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MOFFET, LARSON & JOHNSON, INC.
CONSULTING TELECOMMUNICATIONS ENGINEERS

February 28, 1994

93-177

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FEB 28 1994

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222 - Stop Code: 1170
Washington, DC 20554

Dear Mr. Caton:

Enclosed are an original and four copies of the Joint Reply Comments of duTreil, Lundin & Rackley, Inc.; Hatfield & Dawson Consulting Engineers, Inc.; Moffet, Larson & Johnson, Inc.; Suffa & Cavell, Inc.; and Silliman and Silliman regarding the FCC's Inquiry into the Commissions Policies and Rules Regarding AM Radio Service Directional Antenna Performance Verification, MM Docket No. 93-177, RM-7594 for distribution in accordance with Section 1.419 of the Commissions Rules.

Sincerely,

Wallace E. Johnson

Wallace E. Johnson
Vice Chairman

WEJ/st

Enclosure

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

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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

Joint Reply Comments of du Treil, Lundin & Rackley, Inc.; Hatfield & Dawson Consulting Engineers, Inc.; Moffet, Larson & Johnson, Inc.; Suffa & Cavell, Inc.; and Silliman & Silliman

The firms listed above were the original proponents of the present Notice of Inquiry (herein "NOI") and were major participants in the NAB AM Directional Antenna Forum held on January 13, 1994. We now join together in submitting these reply comments, which respond directly to certain comments submitted by others and include specific recommendations for rule changes, section-by-section, based on the record of this proceeding.

Deregulation is Not Proposed

Several commentors challenged that the AM directional antenna proof of performance requirements should not be deregulated. They seemingly believed that our purpose in requesting the NOI was to propose deregulation. That was not the case when we requested the NOI. It is not the case today.

For instance, most of the AM directional antenna systems in existence today are deemed to be in adjustment on the basis of partial proof of performance field strength measurements referenced back to their corresponding original full proof of performance measurements made, in many cases, decades ago. As is generally known, seasonal variations and construction and development along a propagation path can severely impact measured field strengths. These effects can introduce errors on the order of several decibels (herein dB) when field strengths measured today are ratioed to those made years ago.

Our proposal provides a means for full proof of performance for stations that would, under the present rules, be required only to make partial proof of performance measurements. The fact that a full proof of performance under our proposed rules would, in most cases, cost less than a partial proof of performance under the present rules is a benefit of modern technology.

We are not proposing deregulation. We are proposing changes

in the rules to recognize state-of-the-art methods of antenna analysis which will lead to more certainty of antenna performance within the AM band.

Efficacy of the Rulemaking Process

The AFCCE, in their comments, stated that the issues raised in the NOI warrant study by "a continuous FCC/Industry review process, by a panel of experts working over many months" and suggested that the FCC sponsor an "industry-wide dialogue, similar to the ATV Advisory Panel, focusing on the AM technical rules." This is unnecessary. It has not been proposed to develop new technology, as in the case of the ATV proceeding.

This NOI concerns scientific methods which have proven reliable over decades in the antenna engineering discipline and have been adapted and utilized for AM directional antennas for a number of years. One need only peruse the special mediumwave broadcasting issue of the "IEEE Transactions on Broadcasting" published in June of 1989 to become familar with them. The normal rulemaking process will be sufficient to define the changes which should be made to have the rules recognize the current state-of-the-art in antenna engineering.

Consideration Should be Expedited

The Carl T. Jones Corporation provided an economic analysis in its comments showing that the average AM station in 1991 had less than one-quarter of the revenue of an average AM station in 1947, with correction for inflation. It is clear that the introduction of methods for proving the performance of directional antennas for considerably less cost than required today, without compromising their characteristics which can impact other stations, should not be delayed.

Alternative Proof of Performance Methods

The comments of Cohen, Dippell and Everist, P.C. stated that their firm had not found a modeling program which could take into account all array environmental factors. We agree that arrays on sites with certain environmental characteristics or those with radiating elements which do not lend themselves to moment method modeling might not be suitable for proof of performance without field strength measurements. We have developed the proposed rules appearing herein which divide the stations that we have

found can be reliably modeled from those which possibly cannot, requiring adequate documentation and internal parameter measurement for the former (category A stations) and simplified field strength proof of performance procedures for the latter (category B stations). The proof of performance requirements for category B stations are similar to those proposed in the comments of the Crawford Broadcasting Company and John Furr & Associates, Inc.

