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

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

To: The Commission

Reply Comments of Hammett & Edison, Inc.

The firm of Hammett & Edison, Inc., Consulting Engineers (H&E) submits the following comments in response to the Notice of Inquiry in the above referenced proceeding.

Qualifications

The firm of Hammett & Edison, Inc. was founded by Robert L. Hammett, P.E. in 1952 following his six years of experience as a partner in the firm of A. Earl Cullum, Jr., Consulting Engineers, Dallas, Texas. The Cullum firm, founded in 1936, was a pioneer in the design and construction of directional antenna systems. Both the Cullum firm and Hammett & Edison have specialized in complex directional antenna systems and have been among the leaders in the application of modern techniques to the broadcast industry. The fact that the current distribution on towers in a directional antenna system is not sinusoidal in amplitude or constant in phase has been known by most antenna engineers for a great many years. In 1948, Mr. Hammett was involved in the design and construction of a six-tower end-fire directional antenna system in which the tower heights were intentionally made unequal to create as closely as possible the desired sinusoidal distributions. The method of moments and its predecessors has been used by H&E for many years, beginning in 1964 with mainframe computers using punch cards. At that time we were assisted by the late physicists Robert Tanner and Mogens Andreasen using proprietary methods to analyze non-flat ground systems and reradiation from external structures.

Hammett & Edison pioneered the use of toroidal base-current sampling transformers several years before such equipment became commercially available. Hammett & Edison developed a computerized method for extracting data from the M3 soil conductivity map and a program for

projecting AM coverages by the equivalent-distance method and the Commission's propagation curves. A complete system to project the ground-wave coverage of directional antenna systems was developed and sold to the Federal Communications Commission in 1979, for its own use. In 1966, H&E developed a computer method for optimizing the location and excitation of towers in directional antenna designs to meet arbitrary radiation limits; many stations have since been built using such designs by H&E. Mr. Edison is the author of two chapters on AM directional antenna systems in the current NAB Engineering Handbook. In 1992, Mr. Hammett and Mr. Edison were honored by the National Association of Broadcasters with the Radio Engineering Achievement Award, the citation for which included "For pioneering the development of innovative technical systems and techniques for broadcasting."

Long before it became possible to calculate tower current distribution, Mr. Hammett routinely measured the actual distribution of current on each tower as an aid in the proper adjustment of the array. An example is attached of an array that was adjusted some 45 years ago very close to its final pattern by using the measured current distribution and the sampling system alone; the pattern was subsequently proven by aerial measurements with very few measurements on the ground. Because of the care taken in the adjustment and documentation process, the Federal Communications Commission approved that procedure in the year 1949. Attachment A shows two pages from the proof of performance report.

General Comments

Hammett & Edison is pleased to join the Commission's efforts to update the AM broadcast engineering technical rules. We commend those engineers in the consulting profession and at broadcast stations who have initiated this review, which clearly can benefit the broadcast industry by concentrating FCC requirements only to those areas of essential technical showings, thereby reducing the present high cost of constructing and maintaining standard broadcast stations. Our Comments reply to comments previously filed in this docket by Moffett, Larson & Johnson, Inc.; duTriel, Lundin & Rackley, Inc.; Suffa & Cavell; Silliman and Silliman; and Hatfield & Dawson.

Certain modern techniques, such as the moment-method analysis, should be receiving wider use by the broadcast industry than is the case today. We do not, however, share some expressed opinions that most of the internal and external measurements that have been required to license directional antenna systems are no longer necessary. Specifically, we feel it is necessary to recognize that AM directional antenna systems usually must generate deeper nulls in more directions than FM directional antennas and that the environment in which they must perform is

seldom ideal. While H&E has long used moment-method techniques for the design of directional antenna systems, such methods cannot, in our opinion, provide adequate assurance that a given directional antenna system is operating properly. For that reason, we do not favor the elimination of monitoring point measurements; these are a low-tech and independent check on whether a directional antenna is performing approximately as it was authorized. We recognize that variations of monitor point readings can be caused by change of season and environment but, nevertheless, monitor points are quite useful in the day-to-day and year-to-year maintenance of correct operations.

Some comments have been filed to the effect that FM directional antennas have performed well without the extensive field engineering that has been needed for AM stations. We think the comparison is not valid. FM antennas are not usually measured at all; those that are measured are tested in a controlled environment and should be installed on a tower that is a replica of their test jig. They are usually erected a great distance in wavelengths from any reflectors that were not modeled on the range. In contrast, field strength measurements are needed for AM directional antennas because they are not built in a controlled environment and that environment is subject to change.

