AM Station, Technical Standards
Rules, Amendment of

Section 73.52 of rules amended regarding relative phase tolerances for directional AM Stations. Section 73.68 amended to expand use of toroidal transformers and to provide for use of radio frequency relays in sampling element transmission lines. Outmoded rules and procedures revised or eleminated.
–*Amendment of Part 73* BC Docket No. 78–28

FCC 83–572

BEFORE THE

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

In the Matter of	
Amendment of § 73.52 of the Commission's Rules and Regulations with respect to relative phase tolerances for directional AM stations.	BC Docket No. 78–28
Amendment of § 73.68 of the Rules to expand the use of toroidal transformers as a method of deriving current samples in directional (AM) antenna systems; and, to provide for the use of radio frequency relays in sampling element transmission lines.	MM Docket No. 83–16 RM-3103 RM-3740

REPORT AND ORDER
(PROCEEDINGS TERMINATED)

(Adopted: December 1, 1983 Released: December 20, 1983)

BY THE COMMISSION:

Introduction

1. For reasons of administrative efficiency and because the above-referenced proceedings essentially are concerned with the accuracy and stability of directional AM broadcast station antenna systems and associated monitoring equipment, we wish to bring the two proceedings to a conclusion by means of this single *Report and Order*.

BC Docket No. 78–28

2. On January 25, 1978, the Commission adopted a *Notice of Proposed Rule Making* ("*78–28 Notice*") in BC Docket No. 78–28 (43

Fed. Reg. 4647, February 3, 1978) seeking to formalize a policy that required the relative phases of directional AM station antenna currents to be maintained within $\pm 3°$ of the specified values. The rules did not (and still do not) specify the accuracy within which the phases of the currents should be maintained. Only in cases where there are unusually rigid requirements for the protection of other stations does the station license specify the limits within which phase relationships must be maintained. Accordingly, the Commission proposed to amend then §73.52 (now §73.62) to require licensees of AM stations with directional antenna systems to maintain the phases of the antenna currents within $\pm 3°$ of the values specified in the station license, unless more stringent limits are specified therein.[1] Comments were filed by the Association of Federal Communications Consulting Engineers (AFCCE), E. Harold Munn, Jr. & Associates, Inc. (Munn), American Broadcasting Company (ABC), National Association of Broadcasters (NAB), Association for Broadcast Engineering Standards, Inc. (ABES) and David C. Williams. No reply comments were filed.

Comment Summary

3. The AFCCE, Munn and ABES support the proposal to adopt a tolerance of $\pm 3°$ for directional AM stations. ABC questions whether there is really a need to formally codify the existing policy, but agrees that a $\pm 3°$ tolerance appears reasonable as a general matter. ABES contends that regulation of antenna monitor current amplitudes without similar regulation of antenna phase relationships is anomalous and that all applicable standards should be set forth in the rules. Nevertheless, ABES suggests that adoption of a $\pm 5°$ tolerance might be more appropriate if such deviation resulted in no additional interference to the service areas of other stations. Lastly, all of these parties emphasize that the final rule should clearly indicate that licensees would be expected to maintain the $\pm 3°$ phasing tolerance only during periods of normal operation, not during periods of extreme weather or unusual climatic conditions.

4. NAB believes that neither internal (*i.e.*, antenna monitor indications) nor external (*i.e.*, monitoring point field strength indications) indications can be relied upon exclusively to provide complete information about the operating condition of the antenna array because of potentially significant environmental changes possible in either the antenna array or monitoring point environments. Nevertheless, NAB recommends that if changes are contemplated in the regulation of directional antenna systems, either

[1] By reregulatory *Order* adopted September 27, 1979 (FCC 79–609), the FCC divided the subject matter ("Maintenance of antenna input power and directional antenna parameters") of §73.53 between new §§73.62 ("Directional antenna system tolerances") and 73.1560 ("Operating power tolerance"). Thus, the pertinent rule section for the purposes of this proceeding is §73.62.

internal or external indications should prevail, but not both simultaneously. NAB suggests that if we prefer to rely more heavily on internal antenna indications, a substantial relaxation of the requirements pertaining to external indications would be appropriate. Thus, NAB argues that if the ±3° phase tolerance is adopted as the general rule, a 25% tolerance should be applied to the monitoring point values.[2] Further, NAB indicates that a significant number of stations rely on flexibility in antenna phase relationship to make seasonal adjustments to the antenna pattern in order to obtain correct monitoring point values. Such phase adjustments are apparently viewed as an "escape valve" by which broadcasters can avoid having to continually apply for special temporary authorization to operate outside of license-specified parameters. NAB, like ABES, also favors relaxed phase tolerances if applicants or licensees are able to show that operation within the expanded tolerances would result in no additional interference to other stations.

