F.C.C. 71-39

BEFORE THE

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

In the Matter of AMENDMENT OF PART 73 OF THE COMMISSION'S RULES TO SPECIFY, IN LIEU OF THE EXISTING MEOV CONCEPT, A STANDARD METHOD FOR CALCULATING RADIATION FOR USE IN EVALUATING INTERFERENCE, COVERAGE AND OVERLAP OF MUTUALLY PROHIBITED CONTOURS IN THE STANDARD BROADCAST SERVICE	Docket No. 16222

REPORT AND ORDER

(Adopted January 13, 1971; Released January 18, 1971)

BY THE COMMISSION: COMMISSIONER H. REX LEE ABSENT; COMMISSIONER HOUSER NOT PARTICIPATING.

1. Having fully considered the comments filed in response to a Notice of Proposed Rule Making issued in this proceeding in October, 1965, the Commission, on November 19, 1969, adopted a Further Notice, which embodied a proposed disposition of this matter substantially at variance with that set forth in the original notice. New comments were requested on or before February 9, 1970, and reply comments on or before March 13, 1970. Those dates were subsequently extended to April 9, 1970 and May 13, 1970.

2. In the Further Notice, the Commission proposed that for determinations of service provided and interference caused by a station utilizing a directional antenna, the basic radiation pattern employed be one in which the radiated fields, theoretically determined with a loss resistance of not less than one ohm assumed at the current loop of each array element, would be enlarged by two factors, one of which, a value equal to 3 percent of the root sum square of the fields of the individual elements, or 6 millivolts per meter, whichever was the greater value, multiplied by the vertical field distribution factor $f(\theta)$ for the shortest element in the array, would be added in quadrature to the theoretically determined radiation, and the other, equal to 5 percent of theoretically determined field in each direction, multiplied by $f(\theta)$, as defined above, would be added linearly to the field in that direction. It would require that the RMS of the pattern meet the requirements of 73.189(b)(2) of the rules, and specific justification by the pattern designer, if a loss resistance greater than one ohm were utilized in the computation.

3. Measured fields could not exceed those indicated by the radiation pattern computed as described above. If this nevertheless occurred, these alternative procedures were to be followed, as appropriate:

(1) If a measured field in excess of that depicted on the pattern results in interference to any other station, the input power to the antenna must be reduced, to limit the measured field to the level depicted on the pattern, or

(2) If the excess radiation does not result in objectionable interference, a modified pattern must be submitted encompassing all measured fields, which will replace the original pattern for all service and interference determinations.

4. The Commission indicated its intention of adopting a procedure proposed by the Association of Federal Communications Consulting Engineers (AFCCE) and outlined in Appendix B to the Further Notice, to be employed by applicants where it is desirable or necessary to expand the basic pattern in particular directions.

5. In its comments, AFCCE had proposed when a proof of performance is made of a directional array, that the final result be submitted to the Commission only as a tabulation of measured values. A measured pattern would not be required. It suggested this procedure so that there would be, for each station employing a directional antenna, only a single radiation pattern available for each mode of directional operation, and confusion would be avoided as to the pattern to be employed in studies involving that station. The Commission did not adopt this proposal, noting that its implementation would leave the Commission without a readily available means for determining whether each station, in actual operation, is providing the minimum required service (there may be cases in which the measured fields fall seriously below the fields depicted on the proposed pattern). Further comments were requested on this aspect of the matter.

6. While the Further Notice proposed that a modified pattern for an existing station be prepared in general accordance with the procedures specified for new stations, it discussed the circumstances under which departures from this procedure might be desirable or necessary.

7. With respect to proposals that we, in effect, establish two patterns, one to which the operating fields would be adjusted, and a second, somewhat larger pattern for service and interference determinations—in this way providing for inevitable fluctuations of measured fields, especially in pattern minimums, about the adjustment values, we emphasized that we expected patterns would be designed providing a reasonable tolerance, in each protected direction, between the computed field and the maximum permitted field in that direction, to provide for day-to-day operating variations. Where these tolerances were unduly small, we would require a special showing of means by which the radiated fields would be maintained close to their computed values

8. Finally, we indicated the conditions pursuant to which we might contemplate a waiver of the proposed rules to permit the employment of radiation patterns depicting radiated fields lower than 3 percent of the RSS of the array fields.

9. We have received timely comments in this proceeding from the following parties: Columbia Broadcasting System, Inc. (CBS); Robert A. Jones, Consulting Engineer (Jones); Association of Federal Communications Consulting Engineers (AFCCE); A. D. Ring and Associates (Ring); Clear Channel Broadcasting Service (CCBS);

Association on Broadcasting Standards, Inc. (ABS); A. Earl Cullum and Associates (Cullum); and WCAR, Inc. (WCAR).

The majority of those commenting agree generally with the proposals set forth in the Further Notice, but modifications or additions are suggested by several of the parties. A number of the matters raised can be disposed of rather simply, and we will address ourselves to these initially.

