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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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

COMMENTS OF THE NATIONAL ASSOCIATION OF BROADCASTERS

In this proceeding[1] the Commission asks for public comment on changing Commission rules and policies applying to AM directional antenna systems. This inquiry proceeding was initiated in response to a petition submitted December 15, 1989, by several consulting engineering firms.[2] The petition sought institution of a proceeding that would examine the rules and systems applicable to AM directional antenna performance verification. Over a year later, the Commission placed the petition on public notice,[3] thereby soliciting initial comment on the concepts advanced in the petition.

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[1] See Notice of Inquiry ("Notice") in MM Docket No. 93-177, 8 FCC Rcd 4345 (1993). By Order Granting Extension of Time (DA 93-1024, released August 20, 1993), the Commission established today as the revised deadline for the filing of comments; December 29, 1993, as the revised reply comment deadline.

[2] The petitioning firms were duTreil, Lundin & Rackley, Inc., Hatfield & Dawson Consulting Engineers, Inc., Lahm, Suffa & Cavell, Inc., Moffet, Larson & Johnson, Inc. and Silliman & Silliman.

[3] FCC Public Notice, "Office of the Secretary; Petitions for Rule Making Filed," Report No. 1833, released January 14, 1991

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The National Association of Broadcasters ("NAB")[4] in comments[5] filed in response to the petition, urged the initiation of the requested proceeding. NAB took this position in light of the then-pending proceeding in MM Docket No. 87-267, the omnibus "AM Improvement" docket.[6] Then, as now, NAB urges the Commission to adopt refined methods for dealing with AM directional antennas and ensuring a regulatory regime aimed at non-interference among stations.

In these brief comments filed today, NAB will not offer detailed analysis of the specific questions raised in this Notice. However, NAB agrees that the time is right to review and possibly overhaul the rules relating to the performance verification of AM directional antennas. This action by the Commission appropriately and correctly would follow the sweeping restructuring of the AM broadcast service in MM Docket No. 87-267.

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

[5] Comments of NAB (RM-7594), filed February 14, 1991.

[6] At the time the consulting engineers submitted the petition, the Commission had initiated only an inquiry in the AM Improvement docket. Notice of Inquiry in MM Docket No. 87-267, 2 FCC Rcd 5014 (1987). Three years later the Commission advanced the proceeding to rulemaking status (Notice of Proposed Rule Making in MM Docket No. 87-267, 5 FCC Rcd 4381 (1990)). A year after that the Commission issued a decision in this rule making (Report and Order in MM Docket No. 87-267, 6 FCC Rcd 6273); and just this past spring the Commission adopted a reconsideration decision (Memorandum Opinion and Order in MM Docket No. 87-267, 8 FCC Rcd 3250 (1993)) which, inter alia, adopted final procedures for the inauguration of broadcast service on the expanded AM band.

NAB will defer full comment in this proceeding to the "reply comment" stage, following the submission of comments of AM broadcast engineering consultants and others who routinely design and maintain AM directional antennas. NAB agrees with the original petitioners that technological advances have provided better methods of designing and verifying the performance of AM directional arrays.

NAB has a long history of advocating an atmosphere of non-interference among the broadcasting services. This Notice raises myriad questions, many of which could be answered simply by a relaxation of the present AM directional antenna rules. However, NAB cautions the Commission that while, in many cases, rule relaxations may be appropriate, any changes must be viewed from the perspective of interference potential.

We note with favor the fact that the Commission was very careful, in MM Docket No. 87-267, to adopt technical changes only if they were shown to reduce, or at least not increase, interference on the AM band. While it may be impossible, realistically, to reduce observable interference without reducing the number of AM stations, sophisticated antenna array modeling software is available (and routinely used by engineering consultants) which may very accurately predict the propagation of AM signals from various antenna array configurations. At the time the original AM rules were written, the technology that makes this type of analysis possible simply was not available.

Allowing the use of such proven array modeling software would be another useful step in the direction of reducing interference when stations redesign their antenna systems. Conversely, simply relaxing the present rules relating to performance verification of AM directional antennas inevitably would allow more interference to creep, incrementally, into the band as poorly maintained AM arrays continue to deteriorate.

Also, while the AM interference issue is a genuine concern, broadcasters must not be saddled with more restrictive rules during a period of failing stations and a less than healthy economic climate.[7] Many AM stations today do not have full-time engineers who continuously can "tweak" AM directional antennas for top performance. Contract engineering services offer broadcasters only that for which stations pay, and in many cases this only involves maintaining the studio and transmitter, not extensive maintenance of a directional array. While this is certainly not an ideal situation, it is reality for many AM broadcasters.

