DOCKET FILE COPY ORIGINAL **ORIGINAL**

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
An Inquiry into the Commission's Policies and Rules regarding AM Radio Service Directional Antenna Performance Verification	))))	MM Docket No. 93-177 RM-7594

RECEIVED
MAR - 1 1994
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

REPLY COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS

NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, NW
Washington, DC 20036

Henry L. Baumann
Executive Vice President and
General Counsel

Barry D. Umansky
Deputy General Counsel

John G. Marino
Manager, Technical Regulatory Affairs
NAB Science & Technology

March 1, 1994

No. of Copies rec'd 0+4
List ABCDE

TABLE OF CONTENTS

		Page
EXECUTIVE SUMMARY		i
I.	INTRODUCTION	1
II.	THE COMMISSION SHOULD PROMPTLY ISSUE A NOTICE OF PROPOSED RULE MAKING TO REVISE THE AM DIRECTIONAL RULES	4
III.	THE COMMISSION MUST RELIEVE LICENSEES OF THE BURDENS ASSOCIATED WITH FIELD MEASUREMENTS OF CERTAIN AM DIRECTIONAL ARRAYS	5
IV.	COMPUTER MODELING OF DIRECTIONAL ARRAYS IS A PROVEN TECHNOLOGY AND SHOULD BE ACCEPTED BY THE COMMISSION	7
V.	THE COMMISSION SHOULD ACCEPT DATA DERIVED FROM COMPUTERIZED ANTENNA MODELING AND EXEMPT BROADCASTERS FROM PROOF REQUIREMENTS -- SUBJECT TO CERTAIN CONDITIONS	8
VI.	ACCURATE ANTENNA MONITORING IS MANDATORY FOR INTERFERENCE PREVENTION, ESPECIALLY IN LIGHT OF RELAXED FIELD MEASUREMENTS	12
VII.	THE COMMISSION SHOULD ENCOURAGE THE USE OF UNCONVENTIONAL ANTENNAS IN SITUATIONS WHERE ADEQUATE SERVICE AREA COVERAGE WILL NOT BE COMPROMISED	15
VIII.	CONCLUSION	16

EXECUTIVE SUMMARY

NAB welcomes the Commission's inquiry into the matter of AM directional antenna performance measurements and now recommends the initiation of a rule making action that will take advantage of improved technology in this area.

The present AM directional antenna rules were adopted by the Commission in 1939. Throughout the years, these rules have served the AM radio industry well. Within the past twenty years significant advances have come about in computerized antenna modeling. Antenna system designers began using mainframe computers and a variety of numerical methods to predict the fields produced by various configurations of antenna elements. With the proliferation of microcomputers, sophisticated antenna design and analysis has become available at generally low cost to all engineers. The Commission should now recognize these new computerized antenna analysis methods and use them as a basis for relaxing directional antenna performance measurements which are now required by all AM stations using directional antennas.

The potential savings to the AM broadcast industry, by embracing new technology as a basis for relaxing the measurement burdens, could be enormous. The Commission should not withhold this potential for conserving scarce station resources.

First, the cost of performing a typical AM directional antenna "proof" often amounts to $30,000 to $40,000. By taking advantage of computerized antenna pattern prediction methods, this cost could be reduced in many cases to just a few thousand dollars.

Second, in the 50 years since the AM directional rules were adopted, a wealth of knowledge has been gained pertaining to directional pattern stability factors. Combining this historical knowledge with modern computerized antenna pattern prediction methods can allow many AM broadcasters potential relief from repetetive time-comsuming field measurements required by the present AM rules to prove the stability of the station's directional signal. Such relief will allow stations the ability to use their technical talent for other important purposes geared toward improving their facilities.

NAB urges the Commission to consider the proposed guidelines being presented in these reply comments and to proceed toward rule making crafted around new efficient cost-saving technology. Also, NAB urges the Commission to move swiftly in allowing AM broadcasters the option to take advantage of any new relaxed performance verification rules that may be adopted at the conclusion of this important proceeding.

DOCKET FILE COPY ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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

REPLY COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS

I. INTRODUCTION

The National Association of Broadcasters ("NAB")[1] hereby submits its reply to the parties filing initial comments on the Notice of Inquiry ("Notice") in the above-captioned proceeding.[2] NAB observes that the record being developed in this proceeding continues to provide a sound basis for revising the rules addressing AM directional antenna performance verification.