10. First, we note that AFCCE suggested the need for a better definition of terms. "For example, the distinction between the theoretical and computed pattern should be clearly defined." We have heretofore used the term "computed pattern" to describe the radiation envelope obtained by adding to the theoretical pattern linear and orthogonal components of specified size. However, the theoretical pattern is obviously a "computed" pattern, and we recognize that the continued use of the term to identify the enlarged pattern may lead to misunderstandings. Accordingly, we have decided to use the terms "standard pattern" or "standard radiation pattern" interchangeably to identify the enlarged pattern. These terms are defined in the appended rules, will be used henceforth in our discussion of this matter, and will be substituted for "computed pattern" when we summarize comments.

11. In setting the size of the orthogonal component as 3 percent of the RSS of the fields of the array, we, in effect, accepted the radiation "floor" of 3.5 percent of the theoretical pattern RMS proposed by AFCCE and somewhat arbitrarily set the RSS component at a lower figure in recognition of the fact that, in the majority of arrays, the RSS exceeds the RMS value. While ABS and CCBS [1] accept the 3 percent figure, AFCCE and Cullum both suggest that the differential may be more precisely determined—that the median ratio of RSS to RMS for a large number of existing arrays which they have studied is 1.4. Accordingly, an appropriate value for the orthogonal component is 3.5/1.4, or 2.5 percent of the array RSS. Jones opposes the setting of any minimum radiation level based on the array RSS.

12. Jones is alone in his position on this point. We will accept the modification offered by AFCCE and Cullum and establish the size of the orthogonal component as 2.5 percent of the array RSS.[2]

13. Several parties point out that we have proposed an absolute floor on pattern radiation of 6 mv/m, without regard to station power; while this is a satisfactory value for 1 kilowatt, it may be inadequate for stations of higher power. Ring notes that for array designs having RSS/RMS ratios appreciably less than 1 and powers in excess of 1 kilowatt, a minimum of only 2.5 percent of the RSS of the array may represent a value, which, in practice, is too low to be achieved and maintained. For such cases, a higher floor should be provided. It suggests, as do others, that the 6 mv/m value be multiplied by the square root of the station power expressed in kilowatts, that is, the orthogonal component be 2.5 percent of the array RSS or $6\sqrt{Pkw}$, whichever is higher (either, of course, multipled by f (θ) for the shortest tower in

[1] But for the limited purpose of establishing the radiation pattern by conventional methods. See discussion of CCBS, pp. 10–11.

[2] While it may be obvious, we think it well to emphasize that the RSS value to be employed in the determination of the size of the orthogonal component is from the element field amplitudes which produce the theoretical pattern.

the array). Adoption of this standard would mean the setting of a radiation floor as low as 3 mv/m for stations with power of 250 watts, whereas, under the Commission's proposal, the lowest permissible radiation from a station of this power would be 6 mv/m. While we are persuaded of the general desirability of relating the radiation floor to power level, our examination of numerous proofs of performance has convinced us that inverse fields from a directional antenna appreciably below 6 mv/m are extremely difficult to establish accurately, and to maintain by monitoring observations. Accordingly, the rules which we adopt set a 6 mv/m minimum for powers of 1 kilowatt and less, with this figure multiplied by the square root of the power in kilowatts for higher power levels.

14. There is rather general agreement that, in the design of the theoretical pattern, a minimum loss resistance of one ohm should be assumed at the current loop of each array element with the option of employing a higher loss resistance, if such use is supported by an adequate technical justification. Jones renews his arguments, advanced in the original proceeding, that in some arrays effective losses would be overstated with the one ohm allowance, and measured patterns may exceed the standard patterns in size in such instances. While there is some justification for assuming a smaller loss resistance for short towers (less than 90 degrees in electrical height), we see little need, even in such cases, for assuming a loss resistance of less than 1 ohm. We are providing, in the standard pattern, a 5 percent increase over the theoretical pattern size, and are specifying that the loss resistance be assumed at the base of towers less than 90 degrees in electrical height (in such towers the effect of the loss resistance will be less than if added at the current loop). With these provisions, it appears unlikely that the effect Jones sees will occur.

15. We are adopting the AFCCE procedure, set forth in Appendix B to the Further Notice, for augumentation of the standard pattern. This procedure would normally be applied in the development of a modified standard pattern, which will encompass measured fields where these fields exceed the levels depicted on the original standard pattern in one or more specific directions. However, it may also be appropriate for application to the original pattern, where, for instance, it is desired to provide additional fill for one of two symmetrical nulls.

16. Ring argues that there is little justification from an engineering standpoint, and no useful purpose will be served by the addition of a "patch" to the radiation pattern where the measured field exceeds the pattern in a direction where there is no protection requirement, and such an uncorrectable excess should be ignored in the allocation process.

17. This argument appears to overlook the fact that the standard pattern established for each station defines, at the same time, not only the limits within which the station must operate, but also the rights of the station to radiate specific fields in specific directions. While interference considerations may place no limit on the inverse field produced by a station in a particular direction at the time the station is authorized, the value of this field may become critical if a new station is subsequently assigned to the channel in that direction from the existing station. The new station enjoys protection from the existing station based on the radiation shown on the existing station's pattern.