The Commission's rules spell out specific tolerances that must be maintained in order to verify that an AM directional array is correctly adjusted. Additionally, in order to verify the proper directional pattern, field measurements at the station's monitor points are required as often as the licensee

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[7] In 1991, the last year for which comprehensive data are available, 58.6% of all radio stations lost money; over 65% of AM stations lost money that year. See 1992 NAB Radio Financial Report.

deems necessary; for the same reason, partial or full proofs may be needed. Field measurements are, unfortunately, time consuming and, from the viewpoint of a station using contract engineering services, expensive. Nevertheless, field measurements are necessary. NAB trusts that, as a result of the instant inquiry and subsequent rulemaking action, alternative means will be discovered which will give stations less expensive options to verify their directional antenna patterns.

For example, we may find that it is possible to arrive at a more economical solution for array performance measurements by combining computer modeling with field measurement data. A station engineer may be able to take field measurements at a small number of well-defined points and use these data in conjunction with computer modeling software to determine the performance of the station's directional array.

However, in this scenario it is imperative that the software used for such an analysis create an accurate model of the field conditions over which signals will propagate from the station's antenna site. Computer modeling must be accurate and traceable to well collected historical field data -- data that clearly show directional array performance under varying field conditions.

As an example of well-collected time varying data that may be useful in future studies for the purpose of computerized AM antenna modeling, NAB received a report from L.T. Killion,

Director of Engineering for the Nebraska Rural Radio Association.[8] The report presents an analysis of empirical data acquired over a period of several decades. The data are in the form of field strength measurements for Station KRVN, Lexington, Nebraska. Killion shows the effects of seasonal variations on the KRVN field intensity and compares the data to the last full array proof.

The report shows inconsistencies in NDA/DA comparisons that may be attributed to "free-space" impedance changes near the surface of the earth -- directly related to the Nebraska agricultural growing season. The data gathered on KRVN provide an excellent historical representation of how a station's conducted field can vary by season. Moreover, it explains how an engineer, while attempting to maintain proper monitor point values, as required by the Commission's rules, could chase seasonal changes and easily wind up with a directional array at variance with the theoretical values designed to adequately suppress the skywave -- leading to increased interference.

Additionally, and not related to Killion's report, is the important fact that "clear" monitor points for many stations are becoming difficult to locate. Many directional arrays are encompassed by residential and industrial growth that hampers the proper gathering of array performance data, or corrupts performance data. As in the case of chasing seasonal changes,

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[8] The Killion report is provided at "Appendix A" to these comments.

the engineer may compensate array parameters in order to maintain monitor point values. Subsequently, theoretical array parameters necessary to suppress the skywave are compromised, leading again to potential increased skywave interference.

Historical data, such as that from KRVN, would be valuable in creating software models that are based upon real-world array performance under a wide variety of physical variables. An additional and related area of study may define more precisely critical skywave angles and how these critical angles are affected by seasonal changes, sunspot cycle, etc. Again, this study could lead to improved computer modeling that could be used to assess and potentially reduce skywave interference.

We feel that comments to this Notice may provide the foundation for further study into economical, yet effective, new ways to measure array performance based equally on accurate verifiable computer modeling and specific field data acquired at well-defined points.

CONCLUSION

As was the goal in MM Docket No. 87-267, interference reduction should continue to be the guiding influence for any proposed future rulemaking actions here. Therefore, NAB urges the Commission to view carefully proposals to relax or eliminate the rules that pertain to the verification of AM directional antennas. The Commission should: (1) assess the potential for interference on the AM band that may be created with changes to

the AM directional rules and (2) assess the economic impact to AM stations of any changes to the AM directional rules. Ideally, new AM directional antenna verification rules also should be crafted to rely upon technologies designed to minimize the economic burden of compliance on AM broadcasters.

NAB, in formulating its position on others' comments and on future activity in this proceeding, will review these matters from the perspective of taking a fresh look at how stations with limited resources properly can verify the performance of their AM directional arrays, while at the same time holding the line on technical expenses.

Respectfully submitted,

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 Marino
Manager, Technical Regulatory Affairs
NAB Science & Technology

October 29, 1993

SEASONAL VARIATION IN MEDIUM WAVE AM BROADCAST TRANSMISSIONS

Engineers at Nebraska Rural Radio Association have made weekly field strength measurements of KRVN AM broadcast transmissions for several decades. Raw measured field data is very difficult to correlate. A method has been devised to compare all measurements to a fixed reference value. All variations are compared in dB of change. Monitoring point values from the last antenna proof have been found to be the best absolute value to use as a 0db reference.

Many measurements were made comparing both non-directional and directional operating modes. Both sets of measurements were made at approximately the same time over the same path. It is only logical to assume each measurement at the same location and time has the same path attenuation.

