variation.

Seasonal changes can cause considerable variation in field strength during the year. The most pronounced changes occur with frozen-ground conditions in the winter, when the effective conductivity can increase greatly. It is not unusual to see the average field strength between two and ten miles (the distance span normally measured for partial proofs) along a radial increase by 50% or more in the winter in some parts of the country. If a full proof is run in the winter, then it is possible to go back in the summer, adjust the parameters to let the nulls out by 50%, and run a partial proof showing, through a comparison of field strength readings with the original proof, that the nulls are unchanged. The station files the partial with the FCC and then becomes licensed to operate with parameters that cause its null radiation to be 50% (3.5 dB) out of tolerance. There are many unintentional cases like this out there today, and I believe that there are probably others that were intentional.

Long-term variation, that might often be better called permanent change, is a major source of error for stations with full proofs dating back several decades. In their case, measured field strengths along radials are much lower for given amounts of actual radiated field owing to the fact that the land surrounding their transmitter sites was developed after their original proofs were run. As in the seasonal variation case, this makes it possible to "prove" that the radiation pattern is correct while, in reality, the parameters have been adjusted to produce unattenuated fields far in excess of the required standard pattern values. My experience indicates that this problem is pervasive, though I believe that the ones out there were generally not created intentionally.

I have never forgotten the explaining that I had to do after I tuned up a modified nighttime pattern for a class II station on a foreign clear channel that we had improved by obtaining a CP to increase the radiation in the nulls by about 50% in order to take advantage of a change in the allocation situation. When I got through adjusting the pattern so that it could be proofed for the CP standard pattern, one of the old null monitor points was about half of what it had been running for many years before we "improved" the pattern. The manager was about "fit to be tied" because the consulting engineer who was supposed to be making his coverage better (me) actually made it much worse. The original proof had been run in the 1940s, and the station had been operating with something like three times (9.5 dB) higher radiation than allowed by the old standard pattern since a partial proof that had been run over 20 years earlier. I think that this error is more egregious than most, but my experience indicates that this type of error is fairly typical. I run into this type of situation all the time at older stations.

3. THE ALLOCATION SYSTEM IS FAR FROM PRECISE

We live in an imperfect world. This is seen in the process that we use for protecting our AM stations from nighttime interference. We currently use a propagation model that was developed in the 1980s by Mr. John Wang of the FCC to be an improvement over the methods that had been previously employed. In his paper entitled "Prudent Frequency Management Through Accurate Prediction of Skywave Field Strengths" that was published in the June, 1989 issue of the IEEE TRANSACTIONS ON BROADCASTING, Mr. Wang presented his case for why his method should be adopted. For the six North American propagation examples he offered, the RMS error for the prediction method that was adopted was 5.7 dB.

In general, exact calculation is also absent from the daytime allocation process. The calculations seem exact, but, when you take into consideration the fact that the figure M-3 ground conductivities of the FCC Rules are estimates that can vary widely from reality (in most cases overestimating field strength by a significant amount), they often are not. Field strength measurements are sometimes made to better define the ground conductivity in specific directions, but are generally made only to the extent required to make a desired radiation pattern "fit." In other words, enough measurements may be made on a station that must be protected from interference to pull its troublesome contour back by the necessary amount, with figure M-3 conductivity used for the remainder of the distance between the stations. A fair amount of error is to be expected in groundwave interference analysis, particularly considering that the type of seasonal variation that I mentioned in my discussion of partial proofs is also at play with allocations based on both M-3 and measured conductivities. Besides that, you generally face several dB of field strength uncertainty on the null radials of daytime directional antenna patterns due to scatter. [See the discussion in the section on the field strength measurement process - number 1.]

4. DA SUPPRESSION PERFORMANCE ISN'T PERFECT

The efficacy of proof measurements to determine the real interference potential of directional antennas can be much better understood by examining the information presented in the FCC Memorandum concerning "Suppression Performance of Directional Antenna Systems in the Standard Broadcast Band" by Harry Fine and Jack Damelin, dated September 6, 1957. In this report, which was prepared before the advent of standard patterns, analysis methods to correlate measured and theoretical far-field skywave protection for a number of actual stations were examined. All of the stations that were studied were verified by the FCC to be operating properly under the Rules prior to observation. A quadrature component of 9.0% of pattern RSS was found to produce standard errors in the range of four to six dB. A quadrature factor of 2.5% of pattern RMS was ultimately adopted, so the error would be even higher if the 1957 data were analyzed under the present standard pattern Rules.

5. MANY DIRECTIONAL ANTENNA SYSTEMS ARE OUT OF TOLERANCE

It has been mentioned by others, but I will confirm it. The directional antenna systems that we depend on to provide interference protection are, in general, in pretty poor shape. I visit a lot of AM transmitter sites. Sometimes I'm there to solve problems, sometimes just to find problems. I believe that the majority of AM DAs that I have inspected in the last ten years have been out of tolerance in some way. Many have non-functioning antenna monitors. Others have functioning monitors but the indicated parameters are incorrect. Perhaps the largest group has correct antenna monitor parameters but monitor point field strengths and/or base current indications that are out of tolerance. I believe that the high cost of proof work serves to discourage getting the problems solved. As I mentioned earlier, the licensees of these stations can encounter significant difficulty in even finding a competent consulting engineer with time to work on their systems. Simplification of the Rules would be a step in the right direction as far as getting the deviant arrays into good shape is concerned.

OUR EPISTEMOLOGICAL PROBLEM

Epistemology is the area of philosophy that deals with the nature, limits and validity of knowledge. Epistomologists usually deal with important-sounding matters like whether we can know if there is a God or whether we can know if the material World really exists or is just an illusion. Such questions are beyond my intellectual limits, but even I can clearly see that we need to characterize the nature, limits, and validity of our knowledge about AM DA performance in the context of the overall interference avoidance process before we can talk intelligently about what should be required for proofing them.

Here's a rather mundane and trivial example: If an learned scientist carefully measures a log and marks where it should be cut with a fine line accurate to +/- 0.01 inch and then it is chopped in two by a lumberjack who is capable of hitting it within +/- 1.0 inch of the line with his axe, can the learned scientist say after the lumberjack is finished that he knows the lengths of the two resulting pieces within +/- 0.1 inch? Of course not! This begs the question of whether there is any reason to go to the trouble of marking logs to within 0.01 inch in the first place. Of course not!

Here's an example that is a little "closer to home" for us: If the interference avoidance process relys on DA suppression that has been demonstrated empirically to include at least six dB error, propagation analysis that has been demonstrated to include approximately six dB error, and an external proofing process that demonstrably includes several dB of error, do we know how well directional antenna patterns perform within the overall scheme of things to within a fraction of a dB? Of course not! Should we be quarreling over the importance of tenths of a dB, or even one to three dB, when deliberating how the proof Rules might be changed? I say, of course not! [This does not consider the comparison between MOM and external proof uncertainties which I think, alone, justifies the adoption of MOM techniques.]

I felt like the Rules sancioned highway robbery when I had to have a client pay for a crew to go out and remeasure a major lobe (i.e. non-adjustable) radial for a partial proof earlier this year because the initial readings were 1.1% (0.1 dB) high and I could not find any way to "analyze them in." I'm sure that it cost them at least $1,000 by the time the guys who ran the radial and I charged for the time and expenses we spend dealing with that "problem." Guess what? The radial was found to be barely "in" when it was remeasured.... I suspect just because we were fortunate enough to catch some of the errors having a "down day."