If we followed the procedure advocated by Ring, the existing station may have been allowed to radiate more in that direction than the standard pattern depicts. While the excess radiation, from an engineering standpoint, may not have significant practical impact, it is quite clear that, should the existing station ever have occasion to make a new proof of performance, it would be required to lower its inverse field toward the new station to the standard pattern value. Since the excess field was originally permitted only because it could not feasibly be separately reduced, the only recourse to the existing station at that point might be to reduce the input power to its antenna, with a consequent overall reduction in pattern size. Had the existing station been permitted to modify its standard pattern to include the excess radiation at the time it was first discovered, the latter restriction might have been avoided.

18. Thus, while we concede the validity of Ring's technical criticism, we find that from practical and legal standpoints we must apply techniques to insure that the standard pattern includes all measured fields. (If measured fields systematically exceed pattern fields, a modified standard pattern somewhat larger than the orginal may be employed, if interference considerations permit; otherwise, input power to the antenna must be reduced to restrict critical measured fields to the pattern values. However, where excess fields are measured only in limited pattern sectors, the application of the AFCCE "patch" would appear to be the most feasible solution of the problem.)

19. AFCCE is the only party who responded to our request for comments on its proposal that the end result of a proof of performance of a directional antenna be submitted to the Commission in the form of a tabulation of measured fields vs. azimuths—no graphical representation of the pattern would be supplied. The principal advantage to be derived from this procedure would be that possible confusion as to the radiation pattern which should be employed would be avoided, since each station's file would contain only its standard pattern.

20. Our concern with the employment of this procedure was expressed in connection with the question of whether there should be a limit placed on the minimum size of the measured pattern, envisaging a situation where the measured patterns might be so small that the actual coverage of a station falls seriously short of that predicted.

21. In the rule amendments outlined in the Further Notice, we proposed to require that the measured pattern have an RMS value at least as great as that specified in Section 73.189 of the rules for the class of station proposed. Cullum suggests that we stipulate that the measured RMS value equal or exceed the requirements of 73.189, or be at least 90 percent of the RMS of the standard pattern.

22. AFCCE urges that "it is unlikely under the stricter requirements instituted in recent years on proofs of performance that one would encounter abnormally distorted patterns affecting RMS and coverage. As the FCC itself points out, most distortions of the nature that greatly affect the RMS are more due to 'faulty analysis and measurement procedure'. In any event, if the Commission desires to ascertain the coverage actually achieved by a station, it can be determined from the measured data."

23. As AFCCE states, the measured RMS value and the coverage produced by the measured fields can be determined from the measure-

ment data.[4] The question is largely one of convenience. The availability of a measured pattern makes it easy to determine whether a serious departure from the standard pattern has occurred. We agree that under present procedures (and with the accumulated experience of engineers designing directional antennas) major discrepancies do not often occur. In recent years, such differences have usually resulted from the inadequate assessment and control of the losses occurring in antenna designs having high RSS/RMS ratios.

24. Because major discrepancies occasionally do occur, we cannot subscribe to AFCCE's position that we may safely assume that each measured pattern will be of adequate size. Therefore, while we will no longer require that a measured pattern be furnished in connection with a proof of performance, we will expect that a statement of the RMS value of such a pattern be included in the submission.

25. As to the minimum acceptable level for the measured RMS, we realize that for many arrays the predicted RMS field substantially exceeds that required by § 73.189, and an operating array which meets only this requirement may produce coverage which falls short of that predicted by a significant degree. Therefore, we are inclined to adopt Cullum's proposal. However, we believe that the alternative lower limit he proposes—90 percent of the RMS of the standard pattern—is somewhat too restrictive. In effect, Cullum would require that the RMS value of the measured pattern be at least 94.5 percent of the theoretical pattern RMS, which usually will be based on a 1 ohm element loss. In most cases, this theoretical value probably will not be exceeded by the measured value. On the other hand, we expect negative departures to be more frequent, and we believe that the floor Cullum proposes may be somewhat too high. Consequently, we will require that the RMS value of the measured pattern be at least 85 percent of the standard pattern RMS, or meet the minimum specified in 73.189 for the class of station involved, whichever is the higher value.

26. ABS notes that we have said that we will permit measured radiation to be initially adjusted up to the limits depicted by the standard pattern, but will question the feasibility of a directional proposal where a reasonable tolerance is not provided between the standard pattern field in a particular direction and the maximum permissible field in that direction. ABS suggests that this tolerance should be sufficient to provide for increases in radiation resulting from day-to-day variations in the relative amplitudes and phases of currents in the array elements, and urges the Commission provide a standard in its rules for the establishment of an acceptable tolerance.

27. It states that Cullum had demonstrated in the earlier proceeding that such a time variant effect can be described in statistical terms, and offers the following criterion, presumably for inclusion in our rules.