In these reply comments, NAB offers specific guidance for the Commission regarding performance verification of AM directional antennas. NAB, desiring to relieve AM broadcasters

---

[1] NAB is a nonprofit, incorporated association of radio and television stations and networks which serves and represents the American broadcast industry.

[2] Notice of Inquiry in MM Docket No. 93-177, 8 FCC Rcd 4345 (1993). By Order Granting Extension of Time, 8 FCC Rcd 6324 (1993) and subsequently the Order Granting Further Extension of Time, DA 93-1534, released December 21, 1993, the reply comment deadline for the above-captioned proceeding was extended to today.

of some unnecessarily burdensome technical duties, while controlling the AM band interference environment, urges the Commission to relax its directional antenna performance verification requirements, based upon proven technology available to the AM broadcast industry today. We view this proceeding as a continuation of the AM improvement process, as exemplified by the Commission's Report and Order in Docket 87-267.[3]

NAB's interest in this proceeding is to promote the use of improved technology for the benefit of radio broadcasters. We feel that the proceeding represents a unique opportunity for AM broadcasters and their consultants to work with the Commission to revise the rules relating to AM directional antennas, based upon new methods of computer modeling and improved accuracy antenna monitoring devices.

We hereby encourage the Commission to proceed swiftly toward rule making and promptly grant AM licensees the opportunity to take advantage of any new relaxations in the directional antenna rules that may be enacted at the conclusion of the rule making.

The AM directional antenna proof of performance ("proof") process, as presently specified by the Commission, is

---

[3] Report and Order in MM Docket No. 87-267, 6 FCC Rcd 6273 (1990). "The goal of this proceeding has been to refine and integrate various proposals in a comprehensive plan that will eventually achieve a significantly improved AM service." Id. at 6276.

an arduous and time consuming affair.[4] NAB believes that by taking advantage of modern antenna performance verification methods, the cost to AM broadcasters for a proof can be reduced considerably -- maybe by a factor of ten, as has been suggested in previous comments.[5]

Additionally, as we will discuss further in these comments, the often inaccurate and time consuming process of routine field measurements may be relaxed, thereby freeing up time for station technical personnel to attend to other matters.

NAB urges the Commission to relax its AM directional proof requirements for licensees in situations where certain requirements are satisfied with respect to the type of antenna elements used, their ability to be modeled accurately, and their ability to be monitored precisely. Such requirements are detailed in these reply comments.

NAB is regularly in contact with its numerous AM station members. One of the most pressing concerns for many AM licensees is maintaining compliance with present AM rules. In many small AM stations the General Manager must also function as Chief Operator. At other facilities, contract engineers are the sole truly technical presence on-site, usually only for a minimum number of hours per week.

---

[4] An AM proof performed in accordance with Commission rules typically requires months of field work and weeks of report generation time -- all at a substantial cost, averaging $30-$40,000 or more.

[5] See Comments of du Treil, Lundin & Rackley, Inc. in MM Docket No. 93-177, filed October 28, 1993, at 21.

The benefits of a rulemaking process intent on taking advantage of new technology methods in order to lessen the burden on AM licensees are enormous. NAB encourages the Commission to proceed toward rule making in this docket and provide AM broadcasters with more accurate and lower cost ways to comply with the directional antenna verification rules.

II. THE COMMISSION SHOULD PROMPTLY ISSUE A NOTICE OF PROPOSED RULE MAKING TO REVISE THE AM DIRECTIONAL RULES.

On January 13, 1994, NAB hosted at its headquarters in Washington an ad hoc forum on AM directional antennas. NAB organized the forum in order to provide a vehicle through which experts in the science of AM directional antenna design and maintenance could share their knowledge and experiences. The meeting was convened with the expectation that those experts attending the forum would gain a better understanding of the positions held by their colleagues -- leading to more concise and relevant comments in this complex proceeding.

The consensus of those experts attending the forum can be summarized as follows:

1. The present AM technical rules regarding AM directional antenna performance verification should be revised.
2. Moment method analysis of antenna elements of uniform cross-section and series fed has proven to be sufficiently accurate for FCC consideration in future rule making.
3. Field measurements should not be outlawed. In some situations, field measurements may not be necessary, but can

be used as a cross-check to verify proper monitoring equipment performance.

4. In all cases the directional antenna proof requirements should be relaxed.

Based upon this consensus, it is clear that the Commission should promptly issue a Notice of Proposed Rule Making to revise the AM directional rules.