The first step toward having the correct perspective when we look at AM DA performance as a part of the overall interference protection process, in my opinion, is to view the possible radiation errors in dB. The other steps of the process use dB and, for that matter, every other type of antenna that I am aware of has its performance specified in dB. I have adjusted many DAs using MOM in the last 15 years or so. I generally find it desirable to make small adjustments from the initial MOM parameters once a "sampling" of filed strength measurements have been made to "squeeze" some nulls down by a dB or two to be within the standard pattern with reasonable monitor point tolerance or, sometimes, work a null or two out toward the standard pattern value for coverage improvement. There have been times when I found it reasonable to just leave the parameters at the MOM values for the proof. In no case, even with complicated terrain and/or unequal height towers where the applicability of computer modeling might be questioned, have I ever seen any radial as much as five dB outside of the standard pattern where unobstructed radial field strength measurements were possible. The largest such deviation I remember was about three dB. Most have been in the zero to two dB range. Please don't tell me that MOM isn't accurate enough for proofing AM DAs when the scatter of the groundwave field data that you typically find when you run a null radial in a proof is about the same as the highest dB error I have experienced setting up arrays with MOM techniques, and the errors that were found in the FCC's own suppression performance and skywave propagation studies were significantly higher.

WHERE SHOULD WE GO WITH THIS?

I would like to see the NAB meeting result in the following:

1. Agreement that, since MOM techniques may not be useful for all antennas and some licensees might not wish to use MOM technology to adjust their patterns (to avoid having to install the new sampling systems that will probably be required or to give them the opportunity to field adjust their patterns to optimize null fill), we should keep a means for proofing DAs with field strength measurements in the Rules.

2. Agreement that the Rules for the field strength proofing process can be simplified along the general lines that the FCC has proposed, with some modification.

2. Agreement that our objective should be to make the process for full proofs sufficiently simple that the partial proof process can be eliminated.

4. A thorough examination of how the field strength proof process can be simplified and an agreement on the specific details of a plan to be presented to the FCC in the context of this rulemaking with a request for expeditous action. [I will gladly offer my specific opinions on this matter at the appropriate time.]

5. Agreement to urge the FCC to issue a Further Notice of Proposed Rulemaking to look into how MOM techinques can be implemented for proofing DAs and how to define which types of DA can and cannot use them. I would also like to see the controversial critical array designation question be delayed and included in the Further Notice to give us all some time to get some experience with the FCC's proposal.

6. A commitment on the part of interested broadcasting companies, consulting engineers, equipment manufacturers, and possibly the NAB to conduct the research necessary to explore the matters that will be examined in the Further Notice.

7. A commitment to meet again and examine the evidence generated by the research project in an effort to reach a concensus about what to ask the FCC for in the way of Rules for MOM proofing.

EXTENDING AN OLIVE BRANCH

I regret that I didn't better communicate my thoughts and the reasons for them to those of you who disagree with me a long time ago. I apologize if I have alienated anyone with my promotion of MOM over the years and I hope that, if anyone feels chided after reading this message, they will take what I've said in the good natured way that I meant to say it.

I want what is best for AM radio. I also want us all to still be friends when this is rulemaking over. Let's agree to put aside our emotional issues and past differences on the MOM question and work together to determine what is best for AM radio through a logically sound process.

Cordially,

Ron Rackley
du Treil, Lundin & Rackley, Inc.
Sarasota, Florida

Sent: Friday, September 10, 1999 10:45 AM
Attach: afcceAM.rtf
Subject: Re: AM DA NPRM

Lew and group:

I took the liberty of editing substantially the proposed AFCCE comments in the AM Performance Rulemaking to reflect what I believe to be the views of some of our members (Including Rackley, Dawson, and myself) on the proposed rule changes. I've attached the red-lined file in RTF (I edited in MS Word), please let me know if it does not come through properly.

REVISION 2 Draft Comments on MM Docket No. 93-177, AM Directional Antenna Performance Verification

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

In the Matter of)
)
An Inquiry Into the Commission's)
Policies and Rules Regarding AM) MM Docket No. 93-177
Radio Service Directional Antenna)
Performance Verification)

COMMENTS OF THE ASSOCIATION OF
FEDERAL COMMUNICATIONS CONSULTING ENGINEERS
ON NOTICE OF PROPOSED RULEMAKING

Introduction

The Association of Federal Communications Consulting Engineers (AFCCE), celebrating 50 years, is an organization that includes approximately 90 full members who are Registered Professional Engineers engaged in the practice of consulting engineering before the Federal Communications Commission.

AFCCE supports and commends the Commission for its efforts to review and, where possible, simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas. However, as the Commission notes in paragraph 7, "Prevention of interference among AM broadcast station [sic] remains a core regulatory function of this Commission." While antenna proofs of performance impose a financial burden upon AM broadcasters, it is not a burden that has been concealed by Commission policy, rules, or regulations from station owners, nor is a service-specific burden unique to the AM service, however, the nature of AM antenna designs makes the process time consuming and labor intensive. ~~We suspect that almost every broadcast service, when offered the possibility of relief, could identify costs that pose a greater burden for that service than for other broadcast services~~. The AFCCE ~~can only~~ supports those changes in the rules which do not compromise the technical integrity of the broadcast spectrum. AFCCE understands the concern of the Commission and licensees that some of it's comments may be viewed to be in the self-interest of AFCCE members, therefore it should be noted that AFCCE proposes that the Commission go further than has been proposed in the NPRM to reduce burdens on licensees.

However, it is equally true that the Commission should simplify or eliminate the regulatory and compliance burdens on AM broadcasters using directional antennas (as well as all other licensees) when the changes will result in a net improvement in techniques and where the ~~cost benefits are substantial and the~~ risk of technical compromise can be reduced by adequate safeguards. The challenge for the Commission is to enact rule changes the reduce the burdens on licensees and the Commission while maintaining a reasonable ability to verify compliance.~~that reduce costs without increasing the enforcement burden on the Commission and without eliminating the ability of the broadcaster to verify both his own and his competitors' compliance.~~

Computer Modeling versus Proofs of Performance

The present methods used to verify performance of AM directional antenna systems date to the earliest days of AM broadcasting. Presently, licensees must make hundreds of field strength measurements, in-situ, to "prove" that an AM directional antenna is "properly" adjusted. In many respects, this legacy of field measurements dates to a time before AM stations employed accurate monitoring equipment that measures the relative phases and amplitudes of the RF signal in each tower, and long before modern computer techniques allowed qualified engineers to analyze such antenna systems in intimate detail.

The use of computer modeling to prove that an AM directional antenna is performing as specified in the Construction Permit is not fully accepted among the engineering community. ~~as proof of compliance for an AM directional antenna is controversial.~~ On the one hand, computer modeling offers a significant potential for improved accuracy in the adjustment of antenna systems, cost reductions for AM operators, and a reduction in interference between AM stations. ~~with directional antennas~~. On the other hand, some engineers believe that ~~there are substantial questions regarding the ability of~~ computer modeling may reduce the ability of independent parties to verify performance of AM directional antennas, and that such modeling may not be applicable to all antenna designs and environments. ~~to satisfy the requirements of independent verification and situational adaptability that are the hallmarks of the present field strength measurement approach.~~

For directional FM or TV antennas every effort is made to duplicate during design and construction the near field conditions for the antenna including tower shape, cables, and other appurtenances. At least one complete bay of the antenna is then measured on an antenna range rather than on site in order to control the effects of multipath and reflections on the measurement process. The Commission permits the use of scale models of the antenna bays and structures; in cases where only a single bay is employed or a scale model is used, the Commission permits verification based on application of appropriate array equations and scaling factors. The antenna is then shipped to a site and installed. Restrictions are placed on the local environment around the antenna so that the pattern will not be distorted by the environment but will stay as measured on the test range. It is important to note that in-situ field measurements are not required for FM and TV antennas, nor is there any means for an independent party to verify that the FM directional antenna conforms precisely with the measurements made at the antenna range.

AM arrays are built at the site, and performance is verified by a series of field strength measurements taken in varying distances and directions from the antenna. While it is arguable that the only method of accounting for ~~Only on-site measurements can allow for~~ variations in tower assembly, bonding of such items as critical joints, cables and appendages, and the effect of the surrounding environment is through in-situ field measurements, the Commission's experience with such factors in the FM service have not resulted in any serious interference or degradation of service. ~~These on-site measurements have historically consisted of field strength measurements~~. The experience of AFCCE members is that variations in bonding and tower assembly manifest themselves through fluctuations in the antenna monitoring system, which is (and would remain) a key component of performance verification.