> The computed directional pattern will be so designed as to provide that radiation of the array will not exceed the maximum permissible levels for protection purposes for more than 50 percent of the time.

[4] In fact, 73.151(a)(5) requires that the 25 and 5 mv/m contours be plotted from the measured data, and AFCCE has not proposed that this requirement be eliminated.

28. We have examined this proposal, and conclude that it neither offers an adequate basis for the protection of other stations (as we read it it would seem to condone radiated fields in excess of the levels required for the protection of other stations, as long as they do not occur more than 50 percent of the time—this seems to negate the concept of a tolerance, which ABS believes is necessary), nor offers specific guidance in the formulation of standards.

29. We think a reasonable test, acceptable to the Commission, of whether a sufficient tolerance has been provided between the standard pattern inverse field in a particular direction and the maximum permissible inverse field in that direction is to add in quadrature to the pattern value a quantity which Cullum had suggested in the original proceeding for use in determining the effect of internal array variations, namely: [5]

$$E_q = \frac{E_{rss} \times L}{1.64}$$

Where:

E_q is the tolerance to be added in quadrature to the pattern value in a direction toward an existing station.

E_{rss} is the RSS value of the fields in the array.

L is the tolerance, expressed as a decimal, within which an applicant undertakes to maintain deviations in array parameters.

With the constant 1.64, E_q is of a magnitude which will not be exceeded more than 10 percent of the time.

30. The test is applied separately for phase and amplitude variations, the value ascribed to L in each case representing an assessment of the accuracy with which the proposed monitoring facilities can detect variations in the particular parameter. Thus, if it is determined that the monitoring system is incapable of detecting current amplitude deviations smaller than 5%, 0.05 is used for L. Phase deviations are converted to decimal form for insertion in the above equation on the assumption that a 1 percent change in current ratio is equivalent to a 0.6 degree change in phase. If the monitoring system is considered capable of detecting phase changes of no smaller than ±3 degrees, this is reflected as a value for L of 0.05[6]. Generally, if it appears that L must be smaller than 0.05 if the permissible tolerance toward a protected station is not to be exceeded, the Commission will require a showing of the means which will be employed to insure those phase and amplitude deviations smaller than 3 degrees and 5 percent can be reliably observed. Also, since an array whose parameters must be held within tolerances much smaller than these may require fairly frequent adjustment, the showing must demonstrate that the facilities

[5] Such a test would be applied only in determining the acceptability of a standard pattern for a new station, or for an existing station proposing a major change. Alternatively, an applicant may submit a detailed stability study, in which the tolerable variations of current amplitude and phase, as determined for each element in the array, are related to the monitoring system proposed.

[6] The appropriate values for phase and current deviations should be no less than twice the repeatability of the monitoring system. This figure depends not only on the basic characteristics of the monitoring instruments, but on the stability of the sampling system when subjected to temperature changes, moisture, wind and vibration.

for making these adjustments are readily available to the operators on duty, and necessary corrections can readily be made.[7]

31. While we have specified in the rules no formal procedure under which uncorrected reradiation effects at a proposed antenna site would be evaluated and expressed by suitable allowances in the radiation pattern, we fully recognize the necessity for investigating and quantitizing conditions found at each site. However, it appears to us that the procedure suggested by Cullum for this purpose, or a similar one, can be applied more appropriately in determining whether a radiation pattern incorporating the degree of suppression required for the protection of other stations can feasibly be employed at a particular site. The inclusion of an orthogonal component computed as specified herein in the construction of the standard pattern assures only that the minimum fields depicted in the standard pattern will be no less than 2.5 percent of the array RSS. An analysis of re-radiation conditions in the vicinity of a proposed site may indicate that difficulties will be experienced in adjusting an array to such minimums. Under these circumstances, an appropriate additional amount of null fill, obtained by adjustment of the theoretical parameters of the array, should be indicated on the standard pattern to provide for the effects of re-radiation which are not susceptible to correction. However, if it appears that with the degree of null fill found necessary for this purpose the required level of protection will not be afforded other stations, the site may well be considered unsuitable for the proposed directional operation.

32. It has been the contention of CCBS in its comments in response both to the original and to the Further Notice that stations utilizing directional antennas which offer protection for other distant stations by severely restricting the fields radiated toward these stations, in fact, by a substantial margin fail to afford the degree of protection predicted by conventional methods. CCBS urges the adoption of more sophisticated procedures for interference evaluation, which take into account specific propagation phenomena and other effects occurring at points too distant from the directional antenna to influence measurements made to establish the required radiation pattern.

33. Absent the means for such a specific mathematical evaluation, or distant measurements in the individual case, it suggests that stations employing directional antennas be considered incapable of delivering at distant points signals of less intensity than would be produced by a radiated field approximating 10 percent of the horizontal pattern RMS (or RSS) value.

34. Whatever is done generally, CCBS believes that more stringent protection standards should be applied on the clear channels, where the path distances between stations are generally greater than on other channels, and protection requirements are greater.

