DOCKET FILE COPY ORIGINAL

COMMUNICATIONS TECHNOLOGIES, INC.

BROADCAST ENGINEERING CONSULTANTS

P.O. BOX 1130

MARLTON, N.J. 08053

(609) 985-0077

FAX - (609) 985-8124

CLARENCE M. BEVERAGE

LAURA M. MIZRAHI

CONSULTANT

JAMES W. POLLOCK P.E.

~ *Via Federal Express* ~

February 28, 1994

Mr. William F. Caton
Secretary
FEDERAL COMMUNICATIONS COMMISSION
1919 M Street, NW - Room 222
Washington, DC 20554

RECEIVED

MAR 1 1994

MAIL BRANCH

RE: REPLY COMMENTS
MM DOCKET NO. 93-177
RM-7594

Dear Mr. Caton:

On behalf of the firm of Communications Technologies, Inc., please find attached the original and four copies of Reply Comments in the above noted proceeding.

An extra copy is included to be date stamped and returned in the attached postage paid envelope. Please contact the undersigned if any questions should arise.

Sincerely,

Clarence M. Beverage

CMB/es

Enclosure

fc: CATON.1LT

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

DOCKET FILE COPY ORIGINAL

BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, DC 20554

RECEIVED
MAR 1994
MAIL BRANCH

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

REPLY COMMENTS OF COMMUNICATIONS TECHNOLOGIES, INC.

Communications Technologies, Inc. ("CTI") hereby submits its Reply Comments in response to the Notice of Inquiry ("NOI") in the above referenced proceeding, adopted June 14, 1993 and released June 29, 1993.

IDENTITY AND INTEREST

CTI is a broadcast engineering consulting firm serving AM, FM and TV clients and is involved in ongoing projects concerning directional antenna system performance evaluation. The Reply Comments herein are offered in an effort to secure performance standards which will allow AM directional antenna operation to be verified in the most cost effective and timely manner possible consistent with standards of good engineering practice. CTI believes that proposals put forth by the original petitioners, and later commenters, offer valuable input into how Part 73 of the Rules and Regulations may be revised, taking into account the availability of today's mathematical modeling techniques, test equipment and computer assisted measurement systems. It is hoped that these Reply Comments will provide additional background and insight upon which the FCC may proceed to prepare a Notice of Proposed Rulemaking.

SUMMARY

A number of comments have been filed supporting the use of computer modeling techniques to set up a directional antenna system in the field. By careful adjustment and monitoring of certain critical aspects of the antenna system parameters, such as the amplitude and phase of each driven element, the antenna system's performance may be verified on site without the need for radial field intensity measurements to prove the pattern shape and size. We agree with this concept and support this proposal as a "preferred" method of antenna system adjustment.

However, we are aware that a number of people are not comfortable with this approach and we believe that their reasons are valid based on their own experience and exposure to the AM broadcast environment. Realizing that there are differing schools of thought, CTI wishes to summarize its recommendations as follows:

1. The Commission should add to the Rules a new section detailing exact performance verification methods and procedures. This section will be considered the preferred method because it will be based on current day technology and will offer an implementation that is time efficient and accurate with excellent repeatability being based on full facility documentation.

2. The Commission will maintain the existing Rules concerning field strength measurements and antenna system performance verification and these Rules may be used when the preferred method is not desired or not appropriate. It must be remembered that the current Rules are based on a core of good engineering practice and judgment. It would appear wasteful to abandon the core portions at this time. Rather, as time passes, and the body of expertise with the preferred method builds, it is expected that the current Proof of Performance standards will be relied upon less and less often.

PART 73 - SUGGESTED REVISIONS

Suggested changes to pertinent Rule Sections are as follows:

73.14 Add, "Point of Common Radio Frequency Input Power: The product of the square of the antenna current and the antenna resistance at the point in the antenna system where transmitter power is first applied, taking into account the adjustments in subparagraphs (b)(1) and (b)(2) of 73.51 of the Rules."

"Antenna System Performance Proof: Analysis of a directional antenna system to demonstrate that computer modeling of the physical and electrical characteristics of the radiating structures, feed system and sample system yield the same operating characteristics as measured in the field when the antenna system adjustment is completed."

73.31 No changes proposed.

73.33(b) Revise to . . . "If the station is using a directional antenna, or a radiator other than a vertical radiator, an Antenna System Performance Proof or a Proof of Performance must also be filed (see 73.14)."