As computer models have become more elaborate, more accurate representations of the array and the impact of the local environment on the array have become possible. The method of moments model, in mostany cases, has predicted array performance at least as well as can be measured using traditional field measurements. Such models have been useful tools for several years for achieving a desired antenna performance when designing or adjusting an array.

The problems of field strength measurements to prove array performance are well known to the Commission and the engineering community.

First, the accuracy of the measurements is subject to the experience of the person making the measurements. The measurement technician must determine whether the measurement read on the meter is a direct signal or a reflection, whether there is interference that affects the reading, that the meter is properly calibrated at each point, and that the measurement point is accurately located. The Commission is aware of cases where measurement fraud has been made.

Second, the measurement environment can substantially affect the ground-based readings. At a number of AM sites, arrays are located where large segments of the measurement radials are not accessible, or where the radio wave is affected by diffraction along the edge of a river. In those cases, the engineer must resort to reduced data for analysis, proximity corrections, or helicopter measurements, all of which reduce the accuracy of the analysis.

Third, the accuracy of the analysis is subject to the judgement of the engineer. The absolute field strength along a given radial is determined by a graphical analysis; that is, the engineer must fit the field measurement data to a series of theoretical curves. Depending on the quality of the data, scattering of points, and so forth, the analysis may or may not accurately reflect the actual field strength along a radial. The variation may be as little as 5-10% and as much as 50%. The engineer has the latitude, based on his or her judgement, to include or exclude measurements that fit the desired analysis.

Third, even where measurements are accurately made and analyzed, the use of such measurements for ongoing compliance evaluation is problematic at best, and impossible at worst. Since AM field strengths at distances from the array are affected by ground conductivity, leading to higher readings during periods of high conductivity and lower readings during periods of low conductivity. In the worst case, an array that initially "proved" during the winter months could be readjusted during summer months to be far out of adjustement; likewise, an array initially measured during the summer must be re-measured during the winter just to demonstrate compliance (even if nothing in the array has changed).

The use of computer modeling in lieu of field measurements has three ~~critical~~ problems that AFCCE has identified.

First, the inputs to the model are based on the engineer's beliefs concerning a specific array. For example, tower height is an important parameter in predicting performance. Survey measurements on existing towers often reveal heights up to several feet different than claimed on the available documentation. Tower spacings and array orientation also must be accurately verified to avoid errors in the modeling process. Tower integrity can be a serious problem on older towers as well as on new towers assembled by inexperienced personnel. This problem can be solved by requiring an applicant to make and submit survey measurements for each tower on the site. This is not a substantial burden in that the Commission now requires such a precise determination for FAA tower registration requirements. Such surveys would conform the AM requirements to the FM requirements, and in the opinion of AFCCE members, would reduce the number of arrays built with incorrectly-placed towers (which is a problem regardless of the proof-of-performance requirements).

The second critical problem in using computer modeling in lieu of field measurements is the question of verification. Field strength measurements can be made by the FCC and by other stations without the permission of the licensee. Reliance upon computer modeling exclusively would be no more of an invitation to poor maintenance, incompetence, fraud and corruption than the present field measurement process. The members of AFCCE can recount numerous occasions where fraudulent field measurements have been made. The Commission has long held the assumption that licensees abide by the Rules. Use of modeling would still permit outside parties to verify that an antenna system is properly adjusted by making a series of field measurements and analyzing them; the Commission still would retain the ability to inspect the radio station and determine whether the antenna monitoring system was performing as licensed. In fact, the Commission's burden would be reduced as current policy calls for the Commission to measure an entire radial to determine whether the array were in adjustment; moving to a computer model would enable the Commission to quickly and easily determine the state of adjustment on an antenna system without extensive field measurements. Use of computer models would also reduce the effect of seasonal changes on field measurements. ~~The Commission's enforcement practices depend upon two principles; one, that most licensees try to abide by the rules, and two, that violators can be caught without undue effort. The second of these principles requires enforcement based on observed effect rather than claimed input.~~

The third critical problem is the ability of computer modeling to include the effects of the environment. For example, metallic objects, such as other towers, buildings, power lines, etc., proximate to ~~within one or two miles of~~ a directional array can, under some circumstances, ~~are known to~~ distort the antenna pattern. This problem is ~~has becoming more s~~significant in some circumstances.~~and more the focus of disagreement as cellular radio towers have proliferated.~~ The list of AM directional stations that consulting engineers consider as having special problems or being in difficult locations is lengthy. ~~The unpredictable, complex, and subtle aspects of AM directional antennas interacting with their environments require the talents of some of our most skilled consulting engineers.~~ AFCCE members have noted, on a number of occasions, that it is necessary to "mis-tune" an AM array to account for re-radiating structures near the field measurement points, or to "prove" that the radiation limits are satisfied at ground level. It is troubling to many engineers that such "mis-tuning" to "prove" array adjustment can actually increase radiation at higher elevation angles, increasing nighttime interference between AM stations. These problems can be solved by proper application of a computer model that accounts for significant re-radiating structures that affect the interference protections contained in the station authorization.

As noted, tThese three problems are not insurmountable. We recommend that the use of computer modeling be permitted, under certain the conditions noted below, as an alternative to making field measurements. In the event of a dispute, a combination of factors, including the antenna monitoring system performance and limited field measurements would be considered. Field measurements should continue to be the final authority in cases of dispute. A dispute between a broadcast station and the owner of a nearby communications tower, could, for example, be resolved by considering the nearby tower in the computer model used to prove the AM array performance. This could be backed up with field measurements, if necessary. Cases of dispute would include disagreements between broadcast stations and between a broadcast station and a communications tower owner, for example.

The advantages of using computer modeling include a reduction of time to "prove" array performance, reduced need for the Commission to issue STA's or for stations to operate with temporary facilities, lower costs, and more accurate verification in cases where field measurements are difficult or impossible.

The performance measurements submitted with the FCC Form 302 should conform in spirit to those used for FM stations. The application should contain full details of the model employed, the suitability of the array for modeling, a description of the environment surrounding the array, a certified survey of the tower placement on the site, and the qualification of the engineer that analyzed the model. No prior permission will be required to employ this method.

Prior to using computer modeling in lieu of field strength measurements, a licensee should be required to apply to the Commission for permission. The application should include detailed information as to the suitability of the array for the use of computer modeling. The detailed information should include a review of the environment around the array and a certified analysis by a qualified engineer that the use of computer modeling is appropriate for that array.

A licensee using computer modeling should be required (1) to install the necessary antenna monitoring system to monitor absolute current or voltage and phase rather than relative current and phase, (2) to have a professional surveyor certify the "as-built" physical parameters of the array, (3) to have tower integrity certified by a recognized tower inspection firm at least every three years, and (4) to physically inspect the environment within two miles of the array annually for significant changes. Copies of this documentation should be kept in the public file at the station.

AFCCE believes that the key to proper analysis of a numerical model is verification that the antenna monitoring and sampling system is accurately measured and specified in the station license. Thus, a license issued under computer modeling techniques should include measured parameters for sample line electrical lengths and performance, tower operating impedances, and the exact configuration and placement of sample devices. In fact, AFCCE members can envision that broadcast equipment manufacturers may make equipment that incorporates calibration and sampling circuits to allow instant verification of critical parameters. Variation of such parameters will enable licensees and the Commission to determine tower integrity and sample system integrity through use of relatively simple measurement techniques. A licensee should also be required to check the environment around the array as often as necessary to ensure that the model remains valid.