35. In justifying its proposal with respect to skywave protection, CCBS describes experimental studies tending to support its conten-

[7] In such cases, the applicable tolerances will be specified in each station's license. The proceeding in Docket 18930 contemplates the possible relaxation of operator requirements to permit, under stated conditions, the routine operation of stations using directional antennas by holders of radio telephone third class licenses with broadcast endorsement. Stations whose licenses set forth specific tolerances for relative phase and amplitude variations would not be permitted to take advantage of such a relaxation, even if it were granted in other cases.

tion that ionospheric scattering and other effects defeat efforts to achieve protection of distant stations by utilizing directional radiation patterns in which the fields toward these stations are highly restricted.

36. With respect to groundwave radiation, CCBS advances the theory that re-radiation sources too distant from a directional array to affect measurements made to prove its radiation pattern, while individually perhaps not significant, are so numerous (*i.e.*, the number of sources increases as the square of the distance from the antenna) that their cumulative effect is far from insignificant. CCBS cites, as an example, the multiple sources of re-radiation one might expect to find in a city lying in the main lobe of a directional antenna some ten miles from the antenna. Measurements made in a different direction to establish a pattern null would not be affected appreciably by such re-radiation. However, it is contended that at some tens of miles from the antenna along the protected radial the distant re-radiation sources deliver a signal which may substantially exceed that which the directional antenna radiates in that direction.

37. The effect, of course, occurs. The critical question is one of its magnitude. CCBS offers no experimental data in support of its contention that it is substantial—the argument seems to run that since the distant possible re-radiation sources are numerous, their effect must be substantial. We believe something more is required if the CCBS presentation were to be given serious consideration.

38. Assuming, however, that all of CCBS' contentions are well founded, and we adopt its proposal, we will preclude virtually all new nighttime assignments in the United States (other than Class IV stations), and place a rather severe restriction on new daytime assignments. Moreover, the possibility that we might persuade neighboring countries with which we have broadcast treaties to adopt the more stringent protection standards is extremely remote, and the interference we now experience from stations in more distant countries (principally in Central and South America) and over which we have no effective control, will continue to increase. Under such circumstances, even though a full reconsideration of the allocation standards in light of our present knowledge of propagation phenomena and other effects might recommend a more stringent restriction be placed on the use of directional antennas, the unilateral adoption of such standards would be inequitable, and to a large degree, futile. Finally, it should be observed that even under the perhaps imperfect standards which we employ, the controls which are exercised assure domestic stations better protection from interference from other United States stations, both on the clear channels and other channels, than they can expect to receive from foreign stations, even those in countries with which we have broadcast treaties.

39. Responding to the urging of several parties, we indicated in the Further Notice the conditions under which we would be willing to accept an application proposing a directional pattern in which the orthogonal component is smaller than the minimum permitted by the amended rules. Cullum asks that provision be made for the acceptance of such patterns in the rules, with a specification of applicable conditions, arguing that otherwise acceptance must be predicated on a waiver of the engineering rules—an action which he believes the

Commission only takes reluctantly, if past experience is any criterion. He further contends that the limits on radiation from new assignments are, in general, so restrictive that there will be many instances where it will be necessary to utilize pattern minimums lower than those contemplated by the general rule.

40. We have given these arguments full consideration, but have decided not to establish rules governing the acceptability of standard patterns incorporating radiation minimums lower than those which the general rule would require. If we adopted such rules, they would be considered by some as an open invitation to bypass the newly established radiation floor. This floor is low—much lower than we originally proposed, and lower than the minimums suggested by a number of the parties who commented on this matter. If it is to be achieved and maintained in actual operation, something more than normal attention must be given to all details of design, construction, and operation. While we reiterate our willingness to consider applications embodying directional proposals in which the minimum fields are lower than the rules require, we will consider such proposals only on an individual basis and will act favorably thereon only when the applicant can convince us, by a suitable showing, that the proposed operation is susceptible to practical achievement. We have previously outlined the nature of the showing required. With some modification, we here restate it:

(a) A showing that the proposed antenna site is suitable in all respects for the establishment of the proposed antenna system, and that scattering or residual re-radiation from structures on or near this site will be of insufficient magnitude to preclude the adjustment of the measured fields within the standard pattern. (In an instance where the Commission finds that such a showing is insufficient to demonstrate that the site is fully satisfactory for the proposed operation, it may permit partial or temporary construction and operation, and require measurements as further evidence of site suitability.)

(b) A showing that the electrical and physical design of the array will be such as to insure stable operation.

(c) A description of the proposed current and phase monitoring system, including the electrical components and physical design details, with a specific evaluation of the ultimate accuracy of the system in detecting changes in current amplitude or phase relationships.

(d) A showing that departures in relative current amplitudes and phases smaller than those which the monitoring system is capable of accurately indicating will not result in positive radiation deviations of a magnitude which could result in objectionable interference to other stations.

(e) A showing that phase or current deviations will be easily subject to correction by operators normally manning the directional installation.