Direct dB comparison of a monitoring point NDA and DA field values yields the apparent array directivity at that time. To obtain actual array directivity the RMS field gain in dB must be added to the NDA/DA comparative directivity. (Example: If the NDA/DA directivity measured -38dB and the array directivity is 4.2dB then the actual array directivity is 42.2dB.) Additionally, the actual effective radiated power value can be obtained. (Example: -38dB below 50kw equals 7.9 watts.)

Many inconsistencies have been observed when analyzing NDA/DA directivity on the same radial at various distances. It is not possible for a single element antenna array to exhibit major elevation pattern variations over small angular displacements. Only path propagation irregularities can explain the measured field inconsistencies.

All of the observed inconsistencies are easily explained when the effect of the Poynting vector upon conducted radiation is considered in an air/earth path.

Before going into details we must keep in mind that the power density of a radiated field continually decreases as the distance from the radiator increases. The actual power density at any point is the product of the actual voltage and current fields at that point. It is physically impossible to have a greater power density at a greater distance over the <u>same</u> radiation path.

One hesitates to use the term "ground-wave" to describe day time propagation characteristics of a medium wave broadcast signal. The actual propagation path is really very much like that of a two wire transmission line. The outgoing path is through space and the return path on the earth's surface. Vegetation, trees, and structures at the earth to space junction create a varying dielectric between the two parts of the conductive path. The presence of the dielectric slows or delays the energy flowing in the earth portion of the conducted radiation path and results in "wave tilt" near the earth's surface. The dielectric phase delay also causes circulating-currents to flow in the dielectric material. This creates a rotating "Poynting" vector which recombines both additive and subtractive with the original signal.

The resulting measured E field will periodically exhibit values inconsistent with the actual power density present at the point of measurement. It can therefore be argued that the E field change is the result of a "free-space" impedance change with the resultant something other than the standard 377 ohms.

All of the above is happening at the earth's surface while the real "free-space" portion of the radiated signal is merrily traveling on its way above the horizon until intercepted and dissipated in the D layer, re-radiated by the F layer or lost into space.

It is probable that radiated fields in directional AM antenna system exhibiting deep nulls (-20 to -50db) a considerable differences exists between measured conducted radiation and actual skywave radiation. In fact, it is entirely possible that a portion of the night time skywave interference problem may result from patterns being optimized for conducted radiation rather than operating the array with distributions near theoretical values to obtain optimum skywave radiation supression characteristics.

All of the above was measured in areas with 30 to 40 mmhos/m soil conductivity and no reflections.

SEASONAL VARIATIONS

QUESTIONS:

#1 Why do measured daytime signals beyond 30 miles exhibit summer attenuation? (E-5)

#2 Why do measured nondirectional signals exhibit summer increases at approximately 25 miles and closer? (E-6, E-1)

#3 Why do measured nondirectional signals exhibit dramatic summer increases with the increase being greater as the distance from the source decreases? (E-1)

#4 Why do nearby monitoring points on the same radial taken at the same time with the same radiated power density exhibit greater and less than calculated relative attenuation? (E-2, E-3, E-4)

#5 Why do measured nondirectional and directional measured fields exhibit widely different path attenuation when measured on the same path at the same time? (E-2, E-3, E-4)

#6 Why do measured nondirectional antenna fields exhibit (theoretically impossible) increasing fields at increasing distance when measured on the same path with constant radiated power density? (E-1)

#7 Why at the same monitoring point do measured nondirectional antenna to directional antenna directivity ratios exhibit widely different values when measured on different dates with the same radiated power density? (Also, at certain distances, exhibit the same effect in question #6.) (E-2, E-3, E-4)

#8 Why do nearby monitoring points measured on the same radial at the same time exhibit significantly different nondirectional to directional directivity ratios?

OBSERVED SEASONAL VARIATION EFFECTS BASED ON MEASURED DATA

High measured nondirectional radiated field values directly relate to corn growth cycle.

Measured difference in nondirectional antenna field values over the same path have little direct relation to measured directional antenna field values over the same paths.

Yearly average measured nondirectional antenna field value difference on the same radial at near-by monitoring points is near the calculated free space difference.

Measured directional antenna seasonal variations greatly exceed and do not relate to current and phase distributions in the directional array.

Rainfall and drought have little effect on measured data.

Tower icing and partially frozen ground during freeze transitional periods drastically effect measured field values.

Measured seasonal variation on flat, highly conductive (30 ms/m) farm land increases with vegetation height near the array (0-30 miles). The ratio of variation increases as distance decreases.

Measured far-field conducted radiation (30 plus miles) decreases with vegetation height. (Probably due to dielectric losses.)