III. THE COMMISSION MUST RELIEVE LICENSEES OF THE BURDENS ASSOCIATED WITH FIELD MEASUREMENTS OF CERTAIN AM DIRECTIONAL ARRAYS.

AM directional arrays that are located near residential or industrial areas present problems for engineers attempting to maintain their patterns and remain in strict compliance with the Rules. Residential and industrial growth has encroached on many directional arrays over the years. High voltage transmission towers, cellular towers, cable television towers and other structures are often located in close proximity to a station's directional array.

The proximity of re-radiating structures to directional arrays has made the process of gathering accurate field intensity measurements in order to comply with the present requirements of the AM rules extremely difficult, if not impossible. This is because some re-radiating structures affect field measurements taken only at specific licensed monitor points. The far field directional pattern, which controls interference to other

stations, may be totally unaffected by these localized re-radiators.

Station engineers attempting to maintain licensed monitor point field values often find themselves adjusting array parameters in order to compensate for re-radiators that only affect field readings in a specific measurement area and have no real effect on the far-field pattern of the array. Ironically, a common result of such array parameter "tweaking" is distortion of the far field directional pattern which in turn may lead to interference for other stations.

Over the years, AM licensees have spent countless thousands of dollars either detuning structures that have absolutely no effect on the far-field directional pattern, or generating the detailed engineering reports required by the Commission as justification for changing a monitor point field limit.

Generally, a re-radiating structure will adversely impact the directional pattern if it is located close enough to the array (normally 1 or 2 wavelengths) to act as an array element. In this case, and specifically in ones where it can be shown that the far field directional pattern is affected, the structure should be considered for detuning. In most cases, computer modeling of the array elements plus the re-radiating structure will determine if any adverse effects on the directional pattern can be expected.

NAB strongly recommends that the Commission address this problem and relieve AM licensees of the costly burden of detuning re-radiating structures that can be determined to have no effect on the far field directional pattern.

IV. COMPUTER MODELING OF DIRECTIONAL ARRAYS IS A PROVEN TECHNOLOGY AND SHOULD BE ACCEPTED BY THE COMMISSION.

Software designed for modeling antenna elements has become very popular with the advent of microcomputers. MININEC is one such proven software package that can be used effectively for modeling the elements of a directional array. While such software has been used extensively over the past ten years by directional array designers, the Commission has not generally accepted its use for station directional antenna applications.

Engineering consultants regularly use antenna modeling software, such as MININEC, for initial set up of directional arrays. In many instances, the directional array performs in the real-world nearly identical to its computerized model. The consulting firms that filed the petition for rule making that initiated this proceeding,[6] and others, have gathered considerable data regarding the correlation of modeled vs. measured array parameters.

---

[6] The petition for rulemaking was submitted to the Commission by the technical consulting firms of d Treil, Lundin & Rackley, Inc., Hatfield & Dawson Consulting Engineers, Inc., Lahm, Suffa & Cavell, Inc., Moffet, Larson & Johnson, Inc., and Silliman & Silliman.

However, engineers from those same firms also realize the limitations of array modeling, and are quick to point out that modeling must be done carefully and the limitations of modeling must be considered.[7]

At this time, we suggest the Commission accept computerized array modeling for the case of series fed antenna elements of uniform cross-section only, as we describe in the following section.

V. THE COMMISSION SHOULD ACCEPT DATA DERIVED FROM COMPUTERIZED ANTENNA MODELING AND EXEMPT BROADCASTERS FROM PROOF REQUIREMENTS -- SUBJECT TO CERTAIN CONDITIONS.

NAB believes that certain directional array elements can be modeled without difficulty. Series fed elements of uniform cross-section are easily modeled, for instance, in MININEC. Subsequently, clear cut textbook array designs, consisting of the above-mentioned type radiating elements, should be considered by the Commission for relaxed performance verification showings. The Commission may wish to classify these types of directional arrays in a separate category in order to distinguish them from arrays that are more difficult to model.

In fact, from NAB's perspective, based upon discussions held during the January 13, 1994, ad hoc forum, the following types of arrays cannot be accurately modeled at this time:

1. Folded unipoles

---

[7] See e.g., late filed Comments of Silliman & Silliman in MM Docket No. 93-177, filed December 22, 1993, at 3.