5. Williams does not favor adoption of the ±3° phase tolerance for a number of reasons, and prefers that we pursue a more comprehensive plan designed to ensure proper directional antenna operation. He expresses concern that if we adopt a formal phase angle tolerance, we will attach more importance to it than to field strength, which he considers the final measure of proper antenna operation. Further, Williams demonstrates that antenna arrays with sharp nulls can experience severe distortion of the pattern (particularly in the depth and direction of critical nulls) with phase deviations of ±3°. Thus, he views phase parameters alone as a poor measure of antenna performance. Like the others filing comments, he points out that antenna phase may shift considerably depending on temperature and humidity. This shifting is aggravated, he notes, when the sampling system is poorly constructed and maintained. As an alternative to our proposal, he recommends implementation of a program containing the following elements: additional antenna monitor and field strength measurements when the 5% ratio tolerance and ±3° phase angle tolerance are exceeded; additional skeleton and partial proofs of performance required as necessary; submission of a "proof of performance of the sampling system" after construction or major repairs to the sampling system; mandatory upgrading of sampling systems when deemed necessary; or upgrading of all sampling systems by a specified date.

Discussion

6. We continue to believe that specification of an antenna phase tolerance in the rules is desirable. Proper directional antenna operation can be assumed only when antenna amplitudes and phases

[2] The rules now require that the field strength values not exceed the maximum monitoring point values specified in the station authorization.

are within specified parameters. As ABES points out, it is anomalous that such a tolerance is lacking in the rules when a tolerance exists for antenna current amplitude ratios.

7. As we indicated in the *78–28 Notice*, the ±3° tolerance approximates the current ±5% tolerance applicable to antenna current amplitude ratios. It does not appear that this value would be difficult to maintain, particularly if deviations therefrom are permitted during periods of unusual weather or severe climatic conditions. In this regard, we note that there are a few directional AM stations that are required to hold their relative antenna phases to within 0.5° of the authorized values, and these stations are able to do so using FCC-approved sampling systems and precision antenna monitors. Accordingly, we conclude that as a general rule, operation in accordance with the proposed ±3° phase tolerance is appropriate.

8. Moreover, we disagree with NAB's contention that recent improvements in antenna sampling systems alone do not justify imposition of a ±3° phase tolerance. We take the view that in many cases where an approved antenna sampling system was not used, the actual antenna radiation pattern tended to be more stable than the indications of the antenna sampling system. Any measurement device must be more accurate than the tolerance applicable to the parameter it is being used to measure. This is why we have found it necessary, in various proceedings, to encourage improvements in the quality of both the antenna sampling system itself, and the antenna monitor. We have provided various incentives for AM broadcasters to upgrade the quality of their antenna sampling systems for some time.[3] Yet 35% of directional AM stations still operate with sampling systems of uncertain quality.

9. We believe that monitoring point measurements and internal antenna operating parameters (current ratios and phase) are equally important in determining proper directional antenna operation. The two types of measurements act as a good check and balance system. Only a full proof-of-performance could conclusively demonstrate proper directional antenna operation and this is a very costly and time consuming process. The indications provided by the comparatively few monitoring points specified in the station authorization may vary with changing ground conductivity and may not always reflect the unattenuated radiation. They are also susceptible to reradiation from nearby objects. Further, we require that only a few radials be monitored and these may not conclusively demonstrate that the proper antenna pattern is being obtained. Lastly, we set

[3] Most recently, see the *Report and Order* BC Docket No. 82–537, which eliminated most broadcast periodic measurement and logging requirements. However, the rules required that broadcasters without approved sampling systems continue periodic measurement and logging of those operating parameters concerned with directional antenna operation. See §73.1820(a)(2).

only upper limits for monitoring point indications, but indications which are too low may also indicate misadjustment.

10. The operating values for the antenna current ratios and phases (the internal antenna monitoring parameters) specified on an authorization are established as the result of an extensive proof-of-performance made on the antenna system. Unlike monitoring point field strength indications, antenna monitor indications are easy to obtain on a frequent basis and are often more reliable, being less susceptible to the effects of local environmental changes. Experience has shown that stability in antenna monitor indications generally ensures the stability of directional antenna system operation.

11. However, we are sensitive to the concerns expressed both in this proceeding and earlier in the Docket No. 18471 proceeding that adherence to such a phase tolerance should be the norm, but that short-term variance from such a standard be permissible during unfavorable weather conditions. We agree with the commenters that out-of-tolerance indications during heavy rain, snow or icing, or during abrupt and substantial changes in temperature or humidity, including consequent effects on ground conductivity, may not warrant immediate corrective action. Clearly, to make adjustments to either antenna current amplitude or phase in the absence of appropriate field strength indications may be unwise. Accordingly, we have decided to allow out-of-tolerance operation occuring as a result of adverse climatic conditions for a period of up to 10 consecutive days, provided the monitoring point values specified in the station authorization are within limits. This period is, we think, sufficient for the resolution of most problems of this type. An open-ended period could lead to abuses. Should licensees need to operate out-of-tolerance for more than 10 days, they will be required to notify our AM Branch and request special temporary authority to operate at variance with the rule. Lastly, antenna sample current ratios have an equal potential for being disturbed and we think adoption of a similar policy would be appropriate. Previously, licensees have had to request special temporary authority to operate at variance with the terms of their authorization immediately at the onset of such a situation. We believe this is no longer necessary. Accordingly, § 73.62 is being amended to let the 10 day grace period apply to both antenna monitor ratio and phase indications. The adoption of the 10 day grace period applicable to out-of-tolerance antenna phase and ratio indications should effectively negate any operational or administrative burdens that might be implied by adoption of the new phase tolerance.