The use of computer modeling inherently involves the measurement of on-site antenna parameters as well as requiring the array to have (1) an absolute current or voltage and phase antenna monitoring system, and (2) certified physical parameters. It follows that computer modeling by parties other than the AM licensee to show compliance with FCC requirements should only be used with the explicit cooperation of the AM licensee. The Commission can require that licensees cooperate, as necessary, to ensure that the Public Interest is met. Absent evidence to the contrary, a computer model may be accepted to show that a nearby structure does not re-radiate or is otherwise electrically invisible; however, if the structure is located within a distance of 2 times the array aperature, the entire array must be modeled with the cooperation of the AM licensee. In cases where the owner of a nearby structure employs such modeling, a copy of the model and results must be provided to the AM licensee as soon as practicable. ~~and only on AM directional arrays which (1) have been approved by the Commission for computer modeling, and (2) have implemented computer modeling. The use of computer modeling to show a lack of pattern distortion from a structure within two miles of an AM array when the AM array does not meet the above requirements should be prohibited.~~

If the Commission adopts the use of computer modeling as proof of compliance, the Commission's staff must be prepared to know and provide public notification as to which computer programs are acceptable. Moreover, the Commission's staff must be prepared to replicate a given set of results in the event of disagreements. Both these requirements may take the Commission into controversial areas. It will be important for the Commission to provide the necessary staff resources or contract with a qualified contractor to prepare for the use of computer modeling to ensure compliance with the FCC Rules. ~~before accepting such proofs.~~

Directional Antenna Proofs of Performance

The Commission currently requires a minimum of eight radials, each with a minimum of 30 points between zero and 25 or 43 kilometers (zero and 15.5 or 20 miles) for a full proof. A partial proof currently requires at least 10 points between three and 16 kilometers (two and 10 miles) for each radial used in the last full proof. The Commission proposes to reduce the requirements for a full proof to a minimum of six radials, each with a minimum of 15 points between zero and 15 kilometers (zero and nine miles). The Commission proposes to reduce the requirements for a partial proof to a minimum of eight points per radial with no other changes in the partial proof.

Full Proof of Performance

The purpose of a full proof of performance is to establish the fundamental base line for showing antenna performance and compliance. A full proof is required when the antenna is first constructed and when any permanent changes are made in the location, height, or directional radiating characteristics of the antenna. A full proof of performance is a rare event in the life of an AM station. Many stations have been on for decades and have not had a full proof of performance since the ones that were made when they were constructed. However, in many of those cases, the environment surrounding the AM station has changed to a degree that any partial proof-of-performance measurements will require measurements almost as extensive as a full proof of performance.

Because of the fundamental and infrequent nature of a full proof, we examined the potential cost savings that may occur if the requirements for a full proof are reduced. ~~believe the Commission should look closely at the cost savings before using cost as a justification to reduce the requirements for a full proof.~~ In some cases, t~~T~~he cost difference between a full proof using the present rules and a full proof using the proposed rules is a small part of the engineering cost of building or modifying an AM array. In other cases, the costs of a full proof of performance run into the hundreds of thousands of dollars. AFCCE members are aware of circumstances where the engineering costs for design, adjustment, and analysis exceed the cost of the physical equipment for the array. The engineering costs include the design and adjustment of the array as well as the final proof measurements. While a consulting engineer usually designs and adjusts a new or modified array, it is common practice for the radial measurements to be taken by support personnel. The proposed reduction of 50~~25~~ percent of the points for simple arrays~~, while it~~ will reduce some of the time spent by support personnel in collecting data at the longer radial distances, thereby reducing the field cost to the licensee. There will be little change in the cost of tune-up and engineering office time. ~~, may increase the time required by engineering personnel to analyze the data, since the relative spread in the data will be greater.~~ The proposed changes will reduce some of the cost burden associated with a full proof without materially degrading the value of those measurements.

With regard to nondirectional stations which are required to conduct a full proof due to the proximity of reradiating structures, etc., the Commission proposes reducing the number of evenly spaced radials from eight to six. ~~We oppose this reduction for a full proof for the same reasons as noted above.~~ We see no reason that licensees should have to re-make measurements for existing situations, but we believe that the burden can be reduced in ~~However, in those~~ cases where measurements are required for a nondirectional antenna because of the impending construction of a new tower nearby and a previous full proof does not exist. We~~, we would~~ support requiring a minimum of six radials for a partial proof, equally spaced around the tower with one radial in the direction of the reradiating structure. ~~provided that at least four are on the side facing the proposed construction at no more than 45 degree spacing symmetrical about the bearing to the new construction, while the side opposite the new construction has a minimum of two radials at no more than 75 degrees spacing.~~

As noted in the previous section, we recommend that the use of computer modeling be permitted as an alternative to field measurements. ~~in certain specific cases and that field measurements continue to be the final authority in cases of dispute.~~

Partial Proof of Performance

The purpose of a partial proof of performance is to verify that the array is still in compliance. As noted in the NPRM, many things can trigger the need for a partial proof. If the monitoring point or antenna monitor reading limits are exceeded, if the antenna system is altered by attaching or replacing items such as guy wires, cables, isocouplers, other antennas, etc., or if the station has been dark for more than six months, a partial proof is needed to determine that the array is still functioning as intended. If the partial proof and the antenna monitor readings indicate compliance, there is a high degree of probability that a full proof would also show compliance.

Because of the diagnostic nature of a partial proof, a directional station can anticipate many partial proofs in the course of its existence. For this reason, reducing the cost of a partial proof is more important than reducing the cost of a full proof. Reducing the cost of a partial proof also increases the likelihood that station management will authorize the measurements when the need is indicated. A partial proof typically utilizes a much higher ratio of support personnel to engineering personnel and the proposed reduction of 20 percent or more in the number of points would be a more significant reduction in the partial proof cost than the 25 percent reduction proposed for a full proof.

We support reducing the number of required points per radial for a partial proof from the present 10 to the proposed eight because the cost savings may outweigh the increased engineering risk. The Commission should make clear its ability to require a full proof if a partial proof does not seem to agree with interference measurements or other indications of noncompliance. ~~In addition, the Commission should increase substantially the fine for noncompliant operation to provide more incentive for partial proofs when the need is indicated.~~

We also recommend a change in the Rules to eliminate a requirement for a partial proof of performance in those cases where a station is returned to the air after being dark, provided that the licensee certifies the integrity of the antenna and monitoring system, and that all monitored parameters (including filed monitor points, if applicible) are within licensed limits.

As noted in a previous section, we recommend that the use of computer modeling be permitted. ~~in certain specific cases and that field measurements continue to be the final authority in cases of dispute.~~ For computer modeling, the concept of a partial proof does not apply. All proofs using computer modeling are, by definition, full proofs, and the requirements for a full proof using computer modeling must apply when the need for a "partial" proof is indicated and computer modeling is used to satisfy the need.

Monitoring Points

Monitoring points are based on the full proof, not the partial proof. If a monitoring point needs to be changed because of construction or other factors, then the full proof data should be used rather than a radial partial proof. We agree with the Commission's proposal to assign limits to new monitoring points based on the last full proof of performance.

The Commission proposes eliminating the requirement for maps and directions for applicants using differential GPS-determined coordinates. This precludes the use of coordinates determined by survey or by techniques that may be developed in the future. We recommend that the Commission accept coordinates as a means of locating monitoring points but specify the required accuracy rather than the method.

As noted in a previous section, we recommend that the use of computer modeling be permitted~~ in certain specific cases~~. We recommend against the assignment of ~~that monitoring point~~ monitor points ~~measurements~~ in those situations where computer modeling is employed. Without full proof of performance measurements, neither the Commission nor the licensee can be sure that the monitor point reflects array performance, especially during seasonal variations. A third party can make sufficient measurements on a radial to determine whether a station is in substantial compliance.~~continue to be established and routinely measured whether the antenna proof is performed via field strength measurements or via computer modeling. The use of monitoring points remains a simple and relatively inexpensive way to verify externally the actual performance of an array and of the antenna monitoring system.~~

Finally, regarding augmentation of radials which involve a required monitoring point, 47 C.F.R. 73.152(c)(2)(iv)(B) allows 120 percent augmentation of the actual measured inverse field value if the measured inverse field exceeds the value permitted by the standard pattern. If the data for a monitoring point radial is analyzed and found to be 99 percent of the standard pattern, the field strength limit for the monitoring point will be set at essentially the standard pattern value, leaving no room for drift or seasonal variations. If the data for a monitoring point radial is analyzed and found to be 101 percent of the standard pattern, the field strength limit can be set significantly above the standard pattern by augmenting the radial.