Internal measurements alone, even if supplemented by theoretical studies such as the method of moments, which may not accurately model the environment, cannot give assurance of an AM array's performance. It should be pointed out that various moment-method programs do not yield the same estimates of impedance or of tower current distribution. The quality of such analyses also depends on the judgment of the engineer constructing the model and the capacity of his computer. It is our considered opinion that antenna radiation can only be properly determined by field strength measurements.

Certainly, our experience shows that some of the technical requirements in the Commission's Rules, particularly those involved in proofs of performance, do not provide technical information commensurate with their cost. We feel that numerous simplifications in the Rules could be made with no loss of assurance that directional antennas are performing properly and that this should be the proper focus of a proposed rulemaking that the Commission may issue as a result of the instant inquiry.

Some stations undoubtedly are "basket cases," operated by licensees having scant regard for the Commission's Rules or for good engineering practices. In some cases, a modernization of the Rules could well permit better compliance by virtue of reducing the financial burden of such

compliance. Restoration of a neglected array to proper operation usually requires only a partial proof of performance. We believe that simplified, and therefore less expensive, proof-of-performance rules may indeed encourage stations to restore or improve their facilities.

Insofar as possible economies are concerned, we agree with some of the comments previously filed that fewer field strength measurements are needed. As a practical matter, an expert engineer can determine, with relatively few measurements on critical radials, whether a directional pattern is satisfactory before he directs the taking of the extensive field measurements needed for a full proof of performance. The full proof provides essentially no additional information on the performance of the system. We recommend that the number of measurement radials be reduced just to those in the critical directions, with one additional radial in each major lobe.

Further, the length of the measurement radials can be reduced substantially. Generally speaking, any measurements beyond a few kilometers provide no additional information on radiation, unless strong near-field effects or reradiation from distant objects are present. Those distant measurements out to twenty miles required for the past 50 years have primarily given information on soil conductivities, which was useful many years ago in developing the M3 soil conductivity map. Since it does not appear likely that the soil map will be revised, we are recommending that no measurements be required beyond 10 kilometers from the station. We support a discontinuation of the distinction between partial and full proofs of performance.

We believe it is useful to inform the Commission in tabular form of those measurements together with graphs to facilitate analysis. However, in our opinion, there is no necessity for providing the Commission with copies of the maps showing locations of all measuring points. These maps often have been unreadable reductions of the originals, which typically are plotted on $7^1/_2$ minute quadrangles. We recommend, of course, that stations or the consulting engineers retain the original field maps for possible future use, but that no maps be required for proofs of performance.

One major change that we recommend is the deletion of any requirement for minimum radiation efficiency. In the early days, when technical knowledge was not so widespread, it was important for the Commission to establish criteria to be certain that new stations were built with adequate coverage. It is our opinion that the present highly competitive market will ensure that each owner will try to achieve as much coverage as is possible without causing interference in excess of that permitted by the Rules. If a broadcaster wishes to use an inefficient antenna system with a low height that he could install in an urban location (offset with greater transmitter power), we believe that it would be in the private interest of the broadcaster as well as in the public interest to permit

such an installation. Extensive studies have been made by Hammett & Edison using moment-method techniques to develop effective antennas of low physical height. Similar studies have been conducted by others, including the National Association of Broadcasters. It is apparent that physical factors will require antennas to have at least a certain minimum size to develop adequate RF bandwidths but, beyond that limitation, inefficiencies can be compensated by additional transmitter power, which we think the Commission should explore.

Specific Rule Sections

To facilitate the transmission of our opinions on the various factors, we are listing our comments below on particular Rule sections. Some of our comments are prompted by comments of other consulting engineers who have already expressed opinions in this matter.

Section 73.14. Retain "critical" arrays. The FCC in its recent actions has been trying to reduce interference among stations; relaxing the present controls on critical arrays would run counter to the present efforts. We also note that critical arrays were "squeezed in" and in many cases there are contractual agreements between stations that require the maintenance of critical arrays within tight tolerances.

Section 73.44. Specify measurement in the main lobe of a directional station for the field strength of both carrier level and all spurious emissions. If local reflections are present, such measurements should be made at several different locations in close proximity to the transmitter. Measurements at the transmitter output may not be valid because of the frequency selectivity of the antenna coupling system. The impedance level of the load presented to the transmitter at harmonic and spurious frequencies can depart greatly from 50 ohms and invalidate power determinations based on voltage or current samples. However, measurements of the "RF mask" within 20 kHz of the carrier can be made at the transmitter output.

