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

MEMORANDUM OPINION AND ORDER

Adopted: November 8, 1988; Released: January 13, 1989

By the Commission:

INTRODUCTION

1. On January 15, 1987, the Commission adopted a *Notice of Inquiry* (*Inquiry*) in the above-entitled matter, to solicit information relevant to the development of appropriate technical standards for the operation of synchronous AM transmitters.[1] Having carefully considered the comments filed in response to the *Inquiry*, the Commission concludes that current transmitter synchronization technology does not warrant continuing this proceeding to the rule making stage at this time.

BACKGROUND

2. Synchronous broadcasting involves the use of two or more transmitters that broadcast identical program material on the same frequency. Such transmitters are generally located in geographic proximity to each other and are used to enhance or extend the coverage of an AM station. Since