This is an incentive to analyze the data on monitoring point radials where the result is near the standard pattern value as above the standard pattern value. Since analyzing field strength data involves judgment as well as engineering, there is an inherent conflict. We recommend the Commission eliminate this conflict as part of the present NPRM by allowing a positive 10 percent adjustment to monitoring point values for monitoring point values between 90 and 100 percent of the standard pattern value.

AM Station Equipment & Measurements

We agree with the Commission's proposal to delete the requirement for base current ammeters or toroidal transformers for those directional stations employing approved antenna sampling systems.

Antenna Monitors

We agree that 47 C.F.R. 73.53(c) can be moved to 47 C.F.R. 73.69. We are puzzled as to why the other requirements of 47 C.F.R. 73.53, with the possible exception of 47 C.F.R. 73.53(b)(1), impede the development of antenna monitor systems using advanced technology. These requirements are minimum requirements that a monitor should pass for it to be used to verify and maintain array compliance on a day-to-day basis. There should be recommended standards for performance, rather than a time consuming (and expensive) approval process. A monitor that can not pass these requirements will be of limited value to the station licensee or to an FCC field inspector.

We agree that voltage sampling devices are appropriate as alternatives to sampling transformers and pick-up loops and can be used to feed antenna monitors for towers with electrical lengths of 130 degrees or less. The use of voltage sampling devices for towers with electrical lengths of more than 130 degrees should require a showing by a qualified engineer to demonstrate the accuracy and performance of such devices. ~~specific approval of the Commission on a case by case basis.~~

Impedance Measurements Across a Range of Frequencies

We agree with the proposal to delete the requirement to measure impedance across a range of frequencies. The Commission presently imposes no requirements on the audio quality of AM stations, which is the current reason for measuring impedance across the signal bandwidth. The present competitive environment and consolidation has provided new impetus for stations to provide quality signals to their listeners. Thus, there is incentive for a licensee to ensure performance at the drive point of the antenna. ~~However, we note in passing the Commission's statement that "...we have no reason to believe that audio and video quality of broadcast stations has been lessened by deletion of those requirements [15 years ago]." (paragraph 35) We have observed several AM stations in rural areas with audio quality so poor as to be almost unintelligible. Some of these stations have eventually gone dark. Others remain on the air as the only station in a small town. We are unsure as to whether this type of deregulation is in the public interest.~~

Common Point Impedance Measurements

We agree with the proposal to delete the requirement that the common point reactance should be adjusted to zero ohms. We recommend that this requirement be replaced with a requirement that the common point reactance be adjusted to between zero and minus 20 percent of the common point resistance.

Critical Arrays

AFCCE agrees that the Commission should revisit the designation of some AM directional antennas as "Critical Arrays". The key concern of the Commission should be whether an array can be reasonably presumed to operate in a manner that protects other stations from interference. There are many designated "critical" arrays that are inherently stable in operation.

As with FM stations, AFCCE suggests that AM directional antenna grants be routine for arrays meeting certain minimum specifications that affect ongoing array operation. Instead of the current and proposed analysis techniques for determining whether an array is "critical", AFCCE suggests that the Commission require a showing by a qualified engineer as to the proposed stability of any array that is predicted to operate with the absolute value of base impedance of less than 2 ohms for each tower with a relative field greater than 0.75 (referenced to the tower with the highest relative field). All other arrays would be designated as "non-critical".

We agree with the proposal to discontinue specifying the use of special precision monitors, provided that the monitor requirements continue to require stability over the present range of environmental and electrical parameters and that the monitor installed has sufficient accuracy and precision to assure compliance with the license requirements.

~~The Commission's computer code for determining array stability has not been available long enough for a detailed evaluation. We request that the implementation of the Commission's proposals regarding reclassifying critical arrays be postponed until the computer code has received more extensive review. As a practical matter, this may best be achieved by staying the effective date of these rule changes for a period of six months.~~

Sent: Friday, August 20, 1999 12:48 AM
Subject: Further thoughts on rules changes for AM Directionals

Dear Lou:

Your email narration Wednesday of the pro-MOM (moment of methods) and anti-MOM factions sounded something akin to an explanation of the factions in Serbia. I regret that you think it may be impossible to distill it all into a unified position which all of AFCCE can support.

In line with your "add, delete or substitute, but don't just whine" dictum, I would like to float the following proposal. To give credit where credit is due, the core of this came from Larry Morton in a telephone conversation we had yesterday. I don't say that to duck the blame if someone dislikes it, because I support it 100%, I simply don't want to steal Larry's ideas and present them as my own. Larry, like you, is preparing for vacation and may or may not have time to reduce this to words. As your Wednesday email indicated that you may be out of the office for a week beginning the 23rd, I have taken keyboard in hand in order for this to make the circuit before you have to leave.

Because of the ticking clock, I have also addressed this to the somewhat larger e-mailing list provided by Bob Senior. That way, no one misinterprets the hurried, scattered efforts of the volunteers as a conspiratorial group working in secret behind closed doors. [Note to those on the cc: list having comments, Lou's announced departure on the 23rd is MONDAY. I presume that means he would need your reactions in the next day or two...]

I think the group is agreed on the problem. We are just divided on how to solve it.

The problem (in my humble opinion) is that a full proof is too big. It's more time away from home and our families than we want to spend.

And it's more money than a client wants to spend. There is some challenging math in the on-site work, but it so diluted with the monotony of waiting for the latest data to begin the next iteration, that most of the on-site time is wasted. In simple words, we have an instrumentation problem.

In the past, some have hypothesized fixed-position telemetry trucks at the MP's with a CRT at the phasor, simultaneously showing all of the MP E-fields in real-time. The NEC-model proposal suggested bypassing the instrumentation issue and adopting a computer model. All were attemps at taming the instrumentation problem. I believe that the instrumentation problem can be tamed in another way.

Let me prime the conversation by asking the rhetorical question: "When you run a radial, what percentage of your time is spent driving and what percentage is actually spent collecting the data?" I conjecture that less than 1% of our time is actually spent looking at the dial on the FIM. Data gathering is horribly diluted by the mechanical task of getting to the point.

Let me follow up with same question Larry Morton posed to me: "What information is contained in the e-fields at 20 miles that is not also contained in the data betwee 3 and 5 miles?" I believe that the answer is "very little". A significant re-radiator within 3 miles of the array center will announce itself as a distinct standing-wave pattern in the measured fields between 3 and 5 miles. And while the nulls on physically large arrays may not be completely formed this close in, this can be 100% accounted for using near field correction.

I won't draw this out, as I think most people seee where it's going. A large portion of the 302 is the mechanical task of getting to the points. Not something the client can afford to pay the normal office rate for. On the other hand, if you charge a lesser hourly rate when in the field, you lose money every time you leave the office (compared to what you would make if you stayed at your desk). And this says nothing about the disruption of your personal life and disruption of the work flow on your desk while you are gone.

I believe that we can get just as solid and defensible an analysis... actually, more solid... by taking the same number of points on MUCH shorter radials. After some quick calculations, I believe that 3 through 7 kilometers is the right bracket. These numbers were chosen to accomplish three goals:

1) Starts far enough out to make sure the nulls are formed (or nearly formed) on all but the largest arrays.

2) Ends close enough in to reduce total time required in the car for the 302, and

3) Has a sufficientl length that significant off-site re-radiators will announce themselves as a standing wave pattern in the plotted data.