Proposed Rule Changes

In the following section-by-section presentation of rule change proposals, suggested wording is shown in **boldface type** and [brackets] surround the discussion text. The comments cited are abbreviated as follows: du Treil, Lundin & Rackley, Inc. as "DLR"; Hatfield & Dawson Consulting Engineers, Inc. as "H&D"; Moffet, Larson and Johnson, Inc. as "MLJ"; the National Association of Broadcasters as "NAB"; Silliman & Silliman as "S&S"; and Suffa & Cavell, Inc. as "S&C".

§73.14 Critical directional antenna - reference should be eliminated.

[This will eliminate the inequitable treatment of stations with directional antennas which were designated by the FCC at the time they were originally proposed as "critical." This was commonly done to resolve conflicts stemming from allegations of interference raised by existing stations on channels proposed by their applicants, even though stations with unopposed applications were routinely authorized with directional antenna patterns no more stable than their "critical" counterparts.

In a 1988 study, published in the NAB Engineering Conference Proceedings, entitled "A Realistic Assessment of AM Pattern Stability" by Karl D. Lahm, P.E., it was stated on page 91 that "the results should be surprising, since less than 50 percent of the patterns examined were found to be "stable," yet so few stations have specified tolerances or have been determined to be critical..." In making this determination, Lahm studied 264 directional antennas authorized for stations on both clear and regional channels. "Stable" was defined as staying within the standard pattern for +/- 1.0 percent and +/- 1.0 degree field variations of a computer model.

Stations with critical directional antennas are not able to make use of the most recent developments in antenna monitor

technology, since they are few and the equipment designed two decades ago to meet the cumbersome requirements for monitoring them has not been updated due to their small demand. Modern antenna monitors manufactured for the general market are superior in performance, reliability, and ease of use to the special equipment which has long been required for monitoring critical directional antennas. It would be in the best interest of AM radio to allow their use by all stations.

see DLR pp. 6,7; S&S p. 1]

Antenna proof of performance measurements - should be redefined: **The measurements of antenna system internal characteristics or field strengths made to determine proper adjustment of an AM directional antenna.**

Category A directional antenna - any directional antenna not required to be in category B by its design or physical characteristics and which meets the category A sampling system requirements of §73.68 and for which a category A proof of performance as described in §73.151 has been conducted.

Category B directional antenna - any directional antenna with one or more shunt fed elements preventing sample of radiation mode current without contamination by circulating current (such as a "folded unipole" element with skirt wires covering the entire range of height allowed for a sampling loop, an element shunt fed with a single wire, or an element with a transmission line not at tower potential), an elevated ground system, terrain elevation within one quarter wavelength of any element exceeding plus or minus five percent of the height of the nearest tower in the array, a sampling system not meeting the requirements of §73.68 for category A stations, or choosing to conduct a category B proof of performance as described in §73.151.

[These changes will be necessary due to the new §73.151 provisions.]

§73.33 eliminate completely

[redundant with §73.45]

§73.44 eliminate (d)(2)

[RMS field strength will not be determined by a directional antenna proof of performance. This will eliminate a double standard between the directional and nondirectional AM rules.

Nondirectional antenna efficiency can be degraded by an improper or damaged ground system or defective antenna tuning network components, just as the efficiency of a directional antenna can. The FCC rules now contain no requirement that a nondirectional station make field strength measurements to show its radiation efficiency as part of the licensing process.

If poor coverage is observed, a nondirectional station has a right to make diagnostic field strength measurements and to make repairs, if indicated. An application for direct measurement of power must be filed following any repairs which alter the nondirectional antenna's measured characteristics. The same will be true for directional AM stations under these proposed rules.]

§73.45 change (a) and (b)(2) - to eliminate reference to minimum efficiency and specify that efficiency for a nondirectional AM station should be calculated on the basis of one ohm of loss resistance at the antenna's current loop

[This will eliminate a double standard between AM stations and stations in the other broadcast services.

For instance, to achieve the same effective radiated power, a six-kilowatt FM station can employ a one-kilowatt transmitter and an antenna having a gain of six or a twelve-kilowatt transmitter and an antenna having a gain of 0.5 under the present rules. Similarly, AM stations, which are allocated on the basis of radiation efficiency rather than effective radiated power, should have the flexibility to produce their allowable radiation efficiency with any type of antenna for which the radiation characteristics can be known.

Such flexibility would afford AM stations much greater latitude in antenna and site selection. Local zoning and FAA requirements severely restrict the construction of tower antennas to meet the present minimum efficiency requirements. The ability to employ electrically-short antennas will circumvent many of these difficulties.

The characteristics of electrically-short antennas are completely

predictable. As the height of a vertically-polarized radiator is decreased toward zero, the shape of the vertical radiation pattern remains virtually unchanged. The main effect is that efficiency decreases if losses are assumed. The one ohm current loop loss assumption is a conservative one, making field strength measurements to prove antenna efficiency unnecessary.]