41. Perhaps we have not sufficiently emphasized previously that we will make every effort to persuade Canada and Mexico to adopt the standard pattern for new assignments. Lacking mutually acceptable standards in this area, we have, in some instances, found it necessary to accept station assignments in these countries using directional antennas which give treaty protection to U.S. stations with radiation patterns indicating levels of radiation which we consider impractically low. In any event, before radiation patterns for existing stations in this country can be converted to standard pattern format, an understanding obviously must be reached with neighboring countries, since each standard pattern will be larger than the presently accepted

theoretical pattern, and in many instances paper increases in the level of interference to stations in these countries may occur.

42. The kind of understandings necessary can be reached under the provisions of existing agreements, and we see no major legal impediment to their accomplishment. Assuming the success of this endeavor, the employment of the same pattern for each station for determining interference to both domestic and foreign stations—an important objective of this proceeding—should become feasible.

43. In the Further Notice, we set forth general criteria affecting the preparation of standard patterns for existing stations. We have received useful comments from several of the parties with respect to this matter. ABS has been particularly concerned with the application of the new rules to local site changes.[8] [9]

44. In the interest of expediting this matter, facilitating coordination with neighboring countries, and making possible earlier action in Docket 18651, *Amendment of Part 73 of the Commission's Rules Regarding AM Station Assignment Standards and the Relationship Between the AM and FM Broadcast Services*, we are adopting rules which apply only to new assignments and to major changes (as defined in Section 1.571(a)(1)) in existing assignments. Minor changes will be accomplished pursuant to existing procedures. Specifically, where a modification of a directional radiation pattern is required in connection with a minor change the modified pattern need not be constructed to meet standard pattern specifications.[10] The new requirements will apply only to applications for construction permits for new stations and major changes in existing stations filed after the effective date of the rule amendments adopted herein. Applications presently on file and filed before this date will be examined and processed in accordance with the rules and procedures which have applied hitherto.

45. At such time as it appears feasible to undertake the conversion of existing patterns to standard format further action will be taken. If it appears that a procedure may be adopted for this purpose which will not affect the substantive rights of licensees, a public notice will be issued containing appropriate instructions. Otherwise a rule making proceeding may be necessary. In either case, we would expect to draw on the comments filed in the instant proceeding in formulating rules or procedures and would incorporate them by reference in any new formal proceeding. We do not share ABS's fears that the rules we are adopting today, which apply only to new assignments and major changes in existing stations, will substantially limit our freedom of

[8] ABS expresses concern that the proposal in Docket 18110 to prohibit major changes in broadcast facilities in markets where certain other fulltime facilities are commonly owned would, if adopted, in some cases preclude modification of AM facilities made necessary be environmental changes. Local transmitter site changes, even those requiring rather substantial directional pattern modifications, are consistently treated as minor changes. The change in "station location", cited in 1.57(a)(1) as a major change is a change in the community served by the station (see § 73.30).

[9] The specifications for construction of the standard pattern, set forth in § 73.150 (b)(1)(i) of the appended rules require that the 5 percent linear component be applied after addition of the orthogonal component to the theoretical pattern. AFCCE has indicated that it intended the application of the components in this order in its original proposal. ABS favors such a procedure. This is acceptable to us, and, accordingly, we have adopted it.

[10] Unless, of course, the minor change is made in a station for which a standard pattern has been established.

decision in Docket 18651. In fact, as noted above, we are taking this step as a desirable prelude to further action in that proceeding.

46. Accordingly, IT IS ORDERED, effective February 22, 1971, that Part 73 of the Rules and Regulations IS AMENDED as set forth in the attached Appendix.

47. Authority for the adoption of these rule amendments is found in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended.

48. IT IS FURTHER ORDERED, That this proceeding IS TERMINATED.

FEDERAL COMMUNICATIONS COMMISSION,
BEN F. WAPLE, *Secretary*.

APPENDIX

Section 73.150 is revised to read as follows:

§73.150 Directional antenna systems

(a) For each station employing a directional antenna, all determinations of service provided and interference caused shall be based on the inverse fields shown on the standard radiation pattern for that station. As applied to nighttime operation the term "standard radiation pattern" shall include the radiation pattern in the horizontal (ground) plane, and radiation patterns at angles above this plane, as required by paragraph (b)(1) of this section.

(b) The following data shall be submitted with an application for authority to install a directional antenna:

(1) The standard radiation pattern for the proposed antenna in the horizontal plane, and where pertinent, azimuthal radiation patterns for angles of elevation up to and including 60 degrees, with a separate pattern for each increment of 5 degrees.

(i) The standard radiation pattern shall be constructed in accordance with the following mathematical expression:

$$E(\emptyset,\theta)_{std} = 1.05[(E(\emptyset,\theta)^2_{th} + Q^2]^{1/2}$$

where:

$E(\emptyset,\theta)_{std}$ represents the inverse fields at one mile which are deemed to be produced by the directional antenna in the horizontal and vertical planes.