12. We do not believe that a 25% tolerance need be applied to monitoring point field strength indications if the $\pm 3°$ antenna phase tolerance is adopted. On December 6, 1979, we adopted, on an

experimental basis, a policy of assigning monitoring point limits using the "direct ratio method."[4] This policy substantially relaxed the monitoring point tolerances from those in effect for many years prior to that time. Our experience with this new policy has confirmed its value in reducing the frequency of adjustments to the antenna patterns of many stations and in reducing the number of readjustment applications filed with the Commission. This has been possible without increasing the interference among stations. Accordingly, rather than adopt the 25% tolerance suggested by NAB, we are herewith adopting permanently the monitoring point policy described in footnote 4.

13. As a final matter, NAB and ABES favor a relaxed phase tolerance if applicants or licensees are able to show that operation would result in no additional interference to other stations. However, such a tolerance (and the showing made to support it) could be rendered meaningless by new or modified cochannel or adjacent channel assignments. Further, such a showing would entail substantial study which, by its very nature, would be more theoretical than practical. Guidelines have long been established concerning phase stability requirements and we see no reason to modify them at this time.

Comments in MM Docket No. 83–16

14. On January 13, 1983, the Commission adopted a *Notice of Proposed Rule Making* (*"83–16 Notice"*) in MM Docket No. 83–16 (48 Fed. Reg. 5978, February 9, 1983) in response to petitions filed by the Association of Federal Communications Consulting Engineers ("AFCCE") and Charles P. Crossno ("Crossno"), a consulting engineer. AFCCE, in RM-3103, sought amendment of the rules to provide for greater flexibility in the use of toroidal current transformers as a means of deriving directional AM station antenna sample currents. It asked the FCC to allow use of these transformers whenever it could be demonstrated that the sampling system operated reliably. Crossno, in RM-3740, requested a change in the rules to permit AM broadcasters to use a remotely controlled switching relay to feed the reference and relative sample currents to the antenna monitor from a central point in the antenna array.

15. In the *83–16 Notice*, the Commission proposed restricting the

[4] This policy was implemented by letter from the Chief, Broadcast Bureau to Donald G. Everist, Chairman of the FCC Processing and Procedure Committee of the Association of Federal Communications Consulting Engineers. The complete text of this letter is given in Appendix B. Under the "direct ratio method," monitoring point limits are obtained by multiplying the measured field strength at a monitoring point by the ratio of the authorized maximum radiation divided by the unattenuated radiation established in the proof-of-performance. This method simply restricts unattenuated radiation to within its maximum authorized value whereas the traditional method, in many cases, restricted radiation more severely.

use of toroidal current transformers to stations with antenna towers of uniform cross-section, or self-supporting towers having a central common feedpoint for all tower legs, where the electrical height of the towers would not exceed 130°. Additionally, we proposed to allow the use of such transformers with "folded unipole" antennas of any height, provided the impedance of the individual tower would not exceed 70 ohms. These limitations were based on the assumed impracticality of using toroidal current transformers on towers greater than 130° in electrical height and out of a desire to avoid the administrative burdens that would have been entailed by the showings proposed by AFCCE.

16. Lastly, we proposed to allow the use of a centrally located relay or other type of switch to provide current samples to the antenna monitor as requested by Crossno. However, we expressed the belief that two related suggestions were unnecessarily burdensome in view of the potential benefit. The two suggestions were that the antenna monitor be capable of being installed at the central switching point with no significant difference in observed ratios or phase indications and that impedance line measurements be made at ±5 kHz of the station's operating frequency at the antenna monitor end of the two sampling lines for each selected element. These latter requirements were not included in the proposed rules.

17. Comments in MM Docket No. 83–16 were filed by AFCCE, Robert A. Jones, P.E. (Jones), Charles I. Gallagher, P.E. (Gallagher) and Taft Broadcasting Company. NAB filed reply comments, and late-filed comments were submitted by Thomas G. Osenkowski on behalf of Radio Station WNYC.