2. Non-uniform cross-section towers
3. Shunt fed antenna elements
4. Towers heavily loaded (with land-mobile antennas, etc.)
5. Skirted towers

Additionally, array elements sited on non-uniform terrain could present problems for the array designer using presently available modeling software.

While we understand that, in some cases, accurate modeling has been performed in certain of the above-mentioned cases, we feel that there is not, at this time, sufficient data to support Commission consideration of any modeling except that which is performed on series fed uniform cross-section elements. In time, as modeling techniques are refined, the Commission should reexamine the types of antenna elements that may be modeled and make appropriate changes in its rules.

NAB suggests that the Commission standardize the array modeling algorithm. As previously mentioned, MININEC seems to have been over recent years widely accepted by antenna designers. According to those designers, MININEC has proven to produce results that correlate well with measured data in the case of series fed uniform cross-section elements. Therefore, we feel that at least the basic algorithm used in the MININEC software, or a similar algorithm, should be standardized for use by the Commission. MININEC, for example, is readily available and numerous tutorials on its use and applications have been published.

R. Morgan Burrow, Jr., P.E. stated in his comments that he considers one "hazard" of moment method analysis the fact that the user supplies the array geometry and control parameters.[8] NAB agrees that this practice could lead to inaccuracies especially if the designer has limited modeling experience. However, if the modeling is limited only to series fed antenna elements of uniform cross-section we feel much of the hazard will be removed. In time, engineers may be able to develop a catalog of antenna elements along with their precise modeling parameters for use with moment method analysis. At that time the Commission should review its rules and consider the use of such new cataloged models for array design and verification purposes. We further feel that even engineers inexperienced in the use of modeling software, such as MININEC, can quickly learn proper techniques by modeling some of their existing designs and comparing the results.

Another option, that NAB does not endorse, is nevertheless open for the Commission to consider. That is allowing the use of other array modeling algorithms, where engineers could use the software that they feel most comfortable in their array designs. NAB is concerned that this practice could lead to overwhelming problems for Commission staff during the application process. Computational discrepancies could lead

---

[8] See Comments of R. Morgan Burrow, Jr., P.E., filed August 19, 1993, at 4.

to considerable time being wasted among Commission staff and consulting engineers working to accurately prove array designs.

We therefore suggest the use of one standard readily available computational algorithm, such as MININEC, for the design and verification of directional array patterns.

The use of modeling for simple arrays, taking into consideration the effects of re-radiating objects, relaxing the proof requirements, and modifying the routine performance verification process will lead to significant cost and time savings for AM licensees.

Crawford Broadcasting discussed, in its comments, what seems to be a good method for verifying the performance of a directional array.[9] This method has been used mainly outside the United States. It requires the generation of a computer model that is used to predict field values at specified points close-in to the array. Field measurements are then made at those specific points and compared to the predicted values. If there is good correlation between predicted and measured data, the array is assumed to be in adjustment and operating properly.

NAB suggests the Commission consider this option, described by Crawford, for relaxing the present costly and time consuming field measurement requirements.

---

[9] See Comments of Crawford Broadcasting Company in MM Docket 93-177, filed October 21, 1993, at 6.

VI. ACCURATE ANTENNA MONITORING IS MANDATORY FOR INTERFERENCE PREVENTION, ESPECIALLY IN LIGHT OF RELAXED FIELD MEASUREMENTS.

Although the time and monetary benefits of relaxed field measurements are considerable for AM licensees, NAB continues to maintain its long-standing position of only supporting rule changes that will, if not improve the interference environment, at least not make it any worse.

Accordingly, NAB urges the Commission to formulate a new set of rules relating to the internal monitoring (as opposed to field measurements) of directional array performance parameters. Such rules should provide a practical and, above all, simple method for station personnel and FCC enforcement officers to determine if a directional antenna system is performing in accordance with a station's instrument of authorization. Only by accurately monitoring its array parameters, can a licensee be assured that its directional antenna system is in adjustment and not subjecting the service areas of other AM stations to increased interference.

NAB suggests that, as a prerequisite to FCC authorization to take advantage of relaxed field measurements, a licensee should be required to submit sufficient information to the Commission proving that its array monitoring system is suitable for use as an accurate indicator of proper array performance. Furthermore, the array monitoring system is detailed specifications, as submitted by each licensee, should be made part of the licensee's instrument of authorization.