Section 73.45. Delete requirement for minimum radiation efficiency. Such requirements are unduly restrictive of creative solutions. Market forces are sufficient to insure that stations will attempt to cover as much as possible.

Section 73.51. Permit dissipative resistors on negative towers.

Section 73.54. Delete requirements to measure impedance over a band of frequencies. Although not needed by the FCC, measurements across a band will be taken by a conscientious engineer to help ensure that adequate bandwidth and audio quality is obtained. The use of direct-reading

power meters is acceptable provided they are installed at a 50-ohm impedance level. When such meters are installed, it is recommended that they also be capable of indicating VSWR.

Section 73.58. Delete requirements for base current ammeters. We recommend, but would not require, such meters as a double check on array operations. Also permitted should be the monitoring of base voltages.

Section 73.61. Retain monitoring points. These are an inexpensive, low-tech double check on array performance, not requiring access to the transmitting plant.

Section 73.62. Retain tolerances and permissible variances. However, it is recommended that the matter of tolerances be revisited. Towers having relatively low currents should not be held to tolerances as tight as the high-current towers. The current ratio tolerances for each tower should be specified as a percentage of the reference tower current.

Section 73.68. Retain sampling system requirements.

Section 73.151. Reduce the number of radials to be measured to one in each major lobe and those in critical directions. Require additional radials to further define pattern shape if a request is being made for a modified standard pattern.

Section 73.154. Eliminate the requirement to measure beyond 10 kilometers. Eliminate the distinction between full and partial proofs. Require a showing of near-field effects if such are significant in the analysis of close-in measurements. Eliminate the requirement to file field maps with the FCC.

Section 73.158. Retain monitoring point requirements. [See comment on §73.61.]

Section 73.186. Delete requirements for measurements beyond 10 kilometers. [See comment on §73.154.]

Section 73.189. Delete requirement for minimum antenna height or minimum radiation. This would permit the use of low efficiency antennas in urban areas and greatly alleviate the problem of finding new transmitter sites and complying with aeronautical requirements.

Conclusion

Hammett & Edison supports the efforts being made by its colleagues and by the Commission to update the rules governing AM broadcast stations. In our considered opinion it is not possible, however, to eliminate all measurements outside the array and to do so could seriously compromise the integrity of the present allocations structure.

Respectfully submitted
Hammett & Edison, Inc.

/s/ Robert L. Hammett
Robert L. Hammett, P.E.