73.45(a) CTI wishes to note that the minimum efficiency standards dictate a minimum antenna height and ground system size which are necessary for antenna system stability. However, certain special designs may not be subject to instability when the physical size is small and the RMS is below FCC minimums. It is recommended that, upon a showing of adequate stability, antennas which do not meet the minimum RMS efficiency will be allowed.

73.45(a)(2) Revise to . . . "If the station is using a directional antenna, or a radiator other than a vertical radiator, an Antenna System Performance Proof or a Proof-of-Performance must be filed. See 73.140-73.157."

73.51 No changes proposed.

73.53 Delete Section 73.53(c). Delete all references to critical arrays in the Rules.

73.54(c)(1) Delete the reference to plotted data, only tabulated data need by supplied.

73.57 No changes proposed.

73.58 No changes proposed.

73.61 Stations built under the new Rules using the Antenna System Performance Proof would not have monitor points designated on their license, making it unnecessary to change this section.

73.62 No changes proposed.

73.68(a)(2) Change to . . . "Sampling lines must be of solid outer conductor construction. Sampling lines may be of different lengths as long as the phase difference of signals arriving at the monitor are less than 0.5°, when referenced to the reference tower length, over the range of temperatures to be encountered."

73.68(a)(3) Change to . . . "Sampling lines to be bonded to towers at the sampling loop, tower base and at minimum of 40 foot intervals between these points on towers with electrical heights in excess of 100 degrees. Tower lighting conduit and any other feedlines must be similarly bonded.

On towers less than 100 degrees in physical height, the sampling line may be supported on insulators."

73.69 No changes proposed.

73.140 Section 73.150 should be moved to 73.140. This will allow the future use of 73.141-73.149 for later adopted formulas dealing with slant wire radiators, etc.

73.150 New - "Antenna System Performance Proof."

73.151 No changes proposed.

73.152 No changes proposed.

73.153 Change second sentence to . . . "When measurements of groundwave signal strength are presented, they shall be made on both the offending and affected stations and be of sufficient quantity that the service and interfering contour locations may be reliably located."

73.154 No changes proposed.

73.158 No changes proposed.

73.189(b)(4) Add at end of paragraph . . . "In lieu of a buried ground system, a minimum of four elevated radials, 90 degrees in length at the operating frequency, may be employed if rigidly supported and located 8 degrees, or 20 feet, whichever is less, above grade level."

ANTENNA SYSTEM PERFORMANCE PROOF

CTI proposes that the directional antenna performance verification be called "Antenna System Performance Proof". This procedure requires a detailed description of the array physical characteristics, a computer model accurately describing the array electrical characteristics and on site measurements of system parameters showing significant agreement between the computer model and the measured data.

CTI believes that it would be counterproductive to limit use of this new technique to certain simplified configurations. All tower configurations should be allowed, including skirt feeds, non-uniform cross section towers, and top loaded radiators. Due to the current state of the art in computer modeling, it may be felt, by many, that it would be difficult to obtain computer modeled results for an array of skirt fed radiators which would match the measured parameters. This is not a reason to write the Rules in a restrictive manner that would prohibit modeling of these arrays in the future as computer modeling techniques and/or software improve.

The Antenna System Performance Proof should include three categories of data and a final analysis of operation.

1. Construction details - mechanical dimensions and materials description.

2. Numerical modeling analysis with array geometry.

3. Measurement data.

4. Comparison of computed and measurement data - concluding analysis of correct array adjustments.

Information believed necessary in each of the four proof categories are broken down as follows:

<u>Construction Details</u>

1. Tower make and model.

2. Tower leg diameter, face width and cross member sizes. Furnish copy of manufacturer's drawing for a typical section.

   A. On tapered towers, provide attached data for entire tapered area of tower.

3. Base pier height AGL and dimensions, description of ground straps on pier.

4. Base insulator make and model.

5. Description of tower feed, dimensions of lightning choke and feed attachment point on tower.

6. Description of lighting circuits including attachment point of lighting conduit on tower, static drain or other lighting circuit's make and model number and physical location.