Conclusion: It becomes very clear when trying to correlate the simultaneous NDA and DA field differences that there must be a fundamental reason for the dramatic NDA to DA variation over the same path. Examination of only the amplitude differences yields no obvious conclusion. Therefore phase (timing) differences and the resulting amplitude variations have to be the cause. When one thinks of a DA array as individual NDA radiators located at various distances from the observer the cause becomes obvious. The DA variations are being caused by phase delay. The DA energy arriving at the observation point from each tower has completely different phase (timing) characteristics from the original signal launched from the towers, traveling in free space.

Dielectric phase delay makes surface field measurement of conducted radiation in deep pattern nulls a poor indicator of exact array pattern performance.

L. T. Killion
Director of Engineering
Nebraska Rural Radio Assn

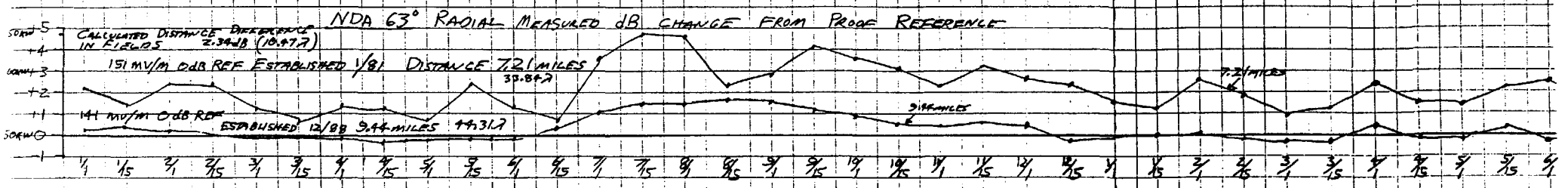
50KW NDA SEASONAL VARIATION FROM ESTABLISHED MONITOR POINT VALUES

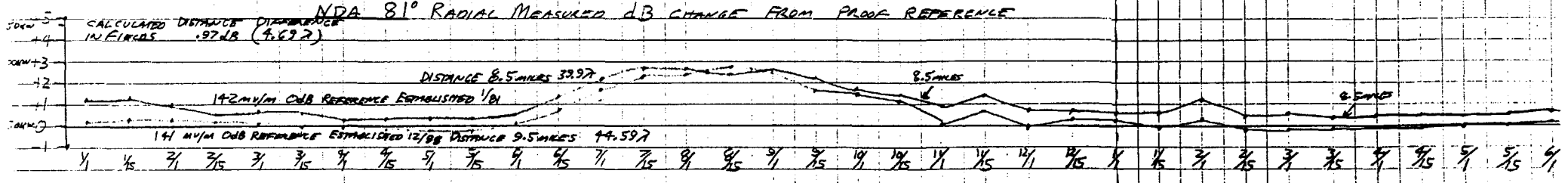
E-1

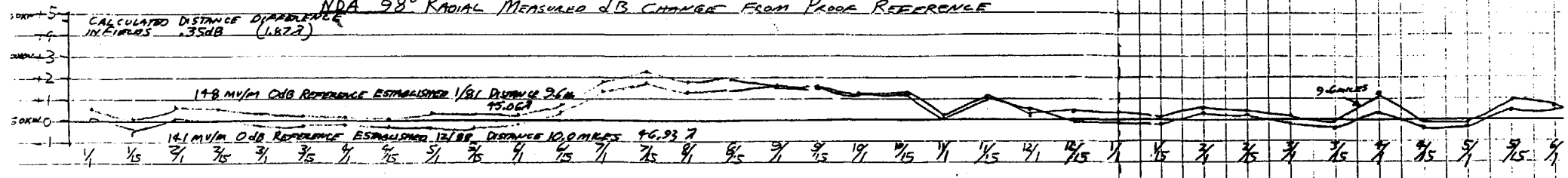
SAME RADIAL
DIFFERENT MONITORING POINTS

1991 DATA

1992 DATA







ALL MEASUREMENTS MADE WITH FIM-41 & CONSTANT 50KW NDA POWER DENSITY

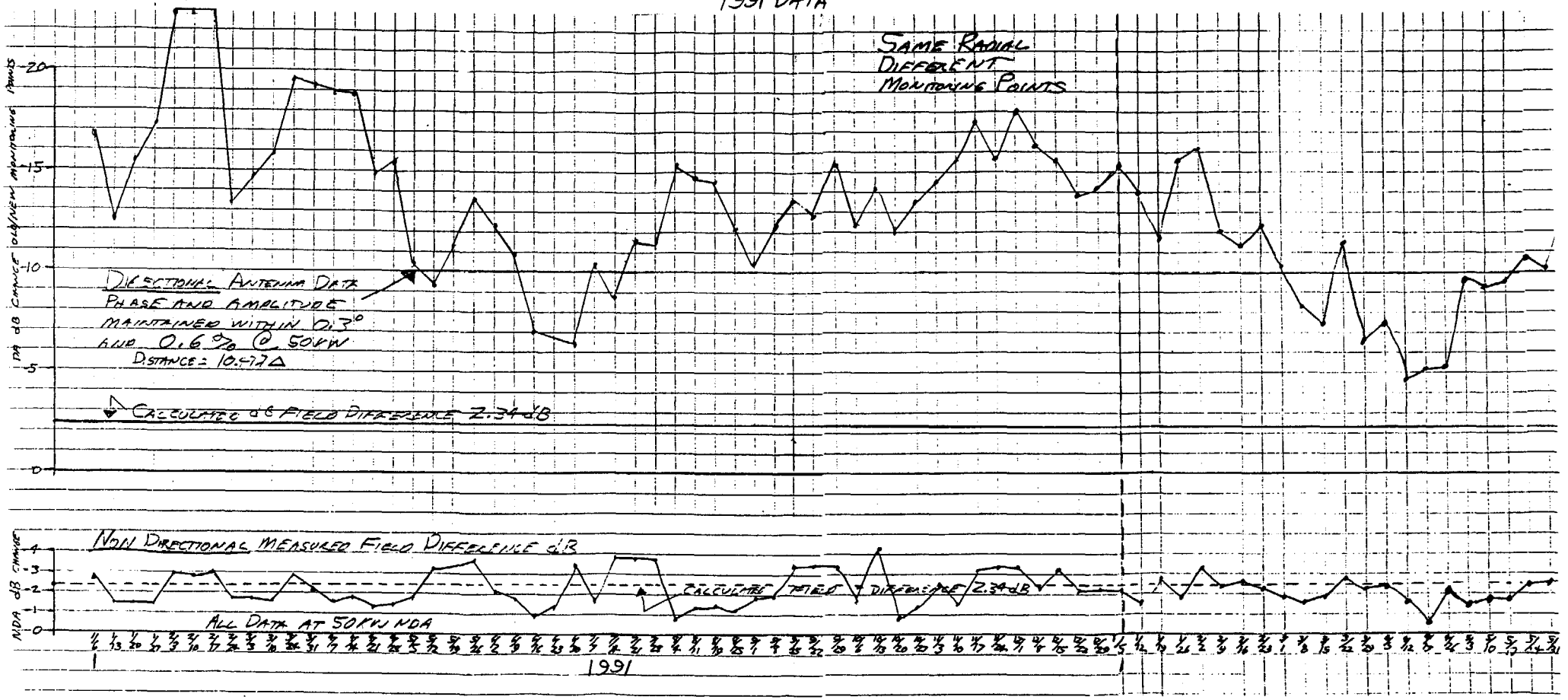
$$dB = 20 \log \frac{\text{MEASURED VALUE } E \text{ mV/M}}{\text{PROOF VALUE } E \text{ mV/M}}$$

ALL MEASUREMENTS MADE AT CONSTANT 50KW ANTENNA INPUT POWER.