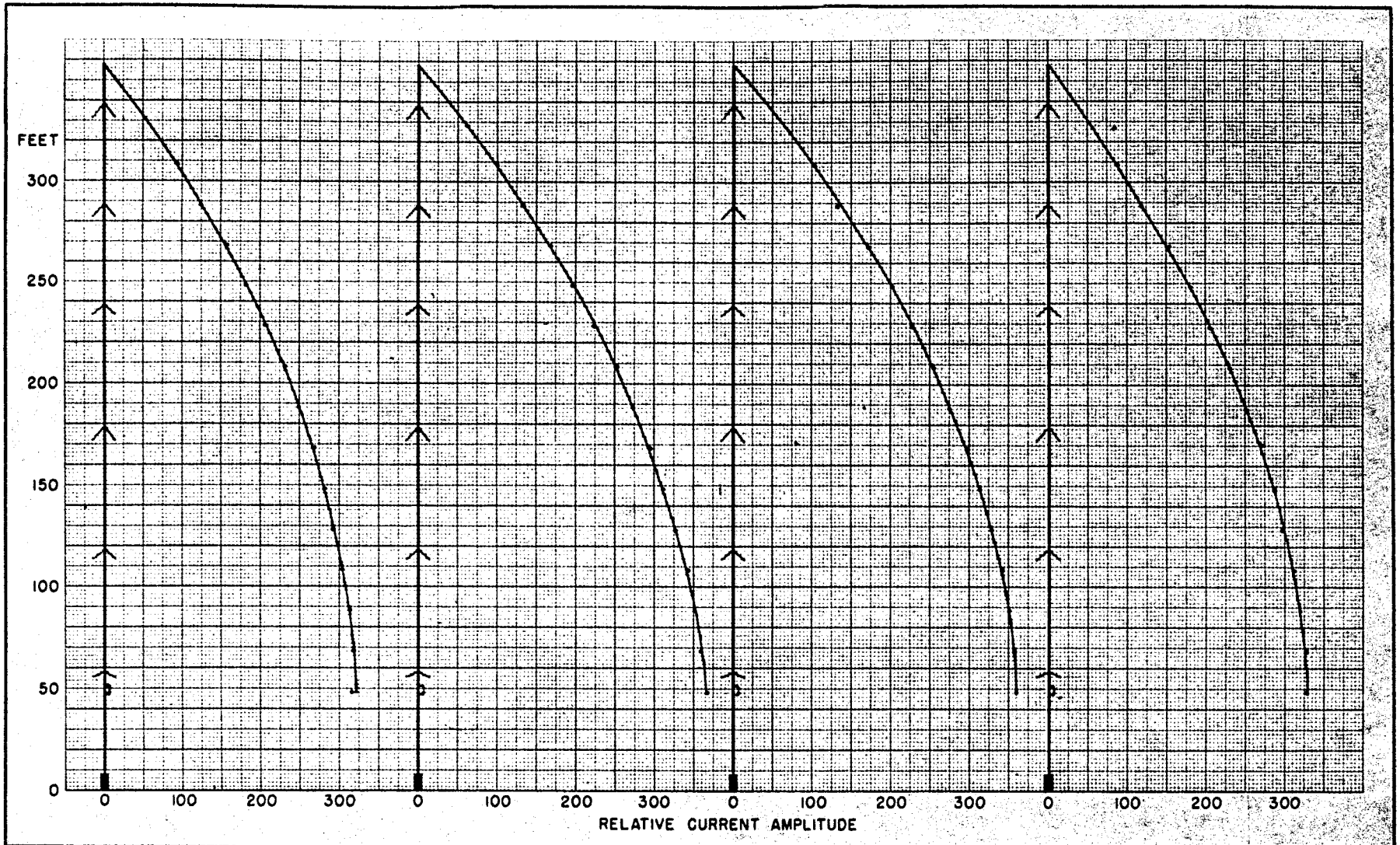
/s/ Edward Edison
Edward Edison, P.E.

/s/ William F. Hammett
William F. Hammett, P.E.

/s/ Gerhard J. Straub
Gerhard J. Straub, P.E.

February 25, 1994

HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
SAN FRANCISCO



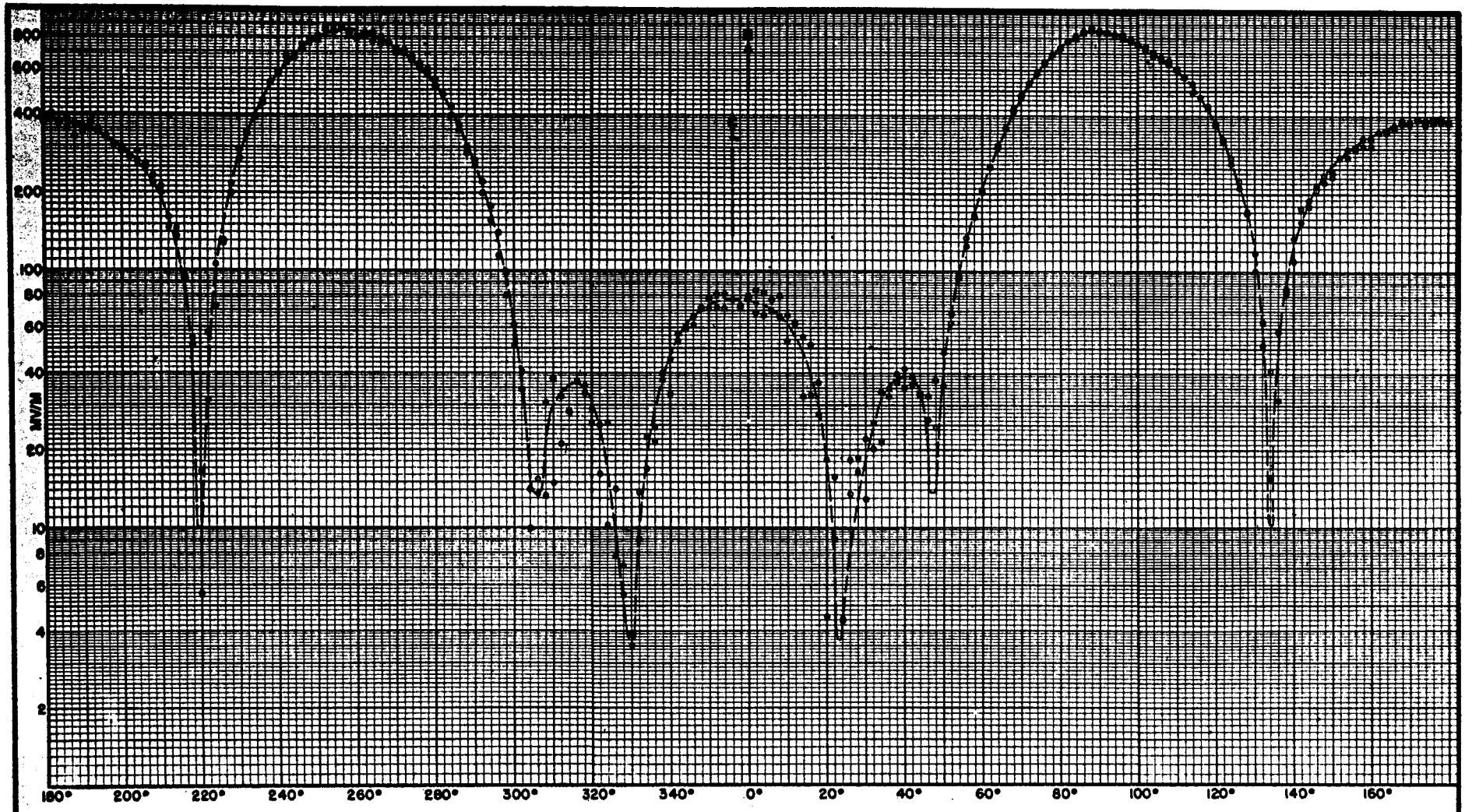
TOWER NO. 1	TOWER NO. 2	TOWER NO. 3	TOWER NO. 4
72.6 MA.	86.0 MA.	82.4 MA.	78.6 MA.