Comments on RM-3103

18. AFCCE and NAB argue for adoption of the original AFCCE proposal (RM-3103) that would allow the use of toroidal current transformers as antenna monitor sample current sources at any AM directional station, provided that a showing of adequate stability could be made. Thus, they are not in favor of the restrictions proposed by the Commission in the *83–16 Notice.*

19. Jones, in his comments, agrees that the toroidal current transformers can be successfully used on guyed towers of uniform cross-section up to 130° in electrical height, but argues that base current sampling is not sufficiently reliable where self-supported or folded unipole types of antennas are used. He also opposes the proposed 30 day test or trial period as a means of demonstrating satisfactory performance of toroidal current transformers in lieu of loops on taller towers.

20. Gallagher expresses the belief that antenna monitor current samples should only be taken from rigid, non-rotatable loops operated at tower potential. He considers any other technique a compromise and cannot see any circumstance where any other

system would result in the sample current being more accurate or reliable than when derived from the tower itself. Amplifying, somewhat, the comments of Jones, Gallagher points out that using the antenna base current as the antenna monitor signal source potentially involves three different types of currents: (1) the actual antenna current (which we will call the "radiated current"), (2) the current to ground which results from the distributed capacity of the base insulator and the lower 10 to 20 feet of tower (which we will call the "distributed base capacity current"), and (3) any current to ground through the tower lighting choke (which we will call the "choke current"). He notes that as long as a tower has a low impedance (as is the case with towers with an electrical height near 90°), the distributed base capacity current will be small and will have little effect on the accuracy of the current sample. However, as a tower (and its impedance) increases, the ratio of the distributed base capacity current to the radiated current will increase and can be significant. He cites two cases where use of toroidal current transformers at stations with taller towers either did or would have resulted in inaccurate sample current ratio indications. On the basis of his experience, Gallagher views the proposed 130° limit as a wise limit on the use of toroidal current transformers.

21. Taft, in its comments, argues that the 130° height limit is inadequate, based on its experience with Station WTVN (Columbus, Ohio). Taft submits extensive measurement data showing accurate and stable current samples derived from toroidal current transformers installed at the base of a tower 141.6° in electrical height. Accordingly, Taft suggests an upper height limit of 150–160° and would prefer to see the terms of the original AFCCE petition adopted (where use with a tower of any height would be permitted if a suitable showing of stability and accuracy was made).

22. Osenkowski discusses at some length his efforts to install untuned sampling loops on two self-supported towers of Station WNYC. He encountered trouble in obtaining sample current signal levels of sufficient amplitude to operate the antenna monitor. After considering various alternatives, he decided to install toroidal current transformers which subsequently provided signals of sufficient amplitude and stability. Osenkowski notes that while uniform, guyed antenna towers generally have sinusoidally distributed current, self-supported, diamond and other assorted types of towers are assumed to be markedly non-sinusoidal in terms of current distribution. Any number of factors, he indicates, can result in nonsinusoidal current distribution, making the point of current maxima difficult to determine and subject to change. In such cases, loop placement can be difficult to determine and use of toroidal current transformers can often be beneficial. Osenkowski notes that while a toroidal current transformer signal sample may not reflect a condition of snow or ice, it should be remembered that such a condition will

generally prevail for all towers in a particular antenna array. Thus, assuming that the transformers are located in the same electrical positions, effects of change in tower operating impedance and the resulting change in the mutual impedance would be reflected back to the antenna monitor. Ice accumulation on a loop antenna or on a loop insulator can result in undesired changes in the array–an unlikely occurence where toroidal current transformers are used. Thus, Osenkowski concludes that use of toroidal current transformers is beneficial to broadcasters, particularly in cases where satisfactory operation cannot be obtained under the terms of the present rules (*i.e.*, with loops).

Comments on RM-3740

23. Gallagher, Jones and NAB (in its reply comments) commented on our proposals relative to petition RM-3740 (use of relays or a motor-driven switch to feed antenna sample currents to the antenna monitor via two coaxial cables rather than with cables from each antenna tower). Jones merely recommended that any switching relays meet all of the requirements for equipment used in FCC approved sampling systems. Gallagher expressed the belief that radio frequency (RF) relays should be of the coaxial type and be adequately shielded. He favors a means of taking sample current indications ahead of the relay and favors retention of the safeguards suggested in the original petition. However, NAB suggested that installation of "fail safe" indicating devices could serve to limit the probability of undetected relay failures. Moreover, NAB notes that other operating parameters (such as direct reading of antenna base currents or field strength measurements) would assist licensees in making accurate determinations of antenna or sampling system component failures.

Discussion

24. Except for the reservations expressed by Gallagher and Jones, the comments support the position taken by the Commission in the *83–16 Notice*. Thus, for the reasons expressed below, we have decided to adopt rules consistent with those proposed in the *83–16 Notice*, with the exception that antenna heights over the proposed limit of 130° will be allowed subject to a showing that the installation meets our accuracy and stability requirements.