While we certainly feel that field measurements are necessary for the purpose of cross checking the antenna monitoring system, for other maintenance purposes, and for directional arrays that cannot be accurately modeled as described above, we also realize that the quality and designs used for modern antenna monitoring systems are more than adequate to insure proper array verification for the primary purpose of interference prevention.

Potomac Instruments, Inc., a manufacturer of antenna monitoring equipment, stated in its comments that there is currently no prescribed (by the Commission) field calibration method or interval for the antenna monitor.[10] Additionally, Potomac suggests that comprehensive field calibration can be performed on the antenna monitor by the use of a calibration device that would check accuracy as well as repeatability.[11]

It seems to us that such a field calibration device, designed to insure proper operation of the antenna monitor, should be a minimum requirement for high accuracy array monitoring that will be necessary if field measurements are relaxed. Additionally, the use of "phase-stabilized" identical type sampling lines of equal length and subject to identical environmental conditions will insure that sample currents are correctly transmitted to the antenna monitor. In order to

---

[10] See Comments of Potomac Instruments, Inc. in MM Docket No. 93-177, filed October 28, 1993, at 4.

[11] Id.

further guarantee the accuracy of the sampling system, properly terminated sampling line impedance measurements should be made at the input to the antenna monitor to insure a correct match. Such measurements should be documented by the licensee and become part of the antenna monitoring system specifications.

Thermocouple type ammeters, long a staple of the AM broadcaster, should not be relied upon for consistently accurate indications of antenna element base currents. The instability of thermocouple ammeter indications under varying temperature conditions is well known. Alternative indicating devices, for instance using current sampling components and remote metering, are far superior -- if base current monitoring continues to be required. As was discussed during the January 13, 1994, ad hoc forum, a more accurate method of proving array performance may ultimately arise from the monitoring of element base voltages instead of currents -- assuming practical methods can be developed for performing base voltage measurements. Accordingly, sampling devices could be designed for this purpose.

NAB defers to companies with years of expertise in the science of antenna monitoring, to advise the industry and the Commission on the best ways to internally monitor the performance of directional arrays in light of the relaxed field measurement requirements being proposed.

VII. THE COMMISSION SHOULD ENCOURAGE THE USE OF UNCONVENTIONAL ANTENNAS IN SITUATIONS WHERE ADEQUATE SERVICE AREA COVERAGE WILL NOT BE COMPROMISED.

The Commission in MM Docket 87-267, encouraged further testing of unconventional, so-called "low profile", antennas.[12] However, based upon the Commission's minimum antenna efficiency requirements, we feel that testing and eventual future use of low profile antennas has been discouraged. This proceeding may be an appropriate vehicle for the Commission to review its minimum efficiency requirements and allow licensees to specify unconventional antennas in a case-by-case basis with appropriate showings of adequate coverage and skywave suppression.

Moment method modeling, as previously described, will allow the efficient design and implementation of low profile antenna elements, not only for licensees close-in to their service areas, but also for licensees precluded from constructing tall towers due to zoning or FAA restrictions.

NAB urges the Commission to remove its present minimum antenna efficiency requirements, as specified in Section 73.45, to allow licensees to utilize low profile antennas upon a showing of adequate service area coverage (i.e. the 5 mv/m contour encompasses the entire principal community to be served) and nighttime skywave suppression.

---

[12] Report and Order in MM Docket No. 87-267, supra note 3, at 93.

VIII. CONCLUSION

In summary, and based upon these comments, NAB urges the Commission to proceed with a rulemaking action designed to relax the field measurement requirements presently required to prove or verify the performance of an AM directional array in accordance with the suggestions we have provided in these reply comments.

Specifically, the Commission should:

1. Allow the use of moment method analysis for the purposes of directional array performance verification. Until sufficient data exists to accurately correlate various types of antenna elements, this type of analysis should be limited to series fed antenna elements of uniform cross-section.
2. Craft rules relating to the monitoring of directional arrays in accordance with present technology monitoring devices and systems. A station's antenna monitoring system specifications and method of calibration should be included in the station's instrument of authorization.
3. Allow licensees to take advantage of relaxed field measurement requirements if they provide the Commission with full specifications showing that their antenna monitoring system and the method used for calibration of the system meets Commission requirements.

4. Eliminate the present minimum antenna efficiency requirements of Section 73.45, thereby allowing licensees to use low profile antennas, based upon a showing of adequate service area coverage and sufficient nighttime skywave suppression.