Not only does the data (Yes, some will say I should use a plural verb instead of a singular verb with the noun "data". They are right.) from 20 miles not bring any significant new information to the analysis, it bring the significant added variability of changing conductivity. Conductivity information is part of the 301 process. But it is irrelevant for the 302. The sole goal is to contain the realized pattern within the artificial construct of the STD Pattern envelope.

If the furthest point is only 7 km from the site, the mechanical task of driving to the points shrinks by at least 2-to-1, perhaps more. Less time driving for those with that task. Less time for the guy twiddling his fingers in front of the phasor, waiting for the guys in the field.

I can hear the challenges forming already. I'll try to anticipate the obvious ones and answer them below... as soon as I finish making my point. If there was more time before Lou left, I would probably float a more refined proposal. I can only hope that my friends and colleagues will take pity on me and forgive the inevitable shortcomings of a hurridly-prepared idea.

Another rhetorical question... "If a shorter radial gets the job done as well... and you say even better... why wasn't 73.186(a)(1) written that way in the beginning? Perhaps Harold Kassens or others can answer that. I will conjecture that it was because they weren't all that comfortable with near-field correction at that time. Plus, at that time, an AM license was a license to print money. When AM had 100% of the audience, economy was less of a concern than was speed in getting on the air. Long radials worked in the economic conditions that surrounded the writing of 73.186.

Is near-field correction reliable or flaky black art?

The first 302 I saw with near-field correction was John Mullaney's 302 for WAPE in Jacksonville, a physically-large, 6-tower broadside on 690 kHz. This would have been appproximately 1976. duTreil, Lundin & Rackley and Hatfield & Dawson also used near-field correction for their October 1997 co-ventured 302 for WDFN, Detroit. Here, a physically-large array was located within 2 miles of the Lake Erie shoreline and data at greater distances was not obtainable on many radials.

I am sure there are other examples which I am forgetting. We have never used near-field correction in a 302, but we have used it several times to figure out what is going on in the array and have found it to be stunningly accurate.

I believe that the problem with near-field correction in the past has been two-fold:

1) it consumed mammoth amounts of time to do manually in the era before computers,

2) when computers finally came along, 73.186(a)(1) was already in place, mandating the present long radials.

While the math theory to do near-field correction was known when 73.186(a)(1) was written, it took more time to do on a slide rule that it took to get in the car and run the long radial. The fact that the writers made the choice they did is logical.

Also remember that, had they used near-field correction as a mainstream method of processing 302's, the burden of calculation was two fold: 1) Once for the office that prepared it, and 2) again for the 302 shop in reviewing it. Before computers, neither side of the street had time to bother with near-field correction.

The obvious questions...

Q: Why is this better than reducing the number of points, as proposed in the NPRM?
A: Because the bulk of the time is spent driving, not handling the FIM. Making significant reductions in those activities which account for only a small percentage of the total enterprice will not make a noticeable reduction in the overall task. (Amdahl's law) Reducing the time spent driving CAN effect significant reductions in the task. Additionally, shortening the radial does not intrudce greater uncertainty into the data analysis. Reducing the number of points does.

Q: What if I can'g get enough points between 3 and 7 kilometers?
A: I propose that the short radials be an "optional" method. Persons not feeling comfortable with near-field correction or having a radial which crosses an inaccessible military base could alway elect to satisfy 73.186(a)(1) in its present form.

Q: Can we reduce the number of points too?
A: To identify the telltale standing wave pattern of a significant reradiator, the granularity has to be pretty fine.

Q: 20 points between 3 and 7 kilometers. Isn't that just a long "walk-in" radial?
A: Perhaps. But I still think that it would take less time. Additionally, if coupled with a differential-GPS option, the "glorified walk-in" could shrink even further in terms of time required. As proposed above, use would be elective. Those who don't believe it benefits them aren't forced to use it. I think a lot of people will hang back until they see someone else do a few and feel comfortable with it.

Q: One of the problems with existing programs is agreement between different computer codes. If we have a dozen people writing near-field correction codes, some of them are bound to disagree with others.

A: To avoid the Tower of Babel problem, there must be a standardized code. The source code should be public. An .EXE implementation should be easily available at no charge, perhaps on the AFCCE web site or on the Commission's web site. I have heard from people that I respect that there are other codes which give better results than the code presently used by the Commission. The adopted code should correct for all three factors:

1) parallax error - differential phase shifts when you are close enough to the array that the ray paths from the towers are no longer parallel
2) 1/d error - correction to the amplitude term of the vector sum to account for the fact that at distances significantly less than infinity, each tower's contribution has traversed a different length path and therefore has a different distance-related attenuation.
3) point source error - a correction that models the tower as a stack of short elements of height dx, rather than treating the tower as a point source at the base insulator.

Our office has a time-proven code which we would be willing to donate to the public domain if others in AFCCE will be willing to beta-test it for holes before release. By beta test, I mean run it on any close-in data you may have accumulated over the years and see if you get high agreement.

In sum, I propose that 73.186(a)(2) be renumbered as (3), that the present subsection (3) be renumbered as (4) and etc. That a new 73.186(a)(2) be inserted which reads:

"Alternatively, an applicant may perform no fewer than 25 meausurements on each radial between 3 and 7 kilometers and which are approximately evenly-spaced. Such data shall be plotted twice, as described in (3) below. [What is now (2)] The first time it shall be plotted in its "raw" (uncorrected form). The second time, it shall be plotted in corrected form, such that each data point would lie on the inverse-distance line for a perfect earth. The raw and corrected data shall be presented in adjacent columns in the tabulation of field values.

The Commission reserves the right to require an applicant to perform "long" radials, as described in (1) above, in the event that the plotted data for the short radials evidences standing waves or other anomalies."

As the last item of the proposal, 20 new curves for Part 73.184(e) shall be generated from the present data. They shall be labeled Graph 1B, Graph 2B, ..., Graph 20B. The minimum value of the x axis shall be 1 kilometer. The maximum value of the x axis shall be 10 kilometers. This expanded scale will facilitate plotting of the "short radial" data in a fashion where it consumes a reasonable portion of the page for legibility sake.

No one of us is as smart as all of us. I'm sure refinement of the above idea is possible and advisable. Comments are welcome. Whatever your thoughts may be, this will probably be the last time for two decades that the Commission opens the book on what constitutes a 302. If we hope to change the meaning of a 302, this is probably the last chance for many of us. Let's make the best use of the opportunity that we can.

The above proposal doesn't get rid of the 302, the airplane trips, the motel rooms and the time away from home. But I do think that it would significantly reduce the time and energy required by a 302 (especially with synchronized changes in GPS rules). I believe that the conclusions drawn from this measurement schema would be as good as (and usually better than) the conclusion drawn from today's long radials. As a result, I believe that it delivers an economic savings without losing defensibility of the end product.

If you think the above is a dumb idea, blame me. If you think it is a great idea, congratulate Larry Morton, as it was he who first verbalized it.

- Glen Clark
Pittsburgh, PA

Sent: Monday, August 16, 1999 11:51 PM
Subject: Re: AM Directional Patterns

Jeepers Bob! Did you really want to start a debate in front of the whole AFCCE mailing list?

OK, I'll bite. I think that it's pretty well academic, as the apple seldom falls far from the tree and the R&O is seldom much different from the NPRM. So I think the Commissions position has pretty well been decided. But, for the sake of academic debate, here goes...

I find myself in the awkward position of wishing you were right for very selfish reasons, but having what I think are legitimate science reasons to disagree. I hate 302's. Actually, I hate being on the road. It was exciting 20 years ago. But the newness is gone. If you've seen one bag of airline nuts, you've seen them all. And the D concourse at O'Hare doesn't look much different from how it looked when Nixon was in office. Today, I like my dog and my backyard. If I never see another hotel room for 20 years, that will be fine with me. But I'm not ready to surrender the world to NEC and MININEC just yet in order to stay home.