25. First, we agree with Gallagher that three separate current components may flow in a tower. These have been identified as the radiated current, the distributed base capacity current and the choke current. An effect similar to that of the choke current may occur when land mobile or other antennas are mounted on a broadcast tower if their feed lines are not sufficiently isolated at the tower's base. However, all such choke currents will be negligible if the tower mounted devices are properly isocoupled. Moreover, in the

absence of antenna or other special devices, any choke currents in the various antennas in the array should be nearly equal, particularly if the antenna towers are of the same type and height.

26. The same observation applies in the case of the distributed base capacity current. As Osenkowski notes in his comments, the weather conditions seen by each tower in a particular array should be the same and the effects on each tower should be similar. Thus, while a change in antenna sample current amplitudes is possible, the ratios and the phase angles should remain unchanged. Of course, this probability will diminish where one or more towers in an array is physically or electrically different than the others. Thus, while we agree with Gallagher that there are theoretical reasons why toroidal current transformers should not be used with towers greater than 130° in electrical height, in the majority of cases (where the antenna towers in the array are all of the same type), the practical consequences of such incidental currents are likely to be minimal.

27. Further, as Osenkowski points out elsewhere in his comments, the sensitivity of antenna monitors is generally around 2 volts for satisfactory performance.[5] High sensitivity toroidal current transformers deliver 1 volt of sample current per ampere of base antenna current. Thus, if a typical antenna monitor is used with toroidal current transformers, a base current on the order of two amperes is necessary for the reference input and .5 ampere for the relative inputs.[6] Since the antenna base resistance generally increases (and the base current decreases) as the height increases, there will be a practical limit on the height of a tower with which toroidal current transformers may be used. This limit cannot be stated as a general rule because it depends, ultimately, on the smallest antenna current present during the station's lower power mode of operation.

28. In view of the foregoing considerations, we have decided not to prohibit the use of toroidal current transformers in cases where an antenna tower is more than 130° in electrical height. Rather, we will leave this decision to the broadcaster or his consulting engineer. Thus, broadcasters who wish to use toroidal current transformers with towers 110° to 130° in electrical height will merely be required to certify the stability of their sampling system by meeting required tolerances for a 30 day period. We continue to believe that the one month period is sufficient to reveal any anomalies in antenna sampling systems using toroidal current transformers where the towers are less than 130° in electrical height. However, in view of potential uncertainties in operation, special showings to demon-

[5] In fact, sensitivity for the reference input is generally around 2 volts, and sensitivity for the relative signal inputs is generally around 0.5 volt.

[6] This assumes negligible loss in the coaxial cable connecting the antenna monitor to the toroidal current transformers.

strate the suitability of toroidal current transformers in antenna systems with towers more than 130° in electrical height will be required.[7] The showing must reflect that over a consecutive 30 day period, all antenna monitor indications were within tolerance. Data shall be taken daily or weekly for each antenna pattern pursuant to the new provisions set forth in § 73.68(a)(4)(ii).

29. The comments submitted in response to the *83–16 Notice* supported our proposal to allow the use of radio frequency relays to switch sampling current signals from different antenna towers and feed them to the antennas monitor by way of only two sampling lines (one carrying the "reference" signal and the other the "relative" signal). Accordingly, we are adopting the rules proposed therein.[8] However, we have anticipated that in lieu of a switch or relay, a licensee may wish to install the antenna monitor at the central point in the array and remotely read its various meter indications. This is already permitted if an antenna phasor unit is located in the center of the antenna field. (See Section 73.69(a)(1)). However, we have no objection to installation of the antenna monitor in a structure other than a phasor house, provided the antenna monitor can operate accurately over the wide temperature and humidity extremes that are typical of antenna tuning houses. In this regard, we expect that a similar type of structure would serve as a junction point for the antenna sample current lines and as a housing for the radio frequency relay or motor-driven switch. However, in the case of extreme temperature or humidity changes, the licensee would have to install such equipment as may be necessary to keep the environment in the housing structure within the specified operating parameters for the particular antenna monitor. Thus, while we are amending the rules as requested, we urge licensees to give careful consideration to cost-benefit tradeoffs associated with centralized installation of a radio frequency relay or switch, or even the antenna monitor itself, since operating and maintenance costs of the additional structure, as well as potential inconvenience in visiting it for maintenance purposes, may eventually surpass the cost of running antenna sample current coaxial cable from each tower directly to the transmitter building.

Conclusion

30. The *78–28 Notice* was issued prior to the adoption of the Regulatory Flexibility Act of 1980 (P.L. 96–354) and is therefore exempt from its provisions. Nevertheless, we recognize that a small number of directional AM station licensees may be adversely affected by our adoption of the ±3° phase tolerance in that they may

[7] We would note that of 1840 directional operations, only 250 have towers more than 130° in electrical height.