§73.51(b)(3)(i) Where a dissipative network is employed, the authorized antenna current and resistance, and the authorized antenna input power, shall be determined **at the antenna feed system input, including the dissipative network. The dissipative network may be employed as the termination for an element of the array whose operating resistance is negative, without any electrical connection to the remainder of the array except that which occurs as a result of the mutual coupling of the array elements.**

[This change will allow stations employing directional antennas which suffer from poor pattern bandwidth because of large power circulation between their elements to terminate the negative power flow elements into dissipative loads and compensate the input power to result in the same total radiated power, enabling them to improve their pattern bandwidth and over-the-air stereo reception.]

§73.53 eliminate (c)

[see §73.14 regarding critical directional antennas]

§73.54 should be revised:

(a) unchanged
(b) eliminate (2)
(c) eliminate the entire paragraph
(d) eliminate the last sentence and (1) and (2), relabel as (c)
(e) relabel as section (d)

[These changes will eliminate provisions which are no longer necessary or desirable with modern transmitters and measuring instruments.

The requirement to set common point reactance to zero was established in the very early days of directional antenna

technology, when it was not common to have the ability to adjust common point impedance without altering array parameters. Today, independent common point impedance adjustment circuitry is standard. Additionally, it is usually necessary to set the common point reactance to several ohms capacitive in order to overcome hookup and switching inductance and present a nonreactive load at the actual transmitter output terminals. Such a load is very important for the modulation systems employed by modern transmitters.

The requirement for impedance observations over a band of frequencies was established to improve accuracy with primitive measuring instruments and is not necessary today.]

§73.58 should be revised:

(a) unchanged
(b) eliminate the entire paragraph
(c) relabel section as (b) and
(d) relabel as section (c)
(e) revise the last section in the main paragraph to read: "**....without further authority of the Commission.**"
eliminate subparagraph (1) and remove the subparagraph designation (2) from subparagraph (2). Relabel the entire paragraph as (d) and
(f) relabel paragraph as (e)

[These changes will eliminate the base current requirements of the rules - see DLR p. 5, p. 10; S&S p. 1]

§73.61 should be revised to read:

(a) Each AM station using a **category "B"** directional antenna and not employing an approved antenna monitoring system must make....
(b) **Whenever the licensee of an AM station employing a directional antenna has reason to believe that the radiated field may be exceeding the limits for which the station was most recently authorized to operate, a measurement procedure appropriate for the category of directional antenna shall be employed to determine the proper operation of the antenna. Licensees of stations employing category "A" antenna shall employ the proof of performance procedure employed for licensing such antenna systems. Licensees of stations employing**

category "B" antennas shall employ the "Proof of Performance" procedure defined by §73.151 for that class of antenna.

(c) **The licensee of an AM station may be directed to make measurements to determine and certify the proper performance of the antenna system, as appropriate for the category of antenna employed,** by the FCC whenever there is an indication .....

[These changes eliminate the requirement to measure and maintain monitor point field strengths except for category B stations without approved antenna monitoring systems see DLR p. 5; NAB "Appendix A"; S&S p. 2)]

§73.62 (a) Each AM station operating a directional antenna must maintain the indicated relative amplitudes and phases of the antenna **monitor parameters within +/- 5.0 percent and +/- 3.0 electrical degrees, respectively.**

(b)...a licensee may operate with parameters at variance from such tolerances for a period up to 10 consecutive days, provided, **for category "B" antenna systems without approved antenna monitoring systems,** the monitoring points.....

[These changes are necessary because of the elimination of the critical directional antenna designation and the changes to the monitor point requirements, which are discussed elsewhere in these reply comments.]

§73.68 (2) Eliminate the first sentence. The second sentence is revised to read "Sampling lines may be of different lengths..." (Eliminating reference to critical arrays.)
(b) revise to read "**A station employing a category "B" antenna system may employ an antenna sampling system..."**
Add to this paragraph **"A station employing a category "A" antenna system with antenna elements which are less than 100 degrees in physical height may employ toroidal current transformers which can be accounted for in the system model, located at the feed points to the antenna elements such that no shunt current paths are present other than through the reactances of base insulators, isocouplers, or lighting transformers on the output**

side of the sample location. A station employing a category "A" antenna system with antenna elements between 120 degrees and 180 degrees may employ a sample derived from a precision voltage divider directly across the base insulator or, in the case of a free-standing tower, one of the base insulators. A station employing a category "A" antenna of any electrical height, including a top-loaded antenna element, may employ a sample loop located on the antenna element in a location which is predicted to produce at least 50% of the amplitude of the current maximum on the element, and which is at least 3 meters above ground. All transmission lines, lighting conduit, or other conductors within three electrical degrees vertical distance of the sample loop must be at tower potential. The loops shall be rigidly mounted with the plane of the loop oriented toward the geometric center of the element, and approximately perpendicular to any other element of the array within 45 electrical degrees horizontal distance. Loops shall be single turn, and shall be of identical construction.
(c) revise to state "**if all other operating parameters and (for category "B" stations not employing approved antenna monitoring systems) the field monitoring point values specified in the station authorization...."**