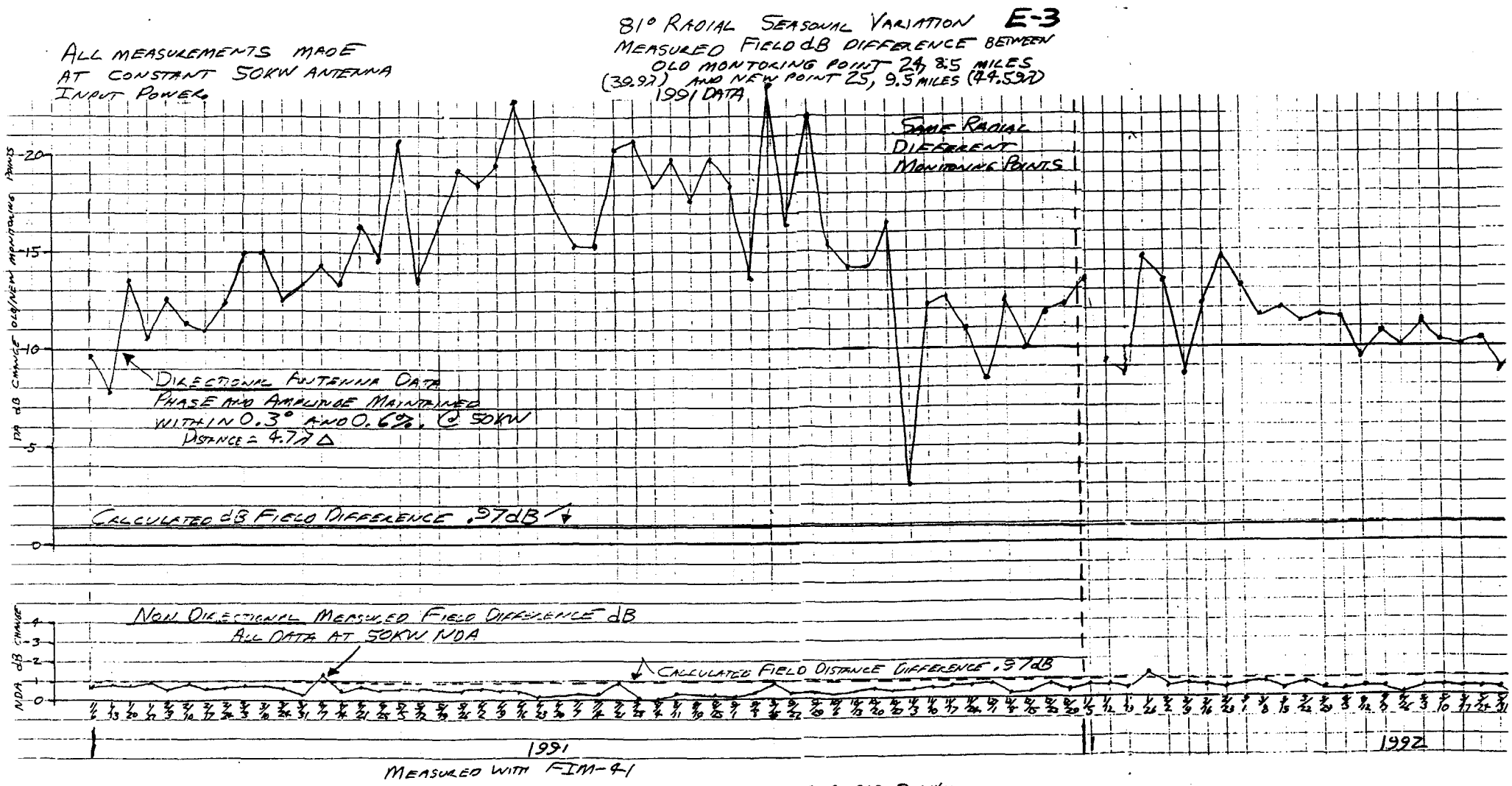
63° RADIAL SEASONAL VARIATION
MEASURED FIELD dB DIFFERENCE BETWEEN
OLD MONITORING POINT 18, 7.21 MILES (33.647)
AND NEW POINT 20 AT 3.44 MILES (44.317)