[8] See the *83–16 Notice*, Paragraph 21.

be compelled to upgrade substandard antenna monitoring systems where the monitoring system, rather than the actual antenna system, is responsible for out-of-tolerance indications. According to our estimates, there are approximately 650 directional AM stations (most of which would probably be classified as "small business entities" under the provisions of the Regulatory Flexibility Act) that have not installed FCC-approved antenna monitoring systems. Of this number, some undoubtedly have sampling systems that are adequate, even if not FCC-approved. Accordingly, the number of directional AM station licensees that potentially would be adversely affected by our adoption of the $\pm 3°$ phase tolerance is small.

31. With respect to the Docket No. 83–16 proceeding, we pointed out in the *Notice* (Paragraph 30) that the provisions of the Regulatory Flexibility Act did not apply since the rules proposed were completely optional in nature and would not compel licensees to acquire any new equipment, undertake new record-keeping requirements or modify existing practice in any way. This contention was not disputed in the comments, so no additional Regulatory Flexibility Act analysis is herein being provided.

32. Accordingly, IT IS ORDERED, pursuant to the authority contained in §§ 4(i) and 303 of the Communications Act of 1934, as amended, that Part 73 of the Commission's Rules ARE AMENDED, effective January 1, 1984, as set forth in the attached Appendix. IT IS FURTHER ORDERED that this proceeding IS TERMINATED.

33. IT IS FURTHER ORDERED that the Secretary shall cause this *Report and Order* and its appendices to be published in the FCC Reports.

34. Further information on this matter may be obtained by contacting James E. McNally, Jr., Mass Media Bureau, (202) 632–9660.

FEDERAL COMMUNICATIONS COMMISSION
WILLIAM J. TRICARICO, *Secretary*

APPENDIX A

I. 47 C.F.R. Part 73 is amended as follows:

1. Section 73.62 is revised as follows:

§73.62 Directional antenna system tolerances.

Each AM station operating a directional antenna must maintain the indicated relative amplitudes of the antenna base currents and antenna monitor currents within 5% of the values specified on the instrument of authorization, unless other tolerances are specified therein. Directional antenna relative phase currents must be maintained to within $\pm 3°$ of the values specified on the instrument of authorization, unless other tolerances are specified therein; provided that during periods of inclement weather or severe climatic conditions, a licensee may operate at variance with these provisions for a period up to 10 consecutive days, providing the monitoring point values specified in the station authorization are within limits. If, at the end of this 10 day period normal operation is not restored, the licensee must request from the

FCC in Washington, D.C., special temporary authority to operate the station at variance with the provisions of this section.

2. Section 73.68 is revised as follows:

§73.68 Sampling systems for antenna monitors.

(a) * * *

(1) All coaxial cable from the sampling elements to the antenna monitor, including cable used in the construction of isolation coils, except short lengths of flexible cable connecting the transmitter house sampling line termination to the monitor, must have a solid outer conductor and have uniform physical and electrical characteristics. The dielectric must be either predominantly pressurized air or other inert gas, or foamed polyethylene.

(i) All sampling lines for a critical antenna array (i.e., an array for which the station authorization requires the maintenance of phase and current relationships within specified tolerances) must be of the same electrical length, with corresponding lengths of all lines exposed to equivalent environmental conditions.

(ii) For other arrays, lines of differing length may be employed, provided that the difference in length between the longest and the shortest line is not so great that, over the range of temperatures to which the system is exposed, predicted errors in indicated phase difference resulting from such temperature changes will exceed 0.5°.

(iii) A sampling line mounted on a tower must be adequately supported to prevent displacement, and must be protected against physical damage. Where feasible, sampling line sections between each tower base and the transmitter house is to be jacketed and buried: lines run above ground must be firmly supported, and protected against physical damage, with the outer conductor strapped to the station's ground system at such points as found necessary to minimize currents induced by antenna radiation.

(iv) All necessary connections and outdoor cable terminations must be made with waterproof fittings designed for use with the type of cable employed.

(v) For determining the permissible differences in line lengths that may be installed, the total difference between the highest listed normal daily maximum and lowest listed normal daily minimum temperatures as shown for the nearest location shown in the most recent issue of "Local Climatological Data Annual Summaries" shall be used in the calculations. This publication is available from:

National Climatic Center
National Oceanic and Atmospheric Administration
Asheville, North Carolina 28801

(vi) The provisions of this subparagraph do not preclude the use of a centrally located impedance-matched radio frequency relay or remotely controlled switch to provide relative sampling currents to the antenna monitor over a single transmission line. However, the reference sampling line and the relative sampling line from the switching point to the antenna monitor must be identical in type and electrical length, and must be exposed to the same environment. The sampling line from each sampling element to the relay must conform to all relevant requirements indicated in this subparagraph. Alternatively, a licensee may install the antenna monitor at a centrally located or otherwise convenient location provided that the temperature and humidity of the operating environment are maintained within the tolerances specified by the antenna monitor manufacturer. When such an antenna monitor is to be remotely controlled and read, installation shall conform to the requirements of §73.67 of this Part.