Furthermore, NAB encourages the Commission to consider specific rules that may be presented through comments of other parties in this proceeding, and in light of the foregoing discussion. NAB advises the Commission to allow AM station licensees, if they upgrade their antenna monitoring equipment as necessary, the option to take advantage of any relaxed performance verification requirements specified at the conclusion of this proceeding.

We agree with those in attendance at the ad hoc forum that the time is right for major revisions in the rules governing the performance verification of AM directional antennas. The Commission's MM Docket No. 87-267 started the trend toward AM technical improvement. We hope that this current proceeding will continue this trend by allowing AM directional licensees the

opportunity to improve their facilities based upon rules crafted around new efficient cost-saving technology.

Respectfully submitted,

NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, NW
Washington, DC 20036

Henry L. Baumann /lg
Henry L. Baumann
Executive Vice President and
General Counsel

Barry D. Umansky /lg
Barry D. Umansky
Deputy ~~General~~ Counsel

John G. Marino
Manager, Technical Regulatory Affairs
NAB Science & Technology

March 1, 1994

CERTIFICATE OF SERVICE

I, Judith L. Gerber, do hereby certify that a true and correct copy of the foregoing "Reply Comments of the National Association of Broadcasters" in MM Docket No. 93-177 was sent, by first class mail, on this date, March 1, 1994, to the following:

Roy J. Stewart, Chief
Mass Media Bureau
Federal Communications Commission
1919 M Street, NW
Room 314 -- Stop Code 1800
Washington, DC 20554

Larry D. Eads, Chief
Audio Services Division
Mass Media Bureau
Federal Communications Commission
1919 M Street, NW
Room 302
Washington, DC 20554

William H. Hassinger
Assistant Chieif (Engineering)
Mass Media Bureau
Federal Communications Commission
1919 M Street, NW
Room 314 -- Stop Code 1800
Washington, DC 20554

Douglas W. Webbink, Chief
Policy & Rules Division
Mass Media Bureau
Room 8010 -- Stop Code 1800D
2025 M Street, NW
Washington, DC 20554

James R. Burtle, Chief
AM Branch
Audio Services Division
Mass Media Bureau
Room 344 -- Stop Code 1800B2
1919 M Street, NW
Washington, DC 20554

John W. Reiser
Mass Media Bureau
Federal Communications Commission
Room 8330
2025 M Street, NW
Washington, DC 20554

Robert M. Silliman, P.E.
Silliman & Silliman
Consulting Engineers
8601 Georgia Avenue
Silver Spring, MD 20910

Wallace E. Johnson, P.E.
Moffet, Larson & Johnson, Inc.
Telecommunications Consultants
5203 Leesburg Pike, Suite 800
Falls Church, VA 22041

David Harry
Potomac Instruments
932 Philadelphia Avenue
Silver Spring, MD 20910

Al Resnick
Capital Cities/ABC, Inc.
77 West 66th Street
New York, NY 10023

Karl D. Lahm, P.E.
Lahm, Suffa & Cavell, Inc.
Consulting Engineers
9653 Lee Highway, Suite 25
Fairfax, VA 22031

Bert Goldman
Shamrock Broadcasting, Inc.
645 E. Missouri Avenue, #244
Phoenix, AZ 85012

Milford Smith
Greater Media, Inc.
2 Kennedy Blvd.
E. Brunswick, NJ 08816

Jules Cohen, P.E.
Jules Cohen & Associates, P.C.
P.O. Box 18415
Washington, DC 20036-8415

R. Morgan Burrow, Jr.
Mullaney Engineering
9049 Shady Grove Court
Gaithersburg, MD 20877

Jerry Westberg
Broadcast Electronics, Inc.
4100 N. 24th Street
Quincy, IL 62301

Benjamin F. Dawson, P.E.
James Hatfield, P.E.
Hatfield & Dawson
Consulting Engineers, Inc.
4226 Sixth Avenue, NW
Seattle, WA 98107

Ronald D. Rackley
duTreil, Lundin & Rackley, Inc.
1140 - 19th Street, NW
Third Floor
Washington, DC 20036

William Suffa
Suffa & Cavell, Inc.
10300 Eaton Place
Suite 450
Fairfax, VA 22030

W.C. Alexander
Director of Engineering
Crawford Broadcasting Co.
c/o John S. Neely, Esq.
Miller & Miller, P.C.
P.O. Box 33003
Washington, DC 20033

Judith L. Gerber

Judith L. Gerber