$E(\emptyset,\theta)_{th}$ represents the expression which determines the basic pattern shape and size. It shall be developed with a lumped loss resistance of not less than 1 ohm assumed to exist at the current loop of each element of the directional array, or at the base of any element of less than 90 degrees in electrical height. An application proposing an antenna design incorporating a loss resistance greater than 1 ohm will be accepted only if it includes an adequate technical justification for the employment of the greater value.

Q is the greater of the following quantities:

$$0.025\ f(\theta)\ E_{rss} \text{ or}$$

$$6.0\ f(\theta)\ (P_{kw})^{1/2}$$

where:

$f(\theta)$ is the vertical field distribution factor for the shortest tower in the array (see §73.190, Figure 5).

E_{rss} is the root sum square value of the amplitudes of the inverse fields of the elements of the array in the horizontal plane, as used in the expression for $E(\emptyset,\theta)_{th}$.

P_{kw} is the input power to the array, expressed in kilowatts, with $P_{kw}=1$, for input of 1 kilowatt or less.

(ii) Where the orthogonal addition of the factor Q to $E(\emptyset,\theta)_{th}$ results in a standard pattern whose minimum fields are lower than those found necessary or desirable, these fields may be increased by appropriate adjustment of the parameters of $E(\emptyset,\theta)_{th}$.

(2) The horizontal pattern shall be plotted to the largest scale possible on letter-size polar coordinate paper (main engraving approximately 7″ × 10″) using only scale divisions and subdivisions having 1, 2, 2.5, or 5 times 10^{nth}, and oriented with the zero degree point corresponding to true North. Patterns for elevation angles above the horizontal plane, may be plotted in polar or rectangular coordinates with the pattern for each angle of elevation drawn on a separate page. Minor lobe and null detail occurring between successive patterns for specific angles of elevation need not be submitted. Values of field intensity less than 10 percent of the effective field intensity of any pattern shall be shown on an enlarged scale. The direction and distance shall be indicated on the horizontal plane pattern toward each existing station which interference may be involved.

NOTE: All directions shall be determined by accurate computation or from a Lambert Conformal Conic Projection Map, such as United States Coast and Geodetic Survey Map No. 3060, or map of equal accuracy, and all distances shall determined by accurate computation or from United States Albers Equal Area Projection Map, scale 1/2,500,000, or a map of eaqul accuracy. These maps may be obtained from the United States Geological Survey, Department of the Interior, Washington, D.C. 20240, and the United States Coast and Geodetic Survey, Department of Commerce, Washington, D.C. 20235.

(3) The effective (RMS) field intensity of $E(\emptyset,\theta)_{std}$, $E(\emptyset,\theta)_{th}$ and the root sum square (RSS) value of the inverse fields at one mile of the array elements, derived from the equation for $E(\emptyset,\theta)_{th}$.

(4) Physical description of the array, showing:

(i) Number of elements.

(ii) Type of each element (i.e., guyed or self-supporting, uniform cross section or tapered (specifying base dimensions), grounded or insulated, etc.)

(iii) Details of top loading, or sectionalizing, if any.

(iv) Height of radiating portion of each element in feet (height above base insulator, or base, if grounded).

(v) Overall height of each element above ground.

(vi) Sketch of antenna site, indicating its dimensions, the location of the antenna elements thereon, their spacing from each other, and their orientation with respect to each other and to true north, the number and length of the radials in the ground system about each element, the dimensions of ground screens, if any, and bonding between towers and between radial systems.

(5) Electrical description of the array, showing:

(i) Relative amplitudes of the fields of the array elements.

(ii) Relative time phasing of the fields of the array elements in degrees leading [+] or lagging [−].

(iii) Space phasing between elements in degrees.

(iv) All assumptions made and the basis therefor, particularly with respect to the electrical height of the elements, current distribution along elements, efficiency of each element, and ground conductivity.

(v) Formulas used for computing $E(\emptyset,\theta)_{th}$ and $E(\emptyset,\theta)_{std}$ together with sample computations.

(vi) Complete tabulation of final computed data used in plotting patterns, including data for the determination of the RMS value of the pattern, and the RSS field of the array.

(6) Any additional information required by the application form.

Section 73.151 is revised to read as follows:

§ 73.151 Field strength measurements to establish performance of directional antennas.

(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 effective measured field strength (RMS) at one mile is not less than 85 percent of the effective field strength specified for the standard radiation pattern for that mode of directional operation, or less than that specified in § 73.189(b) for the class of station involved, whichever is the higher value, and that the measured field strength at one mile in any direction does not exceed the field shown in that direction on the standard radiation pattern for that mode of directional operation:

(1) A tabulation of inverse field intensities in the horizontal plane at one mile, as determined from field strength measurements taken and analyzed in accordance with § 73.186, and a statement of the effective field intensity (RMS), based on these measurements. Measurements shall be made in at least the following directions:

(i) Those specified in the instrument of authorization.

(ii) In major lobes. Generally at least three radials are necessary to establish a major lobe; however, additional radials may be required.