(2) Except as provided below, sampling elements must be single turn, unshielded

loops of extremely rigid construction, with ample, firmly positioned gaps at the open loop end, mounted on towers at a fixed orientation. Loops must be installed to operate at tower potential, provided that for towers less than 130° in electrical height, loops operating at ground potential may be used. Each loop must be mounted on the tower near the point of maximum tower current, but in no case less than 3 meters (10 feet) above ground.

(3) Shielded current transformers may be used in lieu of unshielded loops to extract samples from antenna feed lines at the base of each tower having a uniform cross-section and 110° or less in electrical height, or a self-supporting tower 110° or less in electrical height, provided it has a common feedpoint for all tower legs.

(4) Shielded current transformers may be used in lieu of unshielded loops to extract samples from the antenna feed line at the base of each tower having a uniform cross-section more than 110° but not greater than 130° in electrical height, self-supporting towers not exceeding 130° in electrical height and having a central common feedpoint for all tower legs, and folded unipole antennas of any height having a base driving point resistance and reactance not exceeding 70 ohms, provided the following conditions are met:

(i) Stability of operation during a test period of 30 continuous days using the current transformers must demonstrate that the antenna monitor sample current ratios do not exceed 5% of those specified on the station authorization and that the relative phase indications are within ±3° of the values specified on the station authorization, unless a more stringent tolerance is specified therein.

(ii) The following parameters shall be read and recorded as indicated during the 30 day test period for each antenna pattern:

(A) Indications at each monitoring point specified in the station authorization, weekly.

(B) Base currents and their calculated ratios, weekly.

(C) Common point current, daily.

(D) Antenna monitor sample current amplitudes and their ratios, daily.

(E) Antenna monitor phase indications, daily.

(iii) Failure to meet the stability requirement specified in (i) above will require that the licensee seek special temporary authority to operate at variance with the terms of the station instrument of authorization until the problem can be corrected.

(iv) A certification by the licensee that the sampling system meets the stability requirement specified in this paragraph must be included in the request for approval of the monitor sampling system together with the information specified in paragraph (c) below.

(v) Shielded current transformers may be used in lieu of unshielded loops to extract samples from the antenna feed line at the base of each tower greater than 130° in electrical height provided the requirements set forth in subparagraphs (4)(i) through (iii) above are satisfied and the resulting data is included in the request for approval of the monitor sampling system together with the information specified in paragraph (c) below.

(vi) The FCC may request the licensee to conduct such other tests, or measurements, or submit additional data it deems necessary to determine the stability of the antenna sampling system.

* * * * *

APPENDIX B

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554
December 6, 1979

IN REPLY REFER TO:
8800-DW

Mr. Donald G. Everist, Chairman
FCC Processing and Procedure Committee
Association of Federal Communications
Consulting Engineers
1015 - 15th Street, N.W., Suite 703
Washington, D.C. 20005

Dear Mr. Everist:

I have your letter of October 22nd, written on behalf of your committee, requesting modification of certain Commission engineering practices used in assigning monitoring point limits to AM directional broadcast stations. Your letter formalizes suggestions developed in a series of meetings, begun well over a year ago, between your committee and members of the Broadcast Facilities Division's engineering staff concerning the policies and procedures governing the preparation and processing of various types of applications. The interest shown throughout this period by your committee in helping improve our processing procedures has been helpful and is greatly appreciated.

Specifically, your committee feels that, under the present policy, monitoring point limits are often assigned which are unnecessarily restrictive and urges the adoption of a policy whereby the assignment of these limits is based on the "direct ratio" method. The committee also urges the establishment of a policy whereby stations subject to seasonal conductivity changes can achieve relaxed limits upon submission of "seasonal proofs." Additionally, the committee requests that the Commission refrain from altering monitoring point limits based on partial proofs of performance if "substantial conformance" of the radiation patterns is demonstrated and the antenna parameters are either essentially unchanged or, if changed, adequately justified.

In response to your first suggestion, I am pleased to announce that we have, on an experimental basis, adopted the policy of assigning monitoring point limits using the direct ratio method. Under the direct ratio method, monitoring point limits are obtained by multiplying the measured field strength at a monitoring point by the ratio of the authorized maximum radiation divided by the unattenuated radiation established in the proof of performance. This method simply restricts unattenuated radiation to within its maximum authorized value whereas the traditional method, in many cases, restricted radiation much more severely. Theoretically, objectionable interference is not caused if antenna radiation is maintained below its maximum authorized value. Assuming, therefore, that changes in monitoring point field strength correspond directly to changes in antenna radiation, monitoring point limits determined by the direct ratio method should be adequate to avoid interference. However, since the assumption of a linear relationship between monitor point readings and antenna radiation becomes somewhat questionable with excessive changes, we do not intend to assign limits higher than 200% above proof values. In addition, because operation with monitoring point field strength in excess of the direct ratio limit could result in objectionable interference, we will continue to deny requests to exceed those limits.

Your second suggestion addresses a problem encountered in many areas of the country where complete proofs of performance are done during the summer months when ground conductivity is significantly lower than during the winter months. Often

monitoring point limits resulting from such summertime proofs are not sufficient to accommodate higher readings encountered during winter. In such a case increased limits are obtained by collecting supplemental wintertime data in the form of a partial proof of performance consisting of at least 10 measurements on each radial established in the complete proof (see Section 73.154(a) of the Rules). You suggest that the Commission accept "seasonal proofs" for this purpose in lieu of partial proofs. A seasonal proof would consist of "at least 20 field strength measurements, both nondirectional and directional, on each of the radials specified in the construction permit and at least one radial in the major lobe."

In responding to this suggestion, it is helpful to understand the approach used by Commission engineers in analyzing complete proofs of performance. These generally consist of 20 or 30 measurements per radial (see Section 73.186(a)(1)) and serve as the reference for all subsequent partial proofs. As you know, the fundamental problem is distinguishing between the effects of conductivity and antenna radiation. In making this distinction, we consider it imperative to establish, as conclusively as possible, the size and shape of the nondirectional radiation pattern. The nondirectional radiating system is simpler (fewer variables) than the directional system and its RMS (size) can be more accurately determined since each measured radial is of more or less equal significance, particularly if the radials are evenly spaced. With a directional pattern, many of the minor-lobe and null radials do not contribute significantly toward defining the RMS, leaving the remaining main lobe radials with a disproportionate influence on the determination of the pattern size. For these same reasons, the Commission relies entirely on nondirectional measurement data in determining the extent of seasonal changes in conductivity.

Because of the crucial role played by the nondirectional pattern resulting from a complete proof of performance, extreme care is used in analyzing the measurement data. Experienced engineers who have been carefully trained are used in this work. All known external factors such as terrain features, reradiating structures, pipe lines, etc., are taken into account. Each radial is repeatedly weighed against the others with constant attention to the resulting pattern shape and RMS and the analysis is not considered complete until the importance of each element of data is understood from the perspective of the whole. Of course, the more extensive and "well behaved" the measurement data, the more precise and confident the engineer can be with his/her analysis. Once the nondirectional pattern is established, analysis of the directional data can usually be done mathematically, rather than graphically, using either arithmetic or logarithmic averages. Any subsequent nondirectional partial proofs which are submitted to the Commission for the purpose of documenting suspected conductivity changes are mathematically analyzed, point for point along each radial, against the complete proof nondirectional data (see Section 73.186(a)(5)). If the possibilities of distortion and changed RMS can be eliminated from the partial proof nondirectional pattern, then the extent of conductivity change along each radial can be determined and applied to the directional partial proof data revealing whether, in fact, observed changes in directional field strengths resulted from changes in the radiation pattern or simply from conductivity changes.

The notion of a seasonal proof, to the extent that some of the proof radials would be eliminated, strikes at the very heart of our approach which is an accurate determination of the nondirectional radiation pattern. Although, under the committee's suggestion, the minimum number of measurements on some radials would be raised from 10 to 20, we do not feel the value gained from additional data on these radials would be sufficient to offset the complete loss of data on the remaining radials. This is also the case for directional patterns where changes in radiation in some directions can affect radiation in other directions and assumptions of pattern symmetry are generally unreliable. The Commission encourages supplemental measurements in addition to the minimum of 10 per radial required by the Rules; this should not be accomplished, however, at the expense of fewer measurements on other radials.

Your last suggestion concerns the Commission's assignment of monitoring point limits in response to partial proofs of performance conducted following antenna repairs, refurbishment, construction or readjustment. Often such proofs result in a reduction in limits below those previously assigned because measurements were taken during periods of low conductivity or because antenna radiation in some directions was reduced. The committee suggests we not lower limits in such cases if the pattern remains in substantial conformance and the antenna parameters (phases and current ratios) are either essentially unchanged or, if changed, adequately justified. We believe this suggestion has merit and have, also on an experimental basis, ceased the practice of lowering limits based on partial proofs except when such limits would exceed measured values by more than 200%.

We feel that the current mandatory use of type-approved antenna monitors by directional stations and the widespread use of approved sample systems permit these changes in policy at this time without endangering in any way the technical integrity of our AM broadcasting system. Nonetheless, because of the significance of these changes, we intend to proceed on an experimental basis for at least a year, gaining the benefit of practical experience, before permanently adopting them. In addition, cases clearly falling beyond the scope of these policies will continue to be handled on a case-by-case basis.

We are hopeful that the changes we have initiated in response to your suggestions will provide many stations with operating tolerances sufficient to accommodate variations which, under our old policy, would have required a proof of performance and the filing of an application with the Commission. Again, I would like to express my sincere appreciation for the work done by your committee in bringing forth these suggestions.

Sincerely,

Richard J. Shiben
Chief, Broadcast Bureau