7. Make and model of sampling device. Physical location of sampling device on tower.

8. Physical description of sampling and feedlines and their route from transmitter to tower.

9. Surveyor's statement confirming tower heights, orientation and spacing and array center geographic coordinates.

Numerical Modeling Details

1. Complete printout of NEC analysis including:

   A. Complete array and element geography expressed in x, y, z coordinates.

   B. Segmentation data.

   C. Currents and locations.

   D. Antenna environment conditions.

   E. Antenna base loadings.

   F. Antenna input parameters.

   G. Currents and locations.

H. Power budget.

I. Radiation pattern at 1 kM in 5° azimuth steps at 0° elevation angle.

2. Description of NEC software used.

<u>On Site Measurement Data</u>

1. Matrix of measured self impedance of each radiator with other radiators open and shorted.

2. Measured value of reactance at the base of each tower required to detune the tower.

3. Measured value of base insulator reactance.

4. Measured value of reactance between ATU RF ammeter and tower feed point.

5. Current or voltage distribution readings on tower sufficient to locate the current minima point, in the detuned condition, on each tower.

6. Measured electrical length of each sampling line.

7. RF voltage measured at the sampling line connection point to the phase monitor when a carrier voltage of 100 volts peak to peak is applied at the tower base.

8. Phase monitor readings, amplitude and phase for correct operating parameters.

9. Current or voltage distribution readings on each tower sufficient to locate the current maximum point with the array adjusted and operating.

10. RF voltage measurement at the sampling line connection point to the phase monitor with the array adjusted and operating.

11. Measured common point R & X and current for array adjusted and operating.

Final Analysis - Certification

1. Certification that array has been visually inspected and that the dimensional data used in the computer analysis agrees with the construction data tabulation.

2. Certification that good construction techniques were used including, but not limited to, description of tower section bonding, bonding of line on towers, etc.

3. Description of test equipment and procedures used.

4. Tabular comparison of computed and measured current loop locations, loop current ratios and phases for the array as adjusted and operating.

5. Tabulation of all measured characteristics for later monitoring and maintenance.

6. Certification that the computed and measured values agree within a percentage of accuracy to be determined in the PRM.

NUMERICAL ELECTROMAGNETICS CODE - METHOD OF MOMENTS

Based on comments in this proceeding, and general comments voiced at NAB's January 13, 1994 forum on MM Docket No. 93-177, the expertise of persons in the broadcast engineering field vary widely concerning the use of NEC for computer modeling. In a similar manner, engineers with NEC modeling experience have used many different versions of MININEC and NEC, each with its own unique input/output routines, traps, bugs and accuracies.

Attached to these Reply Comments, as Appendix I, is a list of published papers dealing with the use of numerical modeling techniques for medium wave antenna performance. The list is not all inclusive but does offer a broad scope of the subject including modeling examples, software problems, software availability, and expected accuracies. It is hoped that a review of these articles will be helpful to those wishing to learn more about the field as well as an indicator of the current state of computer modeling in general.

Based on information at hand, CTI believes that NEC-4 would be a superior choice for the FCC to implement and use in performing its own numerical analysis of array performance. Unfortunately, this version of NEC is currently security restricted. It is believed that, as more interest is shown in this software, it will be released to the private sector.

CONCLUSION

CTI hopes that the Commission will issue a PRM proposing to modify the Rules to provide for antenna system performance verification using advanced computer modeling techniques and on site measurement data. Ideally, the rule change will be accomplished in a way that allows, and encourages, future improvements in computer modeling software and measurement techniques. CTI's proposal, described herein, is based on the concept of verifying computed parameters with measured parameters. This approach appears to be the most effective in terms of assuring proper array performance while encouraging software development and measurement procedure enhancement.

The foregoing was prepared by Clarence M. Beverage of *Communications Technologies, Inc.*, Marlton, New Jersey, whose qualifications are a matter of record with the Federal Communications Commission. The statements herein are true and correct of his own knowledge, except such statements made on information and belief, and as to these statements he believes them to be true and correct.

By _____

Clarence M. Beverage
for Communications Technologies, Inc.
Marlton, New Jersey

SUBSCRIBED AND SWORN TO before me,

this 28th day of February, 1994,

Esther G. Sperbeck, NOTARY PUBLIC

ESTHER G. SPERBECK
NOTARY PUBLIC OF NEW JERSEY
MY COMMISSION EXPIRES OCT 15, 1997

APPENDIX I

PUBLISHED PAPERS CONCERNING NUMERICAL MODELING TECHNIQUES FOR MW ANTENNAS

IEEE TRANSACTIONS ON BROADCASTING

C.W. Trueman and S.J. Kubina, R.C. Madge and D.E. Jones, "*Comparison Of Computed RF Current Flow On A Power Line With Full Scale Measurements*," Vol. BC-30, No. 3, pp. 97-107, September 1984.

C.W. Trueman and S.J. Kubina, "*Initial Assessment of Reradiation From Power Lines*," Vol. BC-31, No. 3, pp. 51-65, September 1985.