E-2

1991 DATA



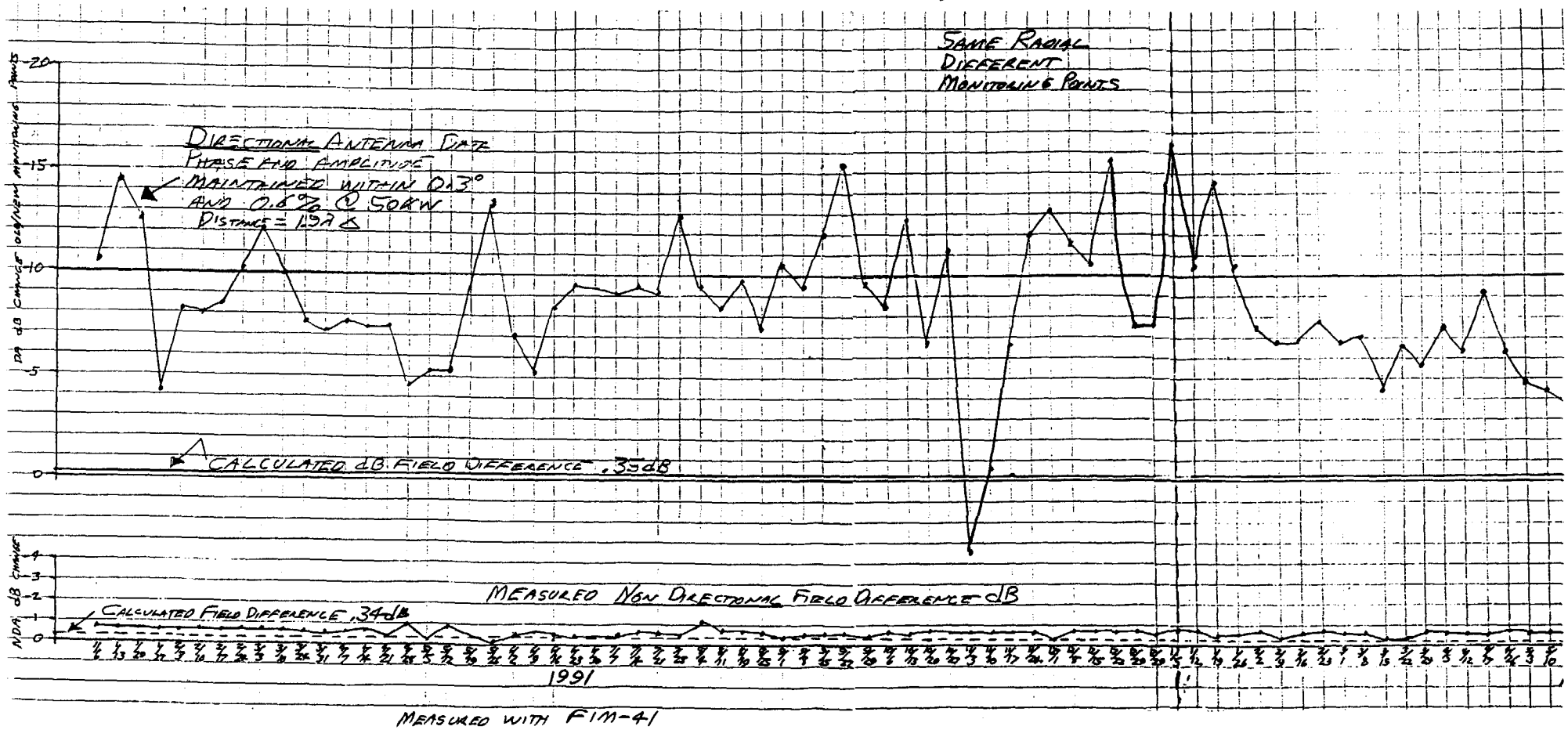
$$dB = 20 \log \frac{\text{MEASURED OLD } E \text{ MV/M}}{\text{MEASURED NEW } E \text{ MV/M}}$$