I am not opposed to new technology in general or computer modeling in particular. I've been building NEC models since it was still called AMP (Antenna Modeling Program). I'm sitting here looking at the 1976 AMP users manual where they tell you what column to put which data on the hollerith card.

Most of the anti-NEC opinions I have seen cite weaknesses in the code (imperfect convergence of the basis functions)

which lead to answers which differ from the real world.
I will go in a different direction and say that I'm not very displeased with NEC. It has holes, but they're managable. My concern has to do with what lies *outside* the model. Many parts of the system which cannot be ignored are simply outside of the model.

EXAMPLE #1: We have all seen surveyor errors. There's a new array in Atlanta where the surveyor added the difference between True north and state tract north instead of subtracting it. The array centerline is misplaced by twice the magnetic declination. NEC would have never caught this because it is outside the model. One could counter that "Well, Of course! If you misplace the towers, the pattern will be wrong." And this would be a valid point. But that makes my point rather than disproves it. The purpose of the 302 proof is to catch any one of a number of subtle errors, including tower misplacement.

EXAMPLE #2: Lets say I have a 50 kW array with several Q-value nulls off the side. Now, suppose someone builds a large building, say a professional sports arena, within my 5 Volt contour. And lets say that the sports arena has a reflection efficiency of 10%. That gives me 500 mV/m of null-fill in my 70.7 mV/m null. [This is a real world case.]. Does the Canadian in the nulls care if I have everything "on-site" on the money if the net of the environment is to raise his NIF from 3 to 21 mV/m? I think not. His listeners radios will respond to the complete system which includes the reflection, not the subset which is only the towers.

Of course, the parallel example is the array where PG&E just ran a 330 kW primary through the 4 Volt contour. Without a proof and a requirement to maintain MP's, the PG&E towers would never need to be detuned and somebody else's NIF just tripled.

In both cases, the solution is simple. Counter-tune the array... the electrical equivalent of "Kentucky windage". If a Kentucky lad has his rifle aimed at a suirrel in a tree and the wind is blowing from right to left, he knows to air to the right of the squirrel. That way, the wind blows the bullet toward the squirrel, not away from it. In the case of the antenna, one adjusts the phasor so that the net field from the towers is equal in amplitude to that of the off-site reradiator, but opposite in phase.

Care must be applied to not destroying the other nulls in the process, but the mathematics are conquorable.

EXAMPLE #3: If I dig up my sample line and splice in a 10-foot section of RG-8, my monitor is off by 6 degrees on the high end of the band. After I crank on the phasor to get the right numbers back on the antenna monitor, what was a 30 mill null on the back of the array is now 150 mills. I just picked up half a county and the shopping center. But the cost was that the poor bloke in the null, 300 miles to the south, just lost three counties from a raised NIF.

Again, one can make the point "NEC can't be responsible for an owner with larceny in his heart." And they would be right. But, without a proof and publically-accessible MP's, there is no external verifiability. My opinion is that the spectre of a competitor checking the MP's is the only thing that keeps many owners honest. It's 10PM and I could drive you to two stations right now which are running day pattern. These are people who have decided to roll the dice and play the odds. How many would be doing it if there was zero chance of getting caught? Publically-accessible MP's allow for "external verifiability".

Lastly, I want to address the analogy to the FM situation. Side mounted FM's are not omni and everyone knows it, even the Commission. But (usually) the greatest excursion from theoretical is in the FM null, not in the FM maxima. Unless someone has deliberately searched for an antenna position which produces forward gain, I have seldom seen the the envelope exceed omni by more than 3 dB and almost never by more than 6 dB. And, as the FM allocation is based on the RMS value not the null (remember we're talking non-D here), the furthest you can get from the FCC's hoped-for protection ratios is 6 dB. AM's (unlike the cited FM case) use the nulls for the allocation. Sometimes very deep nulls. And it is not unusual for a one-quarter turn of one crank on a phasor to cause a 20 dB increase in the field in the null. The allegory to the FM case is incomplete because non-D FM's don't use the accidental null to make the allocation work. So, while the "home" station may lose some service in the shadow of the supporting tower, he is not clobbering someone else. Directional AM's do use their deliberate nulls to make the allocation "fit". And a variation from design values can seriously compromise the service of a distant (innocent) station.

Please also consider these examples within the context of AM IBOC which (I believe) is just around the corner.

The more time I can spend in my air-conditioned office and the less time I spend in a motel in Arvada, Colorado, the longer I will probably live. And the happier I will be. And the moment that someone proposes a simple test to check the end-to-end performance of an array, I will gleefully burn my USAir frequent flier card. But a proposal to trust everything to NEC is not (in my mind) defensible. It has nothing to do with whether or not NEC produces accurate results. It has to do with the fact that there are important (and therefore unignorable) parts of the system which are external to the model and which are often external to the site.

I think this stops being an engineering debate and starts being a philosophical debate. And the distilled question is "What are we trying to accomplish?" One possible answer is that we want to prove that the on-property tower system is generating a pattern of the proper shape. The other possible answer is that we want to control the net radiation arriving at distant points. Chosing the latter answer results in reduced interference in the receivers of many distant listeners. Chosing the former answer is an election to solve a puzzle which has only the loosest of correlations to the benefit obtained by the public.

Which answer is a gesture and which answer accomplishes a worthwhile goal?

Just my two cents. Additional viewpoints are, of course, welcome.

- Glen Clark
  Pittsburgh, PA

19

Summary of

NOTICE OF PROPOSED RULE MAKING
MM DOCKET NO. 93-177

IN THE MATTER OF

AN INQUIRY INTO THE COMMISSION'S POLICIES AND RULES REGARDING AM RADIO SERVICE DIRECTIONAL ANTENNA PERFORMANCE VERIFICATION

Adopted: May 28, 1999 Released: June 11, 1999

Brian Marenco
(202) 898-0111

August 1999

HIGHLIGHTS

MM DOCKET NO. 93-177

An Inquiry into the Commission's Policies and Rules Regarding AM Radio Service Directional Antenna Performance Verification

In this Notice of Proposed Rulemaking, the Commission:

- rejected a proposal to eliminate the requirements for proofs of performance for directional AM antennas tuned using computer models.
- proposed reducing the number of radials and points per radial in proofs of performance.
- proposed eliminating the requirement to conduct a partial proof of performance when changing a monitoring point.
- proposed eliminating the requirement to install and maintain base current meters.
- proposed eliminating most of the antenna monitor specifications and operational requirements
- proposed eliminating the requirement for impedance measurements across a range of frequencies.
- proposed relaxing the requirements for antenna monitoring equipment used with critical arrays.
- proposed reducing the number of directional antennas considered to be critical.

Comment is requested on each of the above items. Submit comments on or before September 10, 1999 and reply comments on or before September 27, 1999.

MM DOCKET NO 93-177

NOTICE OF PROPOSED RULEMAKING

1 Introduction

In this Notice of Proposed Rulemaking, the Commission proposes to eliminate some of the technical rules and relax others to materially reduce the regulatory and compliance burdens on AM broadcasters using directional antennas.

There are approximately 4,790 AM radio stations presently licensed in the United States. About 40% operate directionally during either daytime or nighttime hours.

AM stations employ directional antennas, in order to control interference between stations and assure adequate community coverage.

The Commission believes that AM broadcasters incur a substantial financial burden in maintaining these directional antennas.

Therefore, the Commission proposes to reduce the regulatory requirements to the minimum necessary to achieve the policy objective of controlling interference and assuring adequate community coverage.

The Commission issued a Notice of Inquiry seeking comment as to appropriate rule changes. In response to this Notice of Inquiry, the Commission received 25 comments and 16 reply comments.

II Computer Modeling versus Proofs of Performance

Several commenters suggest that proofs of performance may not be necessary for arrays adjusted to NEC programs.