LOOP CURRENT MONITOR INDICATIONS

A. EARL CULLUM, JR.
CONSULTING RADIO ENGINEERS
DALLAS TEXAS

RADIO STATION WWEZ
690 KC 5 KW DA-N
490329 FIGURE 4C

HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
SAN FRANCISCO



MEASURED UNATTENUATED RADIATION PATTERN
DETERMINED BY AERIAL MEASUREMENTS

• RATIO MEASUREMENTS AT 4 MILES
◦ RATIO MEASUREMENTS AT 5 MILES

A. EARL CULLUM, JR. CONSULTING RADIO ENGINEERS DALLAS TEXAS	RADIO STATION WWEZ 690 KC 5 KW DA-N 490329 FIGURE 9B

940225
Attachment A2

HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
RADIO AND TELEVISION

WILLIAM F. HAMMETT, P.E.
DANE E. ERICKSEN, P.E.
GERHARD J. STRAUB, P.E.
STANLEY SALEK, P.E.
ROBERT D. WELLER, P.E.
DEVENDRA BILLIMORIA

Consultants to the Firm
ROBERT L. HAMMETT, P.E.
EDWARD EDISON, P.E.
HARRISON J. KLEIN, P.E.

BY FEDERAL EXPRESS

March 1, 1994

Mr. William F. Caton
Office of the Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Re: MM Docket 93-177

Dear Mr. Caton:

It has come to our attention that a phrase used in our recently filed Reply Comments to Mass Media Docket 93-177 may be misinterpreted. As a result, we would like to clarify that phrase and amend our Comments by this letter. On pages 4, line 10, and 6, line 14, of our Comments, the phrase "critical directions" should read "the directions of pattern minima critical to the definition of the pattern shape." Three copies of this letter are enclosed.

We appreciate the opportunity to avoid any misinterpretation.

Sincerely yours,

/s/ William F. Hammett

William F. Hammett

tg

Enclosures (3)

cc: Mr. Wallace E. Johnson, P.E.
Mr. Ronald D. Rackley, P.E.
Mr. Benjamin F. Dawson, P.E.
Mr. William P. Suffa, P.E.
Mr. Robert M. Silliman, P.E.

Telephone:
415/342-5200 San Francisco
202/396-5200 DC • 415/342-8482 Facsimile

Mail:
Box 280068
San Francisco, California 94128-0068

Delivery:
1400 Rollins Road
Burlingame, California 94010-2304