81° RADIAL SEASONAL VARIATION E-3
MEASURED FIELD dB DIFFERENCE BETWEEN OLD MONTORING POINT 24, 8.5 MILES (39.9λ) AND NEW POINT 25, 9.5 MILES (44.59λ)
1991 DATA
ALL MEASUREMENTS MADE AT CONSTANT 50KW ANTENNA INPUT POWER.
SAME RADIAL DIFFERENT MONITORING POINTS
DA dB CHANGE OLD/NEW MONITORING POINTS
DIRECTIONAL ANTENNA DATA PHASE AND AMPLITUDE MAINTAINED WITHIN 0.3° AND 0.6%. @ 50KW DISTANCE = 4.7λ Δ
CALCULATED dB FIELD DIFFERENCE .97dB
NON DIRECTIONAL MEASURED FIELD DIFFERENCE dB
ALL DATA AT 50KW NDA
NDA dB CHANGE
CALCULATED FIELD DISTANCE DIFFERENCE .97dB
1991
1992
MEASURED WITH FIM-41
dB = 20 LOG MEASURED OLD E mV/m / MEASURED NEW E mV/m

ALL MEASUREMENTS MADE AT CONSTANT 50KW ANTENNA INPUT POWER.

98° RADIAL SEASONAL VARIATION L-T
MEASURED FIELD dB DIFFERENCE BETWEEN OLD MONITORING POINT 24 9.6 MILES (45.067) AND NEW POINT 25, 10.0 MILES (46.937)