(d)(3) modified or components replaced **licensees of category "A" antennas will perform a proof of performance of the antenna system, and licensees of category "B" antenna systems shall perform a proof of performance of the antenna system. The antenna common point impedance shall be measured as a part of these procedures."**

(d)(4) eliminate reference to base currents

[These changes provide for antenna sampling systems with characteristics which can be verified to sample modeled directional antenna parameters through proof of performance measurements.]

§73.69(a) eliminate second sentence in paragraph
(b) ...if all other operating parameters and **(for stations employing category "B" antennas without approved antenna monitoring systems,** the field monitoring points are within .....
(d) (1) If an authorized antenna monitor is replaced

by another antenna monitor, the following procedures shall be followed:
Stations employing Category "A" antenna systems shall perform an antenna proof of performance subsequent to the change in monitoring equipment and configuration. Stations employing category "B" antennas shall follow the procedure in subparagraphs (2), (3) and (4) of this paragraph.

The phrases "base currents" and "base current ratios" should be removed from subparagraphs (2) and (3), as well as monitor point field strengths for all except category B stations without approved antenna monitoring systems.

[see §73.68 herein]

§73.151 Procedures to Establish Performance of Directional Antenna Systems

(a) In addition to the information required by the license application form, the following showing must be submitted to establish for each mode of directional operation that the antenna pattern is adjusted so that the effective field at all azimuths does not exceed that established for the corresponding azimuths in the authorized standard pattern. This showing shall be made utilizing the following methods, as appropriate for the category of directional antenna in use:
(1) Category "A" directional antennas are those directional antennas which are constructed with array elements and sample system characteristics as defined in §73.14 and §73.68. The proof of performance for these antenna systems will consist of the following data:
(i) Detailed information concerning the model used to predict the array parameters, showing agreement between the predicted and measured base impedances at each tower base with all of the other towers shorted to ground within +/- 4.0 percent and 2.0 ohm. The model should include numerical analysis of the array (the FCC standard method will utilize MININEC III and the methods described in the June, 1989 IEEE Transactions on Broadcasting paper by Mr. J.B. Hatfield entitled "Relative Tower Currents and Fields in an AM directional array" to relate array element parameters to far-field parameters) and circuit analysis to

account for shunt capacitance and series ground system and connection inductance at each tower base.
(ii) A surveyor's or (in those States and territories where permitted by local regulation) engineer's certification of the antenna element spacing and alignment within 0.5 electrical degree of the design value and a showing that the terrain elevation within one quarter wavelength of any element of the array does not exceed plus or minus five percent of the height of the nearest tower.
(iii) An engineer's certification that the array and sampling system have been constructed in accordance with the design.
(iv) A showing that the parameters of the array have been adjusted to within 5.0 percent amplitude and 3.0 degree phase of the calculated value taking into account the measured lengths of sample lines. The calculated array parameters will become the licensed values for operation of the antenna system.
(v) Common point current and carrier-frequency resistance, or other information concerning the power determination device installed.
(vi) Information on the characteristics of the sample system including the following:
(1) Measured open circuit and short circuit impedance of each sample line at appropriate frequencies; calculated electrical length at carrier frequency and characteristic impedance on the basis of the measured characteristics.
(2) Measured impedance at the antenna monitor connection of each line with the sample device as installed in the system connected to the opposite end. The impedance of each line shall be identical within +/- 4.0 percent and 2.0 ohm after taking into account the respective line lengths.
(3) For systems utilizing sampling loops mounted on towers without identical physical characteristics (cross-sectional dimension and number of legs), a showing relating the sensitivities of the loops of the different towers to tower currents at the loop locations assuming that the currents are distributed equally among the legs of each tower.
(vii) Measurements showing calibration of the antenna monitor according to the manufacturer's instructions.
(viii) Measurements of the impedance at each antenna element (tower) base (directly across the insulator) with all other antenna elements in the system shorted to ground.
(ix) A showing that all significant re-radiators (grounded structures whose height above ground is greater than 60 electrical degrees) within 1 wavelength

of any array element have been detuned or that the same numerical analysis model used demonstrates that the potential re-radiator does not result in fields exceeding the standard pattern at any horizontal azimuth. Unused towers in an antenna system array shall be detuned if the analysis method used for proof of performance discloses that such detuning is necessary to maintain the standard pattern radiation values.