Harry R. Anderson, P.E. and David J. Pinion, P.E., "*Short Range Skywave Field Strengths From Tall AM Broadcast Towers*," Vol. BC-32, No. 3, pp. 37-43, September, 1986.

C.W. Trueman and S.J. Kubina, "*Detuning Power Lines By Isolating Towers For The Suppression Of Resonances*," Vol. BC-32, No. 3, pp. 44-55, September, 1986.

C.W. Trueman, S.J. Kubina and C. Baltassis, "*Ground Loss Effects In Power Line Reradiation At Standard Broadcast Frequencies*," Vol. 34, No. 1, pp. 24-38, March 1988.

C.W. Trueman, "*Modelling A Standard Broadcast Directional Array With The Numerical Electromagnet Code*," Vol. 34, No. 1, pp. 39-49, March 1988.

Jerry M. Westberg, "*Matrix Method For Relating Base Current Ratios To Field Ratios Of AM Directional Stations*," Vol. 35, No. 2, pp. 172-175, June 1989.

C.W. Trueman, T.M. Roobroeck and S.J. Kubina, "*Stub Detuners For Free-Standing Towers*," Vol. 35, No. 4, pp. 325-338, December 1989.

C.W. Trueman and S.J. Kubina, "*Power Line Tower Models Above 1000 kHz In The Standard Broadcast Band*," Vol. 36, No. 3, pp. 207-218. September 1990.

Al Christman and Roger Radcliff, "*Using Elevated Radials With Ground-Mounted Towers*," Vol. 37, No. 3, pp. 77-82, September 1991.

APPLIED COMPUTATIONAL ELECTROMAGNETIC SOCIETY - NEWSLETTER

Paul Elliot, "*Modeling Note - Antenna Terminal And Generator Models In NEC,*" Vol. 4, No. 3, pp. 26-28, December 1989.

G.J. Burke, "*NEC-MoM Update,*" Vol 7, No. 2, pp. 31-37, July 1992.

Richard Adler, "*Software Exchange Committee Report,*" Vol. 8, No. 3, pp. 8-10, November 1993.

APPLIED COMPUTATIONAL ELECTROMAGNETIC SOCIETY - JOURNAL

Gerald Burke, "*EM Modeling Notes,*" Vol. 3, No. 1, pp. 34-46, Spring 1988.

Gerald Burke, "*EM Modeling Notes,*" Vol. 3, No. 2, pp. 18-27, Fall 1988.

George H. Hagn, "*HF Ground Constant Measurements At The Lawrence Livermore National Laboratory (LLNL) Field Site,*" Vol. 3, No. 2, pp. 131-165, Fall 1988.

E.K. Miller, "*Characterization, Comparison, And Validation Of Electromagnetic Modeling Software,*" pp. 8-24, Special Issue On Electromagnetics Computer Code Validation, 1989.

Saad N. Tabet, J. Patrick Donohoe and Clayborne D. Taylor, "*Using Nonuniform Segment Lengths With NEC To Analyze Electrically Long Wire Antennas,*" Vol. 5, No. 2, pp. 2-16, Winter 1990.

Ian P. Macfarlane, A.H.J. Fleming, Steve Kskra and Greg Haack, "*Pilgrms' Progress - Learning To Use The Numerical Electromagnetics Code (NEC) To Calculate Magnetic Field Strength Close To A Sommerfeld Ground,*" Vol. 5, No. 2, pp. 58-75, Winter 1990.

B.A. Austin, "*An Assessment Of MININEC And Its Use In The Teaching Of Antenna Theory,*" Vol. 8, No. 1, pp. 7-28, Special Issue On Computer Applications In Electromagnetics Education, 1993.

MISCELLANEOUS SOURCES

D.V. Campbell, "*Personal Computer Applications of MININEC*," IEEE Antennas & Propagation Society Newsletter, Vol. 26, No. 1, pp. 5-8, February 1984.

J.L. Pages, "*Numerical Modelling Of Feedpoints At Wire Junctions*," Journal of Electrical and Electronics Engineering, Australia - IE Aust. & IREE Aust., Vol. 7, No. 4, pp. 257-260, December, 1987.

Al Christman, "*Elevated Vertical Antenna Systems*," QST Magazine, pp. 35-42, August 1988.

R.P. Haviland, "*Using MININEC For Antenna Analysis*," Communications Quarterly, pp. 16-22, Fall 1990.

Roy Lewallen, "*MININEC: The Other Edge Of The Sword*," QST Magazine, pp. 18-22, February 1991.