NEC programs are computer models which have been developed over the years to calculate many of the operating characteristics of AM antenna systems. These programs deal with the internal array parameters such as impedance, currents and voltages at locations within the power distribution and radiation system.

However, the Commission has two main concerns about adopting a methodology for array adjustments based solely on computer models.

First the Commission is concerned that NEC programs may not always accurately predict the radiation being emitted in critical directions toward other stations.

Second, the Commission is concerned about extending AM regulations into new technical areas. The Commission rules do not currently regulate the design of internal circuitry of antenna systems or the methodology employed in the adjustment of antenna systems. Therefore, the Commission feels that basing proofs of performance solely on computer models could create controversial issues relating to the adequacy of adjustment programs and procedures.

Consequently, the Commission will not propose to eliminate requirements for proofs of performance in lieu of computer models.

Comment on this matter is requested.

III Directional Antenna Proofs of Performance

An antenna proof of performance of an AM directional array establishes whether the radiation pattern of the AM station is in compliance with the radiation pattern authorized on the station's construction permit or license.

There are two kinds of proofs of performance: (1) a full proof, in which a large number of measurements of the station's signal are made to establish the shape of the radiation pattern, and (2) a partial proof, which requires a lessor number of measurements to show that the station continues to operate as it did during the last full proof.

A. Full Proof of Performance

1. Number of Radials

Currently

The rules presently require that a permittee use a minimum of 8 radials to demonstrate that an array conforms to its authorized pattern:

Proposal

The Commission proposes to reduce the minimum number of radials from 8 to 6 and generally require no more than 12 radials to define complex patterns. The radials will be distributed as follows:

(a) One radial in the major lobe, at the pattern maximum

(b) At least 5 additional radials, as needed to definitely establish the pattern, generally at the peaks of minor lobes and pattern nulls. However, no two radials may be more than 90° azimuth apart.

(c) Any radials specified on the construction permit.

2. Number of Points per Radial

Currently

The Rules currently require that a permittee measure at least 30 points per radial at prescribed intervals to establish the directional and nondirectional field strengths along each azimuth. In addition, the minimum length of the radial is 34 kilometers.

Proposal

The Commission proposes to reduce the number of points per radial to a minimum of 15, as well as to shorten the minimum length of the radial to 15 kilometers. The Commission proposes the specify intervals as follows:

(1) The closest point at a distance 10 times the maximum distance between the elements of a directional array, or at a distance 5 times the vertical height of the antenna in the case of a nondirectional station (unchanged from the current rule);

(2) Close-in measurements at 0.2 kilometers intervals, out to a distance of 3 kilometers (unchanged from the present rule);

(3) Measurements at 1 kilometer intervals between 3 and 5 kilometers (3 points);

(4) Measurements at 2 kilometer intervals between 5 and 15 kilometers (5 points);

(5) Additional measurements as necessary at greater distances to achieve at least 15 points clear of potential reradiating structures;

(6) Measurements at any monitoring point locations along the radial (unchanged from the present rule).

Comment is requested on all these proposals.

In addition, the Commission is proposing to adopt a standardized format for the submission of the data in order to facilitate electronic filing. Comment is sought on the format to be used for the compilation and submission of this data.

B. Partial Proof of Performance

1. Number of Points required

Currently

The Commission requires that permitees make at least 10 field strength measurements within 3 to 16 kilometers from the array at radial location used in the last complete proof of performance.

Proposed

The Commission proposes to reduce to 8 the required minimum number of points per radial.

2. When Required

Currently

Partial proof of performance is triggered by an indication that the antenna system is not operating properly. Partial proofs are also required following replacement or modification of sampling system components mounted on the tower.

Proposal

The Commission proposes to eliminate the requirement to conduct a partial proof of performance following replacement or modification of sampling system components mounted on the tower provided the new components are mounted in the exact location of the old components and;

(1) measurements made at monitoring points before and after installation establish that substitution had no effect;

(2) antenna monitor values remain within tolerances of specified in the rules on the stations authorization.

C. Monitoring Points

Monitoring points are specific locations on selected proof radials where licensees regularly take field strength measurements to verify that a directional array remains within the radiation limits specified in the station's authorization.

It sometimes becomes necessary to abandon a monitoring point if the original location becomes inaccessible due to construction or unsuitable due to changes in local electromagnetic environment.

Currently

Under current rules, an informal application to change a monitoring point must include the results of a partial proof of performance taken on the radial containing the monitoring point.

The application must also include a written description of the routing to the new selected monitoring pont, as well as a map and photo showing the new location.

Proposed

The Commission proposes to eliminate the requirement to conduct a partial proof of performance along the radial containing the new monitoring point. The applicant may instead reference the measurements taken along that radial in the last full proof of performance submitted to the Commission.

The Commission also proposes to eliminate the requirement for maps and directions for applicants using a GPS to determine the coordinates of the monitoring point. A differential GPS receiver would be required.

IV AM Station Equipment and Measurements

A. *Base Current Ammeters*

Currently

Licensees are currently required to install base currents ammeter or toroidal transformers at the power feed point of each tower, typically at the base of the tower. The ratio of the individual tower currents is an important parameter in the proper operation of a directional array.

Proposed

The Commission proposes deleting the requirement for base current ammeters or toroidal transformers for those directional stations employing approved antenna system sampling systems.

B. *Antenna Monitors*

Currently

All AM directional stations are required to use an antenna monitors verified for compliance with the technical requirements of 47 C.F.R. Section 73.53.

Proposal

The Commission proposes to eliminate the antenna monitor specifications and operational requirements of 47 C.F.R. Section 73.53, with the exception of a few provisions in order to encourage the development of more dependable, less expensive antenna monitor units.

C. *Impedance Measurements Across a Range of Frequencies*

Currently

Directional and nondirectional AM stations are required to measure the resistance and reactance (collectively impedance) at 5 kHz intervals out to 25 kHz above and below the carrier frequency. This rule is intended to ensure adequate audio quality at all frequencies.

Proposed

The Commission proposes deleting this requirement. The Commission feels that competition will serve as sufficient incentive to maintain quality operations.

D. Common Point Impedance Measurements

AM directional stations must take impedance measurements at the common radiofrequency input location.

Currently

In order to enable the maximum power to be transferred from the transmitter into the antenna the reactance of the common point should be adjusted to a value of zero ohms.

Some commenters state that many transmitters operate best with a small amount of impedance.

Proposed

The Commission is proposing to delete the requirement that the common point reactance be adjusted to zero.

Comment is requested as to whether a limit should be set for the maximum amount of reactance permitted.

V Critical Arrays

AM directional licensees must maintain relative amplitudes of the antenna base currents within 5 percent of the value shown on the license, and the relative phases to within 3 degrees of the value specified on the license

Critical arrays are directional antenna which are unusually sensitive to slight variations in internal operating parameters. These licensees operate with tighter tolerances.

A. Antenna Monitoring for Critical Arrays

Currently

To monitor their tighter tolerances, licensees of critical arrays are required to install special precision monitors.

Proposed

The Commission proposes to discontinue specifying the use of expensive specially designed precision antenna monitors for critical arrays.

Instead, the Commission proposes to simply require that the monitor installed have a digital readout graduated in increments no larger than ½ of the critical parameter specified in the authorization.

B. Designation of Critical Arrays

Currently

Commission staff employs computer studies to assess array stability. The computer studies "tags" those arrays which are considered critical.

The Commission now feels that the current criteria are too stringent.

Proposed

The Commission proposes to restrict tests for array stability to the radiation pattern minima (nulls) and maxima of standard patterns in the horizontal plane.

The Commission will classify an array as critical only if the standard pattern is exceeded at 10% or more of the possible parameter variation combinations. For example, a four tower array has 512 possible combinations of 1 percent current amplitude and 1 degree phase variations. An array would only be designated as critical if at least 51 of these combinations would cause excessive radiation. The current test requires only one instance of excessive radiation.