(iii) Along sufficient number of other radials to establish the effective field. In the case of a relatively simple directional antenna pattern, approximately five radials in addition to those in subdivisions (i) and (ii) of this subparagraph are sufficient. However, when more complicated patterns are involved, that is, patterns having several or sharp lobes or nulls, measurements shall be taken along as many radials as may be necessary, to definitely establish the pattern(s).

(2) A tabulation of:

(i) The phase difference of the current in each other element with respect to the reference element, and whether the current leads (+) or lags (−) the current in the reference element, as indicated by the station's phase monitor.

(ii) The ratio of the amplitude of the current in each other element to the current in the reference element, as indicated on the station's phase monitor.

(iii) The value of the current at the base of each element, as read from the thermoammeter installed at the base of the element, and the ratio of the base current in each other element to the base current in the reference element. If there are substantial differences between the ratios established in (ii) and the ratios computed in (iii) and/or if there are substantial differences between the parameters established in (i), (ii) and (iii), and those used in the design of the standard radiation pattern, a full explanation of the reasons for these differences shall be given.

(3) The 25 and 5 mv/m field intensity contours and the nighttime interference-free contour, when the pattern is for nighttime operation, as well as any other contours specified by the instrument of authorization, plotted on a map which has the largest practical scale. These contours need not be shown for distances greater than 20 miles from the antenna except that the field intensity contours on the far side of the business and residential areas of the city in which the main studio is located shall be shown. When the station is limited by interference within the 5 mv/m contour the latter contour need not be shown. In the event the 5 mv/m contour includes and extends beyond the city and beyond 20 miles, the highest signal intensity contour that entirely includes the city may be plotted in lieu of the 5 mv/m contour; in the event that the 5 mv/m contour does not include the city, the contour of highest signal intensity encompassing the city shall be plotted in addition to the 5 mv/m contour.

(4) The actual field intensity measured at each monitoring point established in the various directions for which a limiting field was specified in the instrument of authorization together with accurate and detailed description of each monitoring point to gether with ordinary snapshots, clear and sharp, taken with the field intensity meter in its measuring position and with the camera so located that its field of view takes in as many pertinent landmarks as possible. In addition, the directions for proceeding to each monitoring point together with a rough sketch or map upon which has been indicated the most accessible approaches to the monitoring points should be submitted.

Present § 73.152 is redesignated § 73.153 and a new § 73.152 is added to read as follows:

§ 73.152 Modification of directional antenna data.

(a) If, after construction and final adjustment of a directional antenna, a measured inverse field at one mile in any direction exceeds the field shown on the standard radiation pattern for the pertinent mode of directional operation, an application shall be filed for a modification of permit, specifying a modified standard radiation pattern and/or such changes as may be required in operating parameters so that all measured effective fields will be contained within the standard radiation pattern. The following general principles shall govern such a situation:

(1) Where an excessive measured field in any direction will result in objectionable interference to another station which would not be computed if the stand-

ard pattern field in that direction were employed, the application shall specify the level at which the input power to the antenna shall be limited to maintain the measured field at a value not in excess of that shown on the standard pattern, and shall specify the common point current corresponding to this power level. This value of common point current will be specified on the license for that station.

(2) Where any excessive measured field does not result in objectionable interference to another station a modified standard radiation pattern shall be submitted, encompassing all measured fields, and shall supersede the previously submitted standard radiation pattern for that station in the pertinent mode of directional operation.

NOTE: Where measured fields exceed the values shown on the standard radiation pattern, but objectionable interference does not result, and, accordingly, a modified standard radiation pattern is submitted, the modified pattern may be larger than the original pattern (have a higher RMS value); if the measured fields systematically exceed the confines of the original pattern, or, where the measured field exceeds the pattern in discrete directions, may be expanded over sectors including these directions. A combination of both types of expansion may sometimes be desirable. Where sector expansion, or "augmentation" is desired, it shall be achieved by application of the following equation:

$$E_2=\left[E_1^2+Qf(\Theta)\cos\left(180\frac{DA}{S}\right)^2\right]^{1/2}$$

where:

E_1 is the standard pattern field at some particular azimuth and elevation angle, before augmentation.

E_2 is the field in the direction specified above, after augmentation.

$Q=(E_2^2-E_1^2)^{1/2}$ in which the fields are those in the horizontal plane at an azimuth where the maximum degree of augmentation is applied.

$f(\Theta)$ is the vertical plane distribution factor for the shortest element in the array (see §73.190, Figure 5).

S is the angular range, or "span" over which augmentation is applied. At the limits of the "span" the augmented pattern sector merges into the unaugmented pattern.

D_A is the absolute horizontal angle between the azimuth at which the augmented pattern value is being computed, and the azimuth at which the maximum augmentation occurs (D_A cannot exceed ½ S)

Where a standard radiation pattern is constructed using this method of augmentation, the specific limits of each augmented sector shall be depicted. Field values within an augmented sector computed prior to augmentation shall be depicted by a broken line.