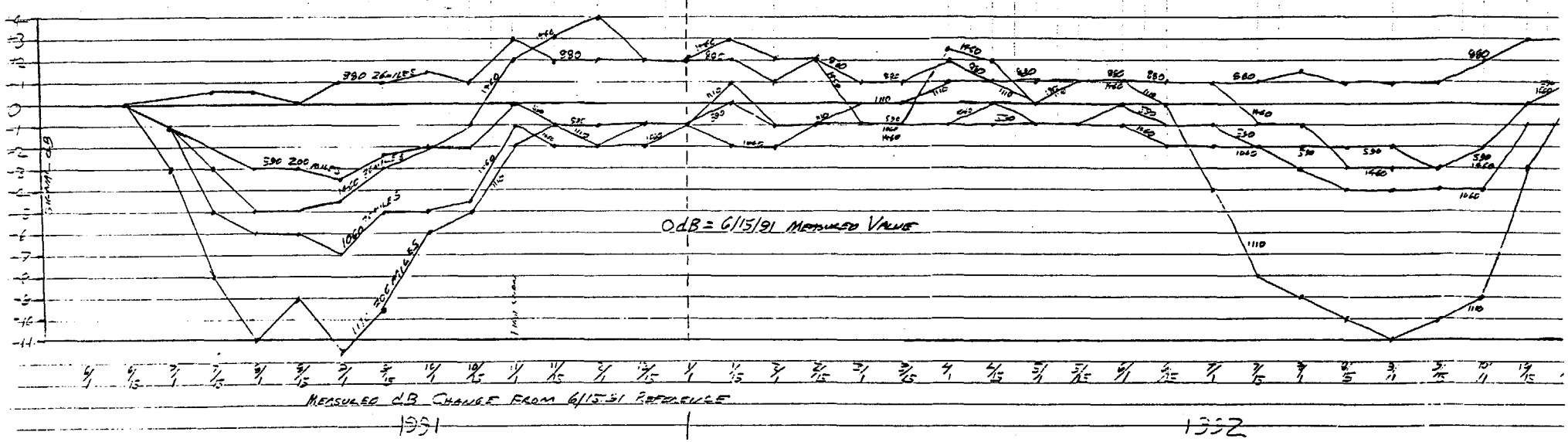
MEASURED WITH FIM-41

$$dB = 20 \log \frac{\text{MEASURED OLD}}{\text{MEASURED NEW}} \frac{E\ mv/m}{E\ mv/m}$$

DAYTIME SEASONAL VARIATION OF RELATIVE OFF AIR SIGNAL LEVELS AS MEASURED IN 100' SELF SUPPORTING TOWER (BASE GROUND CURRENTS)

MEASURED WITH RYCOM 3126A SELECTIVE VOLTMETER

E-5

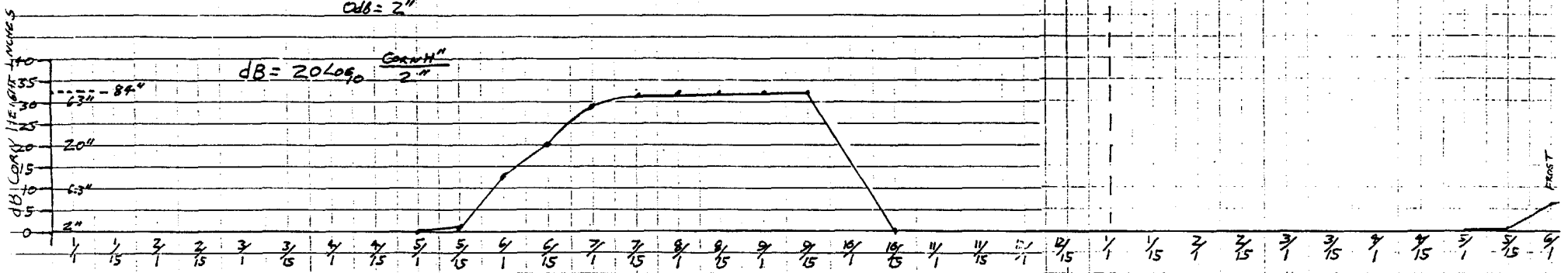


E-6

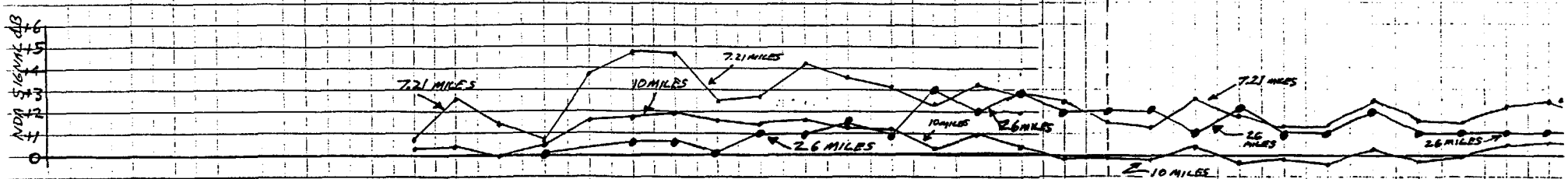
1991 CORN HEIGHT DATA

0dB = 2"

$$dB = 20\log_{10}\frac{\text{CORN H}''}{2''}$$



CHANGE IN AVERAGE OBSERVED CORN HEIGHT AT TRANSMITTER SITE 1991



50KW NDA MEASUREMENTS AT DIFFERENT DISTANCES
CHANGE IN MEASURED FIELD
DATA FROM E-1 AND E-5

1991

CERTIFICATE OF SERVICE

I, Judith L. Gerber, do hereby certify that a true and correct copy of the foregoing "Comments of the National Association of Broadcasters" in MM Docket No. 93-177 was sent, via first class mail, on this date, October 29, 1993, to the following:

Roy J. Stewart, Chief
Mass Media Bureau
Federal Communications Commission
1919 M Street, NW
Room 314
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 Hassinger
Assistant Chief (Engineering)
Mass Media Bureau
Federal Communications Commission
1919 M Street, NW - Room 314
Washington, DC 20554

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

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

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

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

Robert M. Silliman, P.E.
Silliman & Silliman
Consulting Engineers
8121 Georgia Avenue, Suite 700
Silver Spring, MD 20910

Judith L. Gerber

Judith L. Gerber