The Officers and Directors of ACES, Inc. and Paul Elliot, "*The Applied Computational Electromagnetics Society*," IEEE Antennas & Propagation Magazine, Vol. 33, No. 1, pp. 18-20, February 1991.

R.P. Haviland, "*Antenna-Structure Interaction*," Communications Quarterly, pp. 73-78, Fall 1991.

Jian Peng, Constantine A. Balanis and George C. Barber, "*NEC and ESP Codes: Guidelines, Limitations, and EMC Applications*," IEEE Transactions On Electromagnetic Compatibility, Vol. 35, No. 2, pp. 124-133, May 1993.

CERTIFICATE OF SERVICE

I, Esther G. Sperbeck, a secretary in the firm of Communications Technologies, Inc., do hereby certify that I have, this 28th day of February 1994, caused to be mailed by First Class Mail, postage prepaid, copies of the foregoing Reply Comments in MM Docket No. 93-177 to the following:

Thomas G. Osenkowsky
RADIO ENGINEERING CONSULTANT
5 Beechwood Grove
Brookfield, CT 06804

Robert M. Silliman
SILLIMAN AND SILLIMAN
8601 Georgia Avenue - Suite 910
Silver Spring, MD 20910

Joseph M. Johnson
FEDERAL COMMUNICATIONS COMMISSION
Mass Media Bureau
Room 8104
2025 M Street, NW
Washington, DC 20554

Ronald D. Rackley
duTREIL, LUNDIN & RACKLEY, INC.
240 N. Washington Blvd.
Suite 700
Sarasota, FL 34236

Robert duTreil
duTREIL, LUNDIN & RACKLEY, INC.
240 N. Washington Blvd.
Suite 700
Sarasota, FL 34236

Edward A. Schoeber, P.E.
RADIOTECHNIQUES
402 Tenth Avenue
Haddon Heights, NJ 08035

Herman E. Hurst, Jr.
CARL T. JONES CORP.
7901 Yarnwood Ct.
Springfield, VA 22153

Robert D. Culver, P.E.
LOHNES & CULVER
8309 Cherry Lane
Laurel, MD 20707-4830

Donald G. Everist, P.E.
COHEN DIPPELL & EVERIST P.C.
1300 L Street, NW - Suite 1100
Washington, DC 20005

William P. Suffa, P.E.
SUFFA & CAVELL INC.
3975 University Drive - Suite 450
Fairfax, VA 22030

Garrison C. Cavell
SUFFA & CAVELL INC.
3975 University Drive - Suite 450
Fairfax, VA 22030

David Harry
POTOMAC INSTRUMENTS
932 Philadelphia Avenue
Silver Springs, MD 20910

Clifford C. Hall
POTOMAC INSTRUMENTS
932 Philadelphia Avenue
Silver Springs, MD 20910

Kenneth J. Brown
CAPITAL CITIES/ABC INC.
77 W. 66 Street
New York, NY 10023

Roger Goodspeed, Esq.
CAPITAL CITIES/ABC INC.
77 W. 66 Street
New York, NY 10023

James B. Hatfield, P.E.
HATFIELD & DAWSON, CONSULTING ENGINEERS, INC.
4226 Sixth Avenue, NW
Seattle, WA 98107

Benjamin F. Dawson, P.E.
HATFIELD & DAWSON, CONSULTING ENGINEERS, INC.
4226 Sixth Avenue, NW
Seattle, WA 98107

Wallace E. Johnson, P.E.
MOFFET, LARSON & JOHNSON INC.
Consulting Telecommunications Engineers
Two Skyline Pl.
5203 Leesburg Pike, Suite 800
Falls Church, VA 22041

Henry L. Baumann, Esq.
NATIONAL ASSOCIATION OF BROADCASTERS
1771 N Street, NW
Washington, DC 20036

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

John R. Furr
JOHN FURR & ASSOC.
2700 NE Loop 410
Suite 325
San Antonio, TX 78217

John S. Neely, Esq.
MILLER & MILLER, P.C.
1990 M Street, NW - Suite 760
Washington, DC 20036

R. Morgan Burrow, Jr., P.E.
MULLANEY ENGINEERING INC.
9049 Shady Grove Ct.
Gaithersburg, MD 20877

William J. Sitzman
INDEPENDENT BROADCAST CONSULTANTS INC.
110 County Road 146
Trumansburg, NY 14886-9721

Esther G. Sperbeck

Esther G. Sperbeck