(2) Category "B" directional antennas are those directional antennas which are not constructed with array elements and sample system characteristics as defined in §73.14 and §73.68, or those for which licensees choose to provide proof of performance data on the basis of the category "B" requirements. The proof of performance for these antenna systems will consist of the following data:
(i) The inverse distance field radiated from the antenna shall be determined by 10 or more measurements on each radial corresponding to the local maxima and minima of the pattern which have standard field less than the standard pattern RMS, provided that a maximum between minima at azimuths separated by less than 20 degrees need not be measured. These measurements shall be made at points beyond 10 times the array maximum spacing. These measurements shall be made for both directional and non-directional operation.
(ii) A showing shall be made that all unused antenna towers or elements are properly detuned for each mode of operation, including the nondirectional operation used for measurements.
(iii) The measurement data shall be analyzed using DA/ND ratios (arithmetic or logarithmic) assuming that the non-directional field is within +/- 10 percent of the inverse field shown by §73.190 Figure 8. This analysis shall show that the directional inverse field value is within the standard pattern value. The use of close-in points and graphical analysis will be accepted on a case-by-case basis. Analysis considering array proximity will be accepted upon a specific showing that an adequate distribution of far-field points is not available within 10 miles, and must be based on agreement of unattenuated field determined from measurements at the various points along each radial with values calculated taking the array geometry into account.
(iv) Common point current and carrier-frequency

resistance, or other information concerning the power determination device installed.
(v) For stations which do not have sampling systems which meet the requirements of the former §73.68 (approved antenna monitoring systems), a measurement point on each radial specified in the construction permit shall be selected as a monitor point. The monitor points must be points included as a part of the data contained in paragraph (i) above. A description of the monitor point, including directions from the transmitter site, and a photograph of the monitor point showing the location of the field measurement equipment for proper measurement at the point shall be included.
(vi) The antenna monitor indicated parameters shall be included in the data. These values will become the licensed parameters.

[These new provisions will make it possible for stations with directional antenna systems that lend themselves to computer modeling and with antenna monitor sampling systems which can be verified to be indicating observable modeled parameters to conduct their proof of performance measurements on the internal properties of their arrays, if they so wish. Other stations may conduct greatly simplified field strength proof of performance measurements, including only the information necessary to show that their measured radiation patterns are within their corresponding standard patterns.

see DLR pp. 8-14; H&D pp. 2-5; MLJ pp.2-8; S&C pp. 2-8; S&S pp. 2,3]

§73.152(a) If, after construction and final adjustment of **a category "B"** directional antenna, a measured inverse field .....

[This provides for modification of standard radiation patterns for stations conducting field strength proofs of performance.]

§73.154 Delete

[This section will no longer be necessary, since partial proofs of performance will be replaced by the new, simplified, proofs of performance.]

§73.158(a) When a licensee **of a category "B" directional antenna system without a type approved sample system** finds that a field monitoring point.....
(a)(1) **A proof of performance** conducted on the radial.....

[These changes are necessitated by changes in the monitor point requirements and proof of performance standards.]

§73.186(a) **In some situations it may be necessary to determine the effective field of an antenna system at a particular azimuth by the analysis of field strength measurements.** The following requirements .....

eliminate paragraph (a)(4) and renumber paragraph (a)(5) as (4).

[These editorial changes are necessitated by the elimination of the minimum antenna efficiency requirements and the requirement to establish directional antenna RMS efficiency at the time of a proof of performance.]

Conclusion

The rule changes proposed herein will make it possible for the FCC to know that our nation's AM directional antenna systems are functioning properly while greatly reducing the cost burden on their licensees. Many of the NOI comments suggested that the licensees of AM stations are not paying as much attention as they should to compliance with the present rules. In our experience, this is generally true. Some suggested that the rules should require even more proof of performance work than they now do, while others favored stepping up FCC enforcement efforts.

We do not find any merit in increasing the cost burden on the licensees of AM directional antennas and doubt, given the FCC's fiscal constraints, that we will soon see a return to the rate of station inspections of 20 years ago. Our proposed rule changes, though, will encourage voluntary compliance by taking advantage of modern technology to reduce the costs of proper maintenance for AM broadcasters. The proof of performance rules we propose will provide superior information on array performance than is available from the procedures of the present rules, which emphasize partial proof of performance field strength measurements for existing stations.

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February 25, 1994