

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

MM Docket No. 87-6

In the Matter of

Amendment of Part 73
to Authorize the use of
Multiple Synchronous
Transmitters by AM
Broadcast Stations

NOTICE OF INQUIRY

Adopted: January 15, 1987; Released: March 3, 1987

By the Commission:

I. INTRODUCTION

1. This action initiates a *Notice of Inquiry (Inquiry)* into the use of multiple, synchronous transmitters to enhance and extend the signal coverage of AM broadcast stations. In April 1986, the Commission released the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, (*Report*).¹ The *Report* discussed, among other things, the use of multiple transmitters. Of the various uses of multiple transmitters discussed, the application of "synchronous transmitters" has prompted the most interest as a means of providing immediate benefits. Thus, this proceeding will initially focus only on issues primarily related to the use of synchronous transmitters. Synchronous transmitter systems involve the use of two or more broadcasting transmitters on the same frequency in near geographical proximity, broadcasting the same program material. They employ precision carrier frequency and phase control in order to minimize mutual interference. Other uses of multiple transmitters will be considered in other rule making actions where appropriate.

2. Although there has been much interest expressed regarding the use of synchronous networks, the Commission has concluded that it is necessary to develop a more complete record on the several related technical and non-technical issues before proposing specific rules. In addition to this *Inquiry*, the Commission has encouraged applications for experimental authorizations to develop technical data.² Additionally, the Federal Communications Commission Radio Advisory Committee is encouraged to study these issues and to report its recommendations to the Commission.

II. BACKGROUND

3. Conventional methods for enhancing and extending the service area of an AM broadcast station typically called for increasing the transmitter power, designing a directional antenna system to improve service in a desired direction, relocating the station, or any combination of these. However, the crowded conditions that now exist in

the AM band limit the opportunities for such changes without creating objectionable interference. Moreover, these conventional methods do not always provide stations with sufficient economic flexibility to improve their service to all areas. The use of additional transmitters that simultaneously broadcast the programs of a primary originating station is an effective and economical method that could be applied in some circumstances to improve and extend a station's service area.

4. The technology relating to synchronized transmitters was discussed early in the United States in a paper written by Charles B. Aiken of Bell Telephone Laboratories in 1933.³ In 1937, the first experimental authorization to explore this technology in the U.S. was granted to radio station WLLH, Lawrence, Massachusetts, which has continued its synchronous operations to this day. Similar experiments have been conducted in Boston (WBZ), Charlotte, North Carolina (WBT), Cincinnati, Ohio (WSAI), and in Washington, D.C. (WINX and WWDC). Synchronized groups of transmitters have been used in the AM band on a large scale in Europe for many years, and more recently in Japan. These foreign operations have been based upon the same theoretical bases as the earlier United States operations.⁴ The results of the international experience have been largely consistent with those obtained in the United States. These operations have further demonstrated the feasibility of synchronous operations and have confirmed earlier predictions of performance to be expected from different system designs.

5. There are numerous examples where such applications could be made. For instance, additional transmitters simultaneously broadcasting the programs of a primary station could be located in or near the areas where service improvements are desired. Such service enhancements could be instituted along major highways in order to permit a station to serve the traveling public over long distances forming "ribbons of service." Additional transmitters also could be located in nearby communities lacking sufficient population to support their own independent stations. Other uses could include use of low power transmitters within a station's predicted service area at locations suffering from inferior service because of anomalous propagation conditions or to provide service in nulls of directional antenna patterns.

6. Although three distinct uses of multiple transmitters were discussed in the *Report*, synchronous operation stimulated the greatest interest, as revealed in the comments that were filed in response to the *Report*. The comments gave general support to the suggested use of multiple transmitters for improvement or extension of AM service areas. The commenters were encouraged by the prospect for coverage enhancement that synchronous techniques may offer. Other commenters to the *Report* recognized the need for careful study and the value of experimentation. CBS Inc. and Association for Broadcast Engineering Standards Inc (ABES), however, expressed concern that such uses might increase the overall level of interference in the AM frequency band. Although ABES agreed with the *Report's* suggested methods of minimizing mutual interference within synchronous transmitter networks, it added that synchronous operations would offer only marginal improvement in the coverage of some stations.

III. DISCUSSION

7. There are both technical and non-technical issues on which data and information are needed in order to establish bases for specific rule proposals for the operation of synchronous transmitters. Of particular importance are issues pertaining to criteria used to define mutual interference between transmitters in a synchronized network. Of equal importance are the interference protection criteria to be applied between synchronous networks and stations outside of the synchronous systems.

8. With respect to non-technical issues, the Commission is of the view that restrictions on the use of synchronous transmitters should be minimized to the extent possible, in order to maximize opportunities for innovation and service improvements to the public. Non-technical matters of importance include ownership and licensing issues. These are discussed in detail below.

Technical Issues

9. Previous experiences, both in the United States and abroad, have demonstrated that there are areas of concern in synchronous transmitter operation. While advancements in fixed point-to-point communication techniques made since the earlier experiments will solve some of the earlier program distribution problems, *e. g.*, radio or land line signal propagation delay, a principal consideration of synchronous operation is that of the zones of mutual-interference. This interference occurs most prominently in the service areas of the synchronized transmitters at locations where the signal levels from two or more synchronized transmitters are nearly equal. AM radio receivers located in these interference zones may experience program signal fading or distortion, depending on the method of transmitter synchronization employed. The boundaries of these zones or areas of interference as well as the nature of that interference are dependent upon the system design of a group of synchronous transmitters.

10. The interference can be controlled through geographically spacing the synchronous transmitters or by locating them in such a way as to cause the areas of mutual interference to occur at locations where there are few listeners. The effects of mutual interference can be further minimized through the equalization of modulation delay among transmitters,⁵ and through the use of phase rather than frequency synchronization. At night, however, these zones of interference may be less significant, because skywave interference received from transmitters within the group or from co-channel stations outside the synchronized group could have a greater effect upon service.

Intra - system interference considerations

11. *Synchronization Techniques.* Synchronization can be achieved through either frequency synchronization or phase synchronization. The former is accomplished by closely aligning the carrier frequencies (to 0.1 Hz or better), and the latter is accomplished by phase locking the transmitters together through the use of a control circuit.⁶ The earlier experimental operations, previously referred to, tested both forms of synchronization. The experiments for phase synchronization employed transmitters called "boosters" or "synchronous amplifiers." Where synchronization is only required during nighttime

hours, it may be feasible during the daytime hours for each transmitter to broadcast separate programming, depending on the transmitters' proximity to each other.

12. When phase synchronization is employed, there is no relative carrier frequency variation between the different transmitters, and the pattern of mutual-interference remains fixed in time and place. Such interference would not be very noticeable on automobile receivers since automobiles in motion would normally move quickly through any areas of interference. For AM radios with ferrite rod antennas (virtually all modern table models and portable radios), the effect of the stable pattern of interference can be greatly reduced by orienting the radio to improve the signal strength received from one of the transmitters.⁷

13. A difference among the carrier frequencies of the transmitters in the group results in a variation in the total received signal at any point in the common service area over time. If the frequency difference is small enough (on the order of 0.1 Hz), the variation can be compensated for by the automatic gain control (AGC) circuitry of the receiver and the listener will not notice significant distortion, except at locations where the signals from the different transmitters are nearly the same field strength. At these latter points, the variation may exceed the dynamic range of the AGC and distortion effects similar to slow fading will be experienced.

14. The relative merits of these methods need to be studied. Is there a significant advantage of one technique over the other or should the Commission establish rules for both? Where possible, those stations operating under experimental authorizations with synchronous transmitters are encouraged to develop data on this issue.

15. *Protection ratios for synchronized transmitters.* The term "protection ratio" generally refers to the minimum ratio of the field strength of a desired signal to the field strength of an interfering signal, in order to define the existence of interference. In the case of synchronized network, such a ratio is applied in determining the zones of mutual interference that occur within the synchronized system.⁸ In order to facilitate establishment of an appropriate protection ratio for synchronous operations, we encourage present and prospective experimental licensees to investigate the values of the signal-to-interference ratio applicable to reception of transmissions from synchronized transmitter groups comprised of two or more transmitters, taking into account alternative frequency tolerances. Both phase and frequency methods of synchronization should be considered. A European study suggested one approach to determining the protection ratio. This approach involves the use of a statistical method based on subjective listening impressions of reception quality from a transmitter in a synchronized group. The results are then compared with reception quality of a single non-synchronized transmitter station.⁹ The EBU Report cited an instance in which protection ratio values for nonfading signals were first determined under laboratory conditions. For fading signals, however, only operational tests using a synchronized network were conducted.

16. There are several factors to be considered in determining the protection ratio. These factors include: difference of transit time, frequency tolerance, whether the interfering signals are groundwave or skywave, and the effects of stereo and other audio processing techniques. There are also subjective factors to consider. For instance,

speech and some forms of contemporary music may appear less susceptible to distortion than other program formats.

17. When three or more transmitters are used in a synchronous network, the problem of mutual interference is compounded. In such cases the combined effects of multiple interfering signals during nighttime hours must be considered. For non-synchronized transmitters, this is accomplished by calculating the root-sum-square (RSS) of the interfering signals. The EBU report, referenced above, states that in most cases where the desired signal is the groundwave and the interfering signals are skywave, the interference protection ratio is defined as the ratio of the field strength of the wanted signal to the median value of the interfering field strengths. They also suggest, however, that the time probability of interference will lessen with the use of several synchronous transmitters within a network. We invite comments on the treatment of multiple interfering signals within a synchronized network. Additionally, where experimentally possible, tests should be conducted on the effects of two as compared with three or more synchronized transmitters. Results of such tests should be reported in the comments.

18. *Transit time.* Transit time is the signal propagation time interval from the transmitter to the receiver. It is dependent on the location of the receiver, and may vary in the case of nighttime ionospheric propagation. If the difference in transit time from several sources is negligible and the distribution delay is equalized, theoretically there should be no distortion, but this occurs in practice for only a very small geographical area. Comment is requested on the effects of transit time and the manner in which program distribution equalization can be employed to minimize these effects.

19. *Transmitter Power.* Much of the experience from experimental synchronized operations previously gained within the United States employed relatively low powered synchronized transmitters. As shown in the EBU report, however, this is not necessarily an inherent requirement for synchronous operation. Comments are requested as to whether the power of synchronized transmitters should be restricted or whether power levels up to that permitted for the station class of the primary station should be allowed, consistent with requisite protection to other stations.

Inter - system interference considerations

20. Additional important issues upon which comment is desired concern the interference protection criteria that would be applied between synchronized networks and stations not in the synchronized network. With respect to groundwave interference protection criteria, it appears that the groundwave signal overlap restrictions specified in Section 73.37(a) of the Rules may be appropriate. The matter of skywave interference protection criteria, however, is not as clear. One such issue concerns the manner in which transmitters in the synchronized network should be protected from skywave interference caused by stations not in the synchronized network.

21. Similarly, another issue is whether the nighttime skywave interfering signals from the transmitters in a synchronized network should be considered individually or whether the cumulative interference effect of the entire synchronous group should be considered when calculating skywave interference to other stations on the channel. In this regard the effect of the 50% exclusion rule must

be evaluated. A decision in this area could affect the amount of power permitted for each transmitter in a synchronous group.

Non - technical Issues

22. Beyond the technical issues discussed above, we also solicit comment on various non-technical policy issues related to the use of synchronous group transmitters. These non-technical issues can be divided into two major categories -- (1) licensing and eligibility requirements, and (2) ownership restrictions.

23. *Licensing and Eligibility Requirements.* There are three areas of concern regarding the substantive requirements and applications procedures that should be utilized in authorizing synchronous transmitters. First, we request that commenters address the question of what criteria should be utilized in deciding whether a synchronous transmitter should be authorized. For example, would a synchronous transmitter be appropriate only in situations where a conventional AM station would be precluded? Such preclusion could occur if a proposed new AM station would cause prohibited overlap to other AM stations in violation of Section 73.37(a) of the Commission's Rules or would cause nighttime interference in violation of Section 73.182. Additionally, would the mere desire of a licensee to increase coverage in one or more directions be sufficient justification to permit synchronous operation?

24. Although synchronous transmitters may be used to enhance or extend the coverage areas of AM stations, should there be any limits imposed on the extent to which the coverage area of an AM station may be augmented by the use of synchronous transmitters, and if so, what should they be? Alternatively, should synchronous operation be permitted only within an AM station's protected contour under the Commission's Rules? We solicit comments on these questions and other matters related thereto.

25. Second, we invite comment on who may be licensed to operate synchronous transmitters. Because these transmitters may cause interference to the signal of the primary AM station that is being rebroadcast or to other synchronous transmitters within the same network, we are not inclined to authorize their use by any party other than the AM station licensee who seeks to expand its service area. Moreover, such a licensing limitation is consistent with the requirement that FM boosters--which rebroadcast the programming of a parent FM station on the same carrier frequency as the parent station--be authorized only to the licensee or permittee of the parent station.¹⁰ Since synchronous transmitters, like FM boosters, operate on the same frequency as the parent station and pose a potential for interference to the primary station, we believe that a similar licensing limitation would be appropriate.

26. Third, we question how requests or applications for synchronous transmitters should be processed. Our initial view is that such applications should be processed like applications for major or minor changes in AM broadcast facilities because synchronous transmitters are intended to be permanent and protected improvements to the coverage of existing AM stations. Consequently, if an application for a synchronous transmitter is processed like a major change, it would be placed on a cut-off list and could not be acted upon by the Commission until after a 30-day public notice period. During that time, the public

would be afforded an opportunity to file petitions to deny pursuant to Section 309(d) of the Communications Act and Section 73.3584 of the Commission's Rules. In addition, any applications for changes in existing AM facilities or for new AM stations which may be mutually exclusive with a synchronous transmitter proposal would have to be filed during this 30-day period.¹¹ Such mutually exclusive applications generally warrant a comparative hearing to select a permittee under the *Ashbacker* doctrine.¹² However, if a request for a synchronous transmitter were processed like a minor change in facilities, it could be granted without the necessity of being placed on a cut-off list; and only those informal objections filed prior to grant could be considered. Accordingly, we request comment on whether such a cut-off list approach should be utilized or under what circumstances requests for synchronous transmitters should be considered as minor changes. Alternatively, we question whether synchronous transmitters should be treated as secondary to full-service stations and be afforded no continuing protection.

27. *Ownership Restrictions.* Next, we must consider whether ownership restrictions should apply to synchronous group transmitters on either a local or a national basis. Such restrictions currently apply to the commercial AM, FM, and television services. With respect to national ownership restrictions, the Commission generally permits an individual to have a cognizable ownership interest¹³ in a maximum of 12 commercial AM stations.¹⁴ The question arises as to whether synchronous transmitters, additional to the primary station, should be counted for purposes of this "rule of 12." Our preliminary view is that synchronous transmitters should *not* be attributed under this rule. We base this position on two reasons. First, we believe that such a restriction may not allow for the full development of this proposed new broadcast technique and the benefits that it may afford. If broadcasters are limited to owning a total of 12 commercial AM stations, including synchronous transmitters, then they might be discouraged from building many synchronous transmitters because it could affect the number of additional AM stations that they could acquire. Second, exempting synchronous transmitters from the national ownership restrictions would be consistent with Commission precedent. In this regard, the Commission does not count terrestrial satellite television stations for purposes of the twelve-station rule. Like synchronous transmitters, these satellite television stations repeat most, if not all, the programming from a parent station and can have broadcast facilities comparable in power and coverage to the parent station. Accordingly, we solicit comment on whether we should take the same approach for synchronous transmitters.

28. We also need to consider whether local ownership restrictions should apply to synchronous group transmitters. One such restriction is the AM "duopoly" rule which currently prohibits overlap between the 1 mV/m contours of commonly owned commercial AM stations.¹⁵ Clearly, the "duopoly" rule should not apply to overlap occurring within a synchronous network. Such local ownership restrictions would have the detrimental effect of unnecessarily inhibiting the development of this new technology and preventing the enhancement or expansion of service by AM broadcasters. For similar reasons, we also believe the "duopoly" rule should not prohibit in-

stances of contour overlap between synchronize transmitters and other commonly owned AM stations that are not part of the same synchronous network.

29. Another local ownership restriction is the "one-to-a-market" rule which, *inter alia*, prohibits the common ownership of commercial AM and television stations in the same market. Specifically, the rule achieves this result by barring cross-ownership where either the 2 mV/m groundwave contour of the AM station encompasses the entire community of license of the television station, or where the predicted Grade A contour of the television station encompasses the entire community of license of the AM station.¹⁶ We believe that it would be inappropriate to apply this cross-ownership restriction to synchronous transmitters as this would also hamper the development of this technology. Moreover, exempting synchronous transmitters from this rule would give AM broadcasters greater flexibility in using this technology to enhance and expand their service areas since they would not have to be concerned with contour encompassment between commonly owned television stations and AM synchronous transmitters. Accordingly, we solicit comment on whether the public interest would be served by exempting synchronous transmitters from the "duopoly" and "one-to-a-market" rules.

IV. CONCLUSION

30. Synchronous transmitter systems have been successfully used in Europe for many years to extend service. Although conditions in the United States differ, such operations appear to offer advantages here as well. Internationally, general standards for synchronous transmitter systems already exist, but standards specifically tailored for the U.S. need to be developed. Moreover, non-technical issues unique to the U.S. need to be resolved before synchronized networks can be routinely authorized.

31. The primary issues addressed in this *Inquiry* are summarized as follows:

What technical standards should be adopted governing the operation of a synchronous group of transmitters as it affects intra-system interference and other system impairments.

What interference protection criteria should be applied between synchronous networks and individual stations not in the synchronous network?

What level of distortion can be anticipated as a result of using frequency or phase synchronization techniques, and which synchronization technique is more advantageous?

Would the utility of nighttime synchronous transmitter operations be diminished significantly because of skywave interference?

What treatment should synchronous transmitters be afforded under the multiple ownership rules and what licensing criteria should be applied?

32. In order to assemble a comprehensive record, we invite comment from all interested parties on the issues discussed in this *Inquiry*. We also encourage experimental licensees to submit their results or observations relating to the technological concerns raised in this *Inquiry*. If com-

menters wish to address issues we have not identified, we encourage them to do so. The record established in this proceeding will allow the Commission to analyze the impact of synchronous group transmitters on the delivery of AM service to the general public, and to develop rule proposals.

33. Pursuant to applicable procedures set forth in Sections 1.415, and 1.419 of the Commission's Rules, interested parties may file comments on or before May 4, 1987 and reply comments on or before June 3, 1987. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference Room (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

V. AUTHORITY

34. Authority for issuance of this Notice is contained in Sections 4(i), 303(r) and 403 of the Communications Act of 1934, as amended.

35. For information concerning this proceeding contact Bernard Gorden at (202) 632-9660 or Andrew J. Rhodes (Legal) at (202) 632-7792.

FEDERAL COMMUNICATIONS COMMISSION

William J. Tricarico
Secretary

FOOTNOTES

¹ The Report (pp. 71-77) included a discussion on the following three types of multiple transmitters: (1) synchronous operation, (2) AM satellite stations, and (3) AM/FM translators.

² Since January 1986, the Commission has granted experimental authorizations for the construction of synchronous systems to the following licensees: KROL of Henderson, Nevada; KOB of Albuquerque, New Mexico; KIPA of Hilo, Hawaii; and WJNO of West Palm Beach, Florida. Requests for experimental authorizations for synchronous transmitter operations are currently pending from the following stations: KGNW of Seattle, Washington; KNEW of Oakland, California; KNUZ of Houston, Texas; and WORC of Worcester, Massachusetts. Experimental authorizations are on a secondary basis and are not afforded interference protection from other existing or future primary station assignments. Such authorizations also require that the permittees file comments to this Inquiry and detailed progress reports on their experimental operations.

³ See Bell Telephone System technical publication, "A Study Of Reception From Synchronized Broadcast Stations," by Charles B. Aiken. Bell Telephone Laboratories, published in Proceedings of the Institute of Radio Engineers, Vol. 21, pp. 1265-1301, September, 1933.

⁴ See European Broadcasting Union (EBU) Technical Report 3210, August 1974, "Synchronizer Groups of Transmitters in LF and MF Broadcasting," which includes examples of low to high powered synchronous transmitters and techniques of frequency control, etc.

⁵ Modulation delay, in this case, is the amount of time that the program signal is delayed in being processed onto the carrier frequency.

⁶ The control could be accomplished in any of several ways, including for example, the use of digital techniques employed via a microwave radio link.

⁷ See the British Broadcasting Corporation, Research Department Report, February 1976, "Reduction of mush-area distortion in common-frequency M.F. transmitter networks."

⁸ The current international protection ratio for synchronous operation used in international Agreements applicable to the U.S. is 8 dB. See Final Acts of the Regional Administrative MF Broadcasting Conference (Region 2), 1981 and Agreements between the U.S. and Canada, and Mexico, respectively signed in 1984 and 1986.

⁹ See CCIR Document Recommendation 560-1 listing EBU reports on synchronized transmitter networks from the United Kingdom, India, and Japan.

¹⁰ See 47 C.F.R. Section 74.1232(e) (1985).

¹¹ A mutually exclusive situation arises whenever two or more bona fide applicants timely file for use of the same broadcast frequency, or for different frequencies whose use would be technically incompatible under the Commission's Rules.

¹² See *Ashbacker Radio Corp. v. FCC*, 326 U.S. 327, 333 (1945).

¹³ An individual generally has an attributable interest in a broadcast station if the individual is an officer, director, general partner, or owner of 5% or more of the voting stock of the station. See 47 C.F.R. Section 73.3555, Notes 1 and 2 (1985).

¹⁴ See 47 C.F.R. Section 73.3555(d)(1) (1985). This limit may be increased to 14 AM stations provided that the additional two stations are controlled 50% or more by members of minority groups as set forth in 47 C.F.R. Section 73.3555(d)(3) (1985).

¹⁵ 47 C.F.R. Section 73.3555(a)(1) (1985). We recently proposed to relax the radio "duopoly" rule. See *Notice of Proposed Rule Making in MM Docket No. 87-7, FCC 87-28*, adopted January 15, 1987.

¹⁶ 47 C.F.R. Section 73.3555(b)(1) (1985). In MM Docket No. 87-7, we have also proposed to modify the scope of the radio-television cross-ownership provisions of the "one-to-a-market" rule. See note 15, *supra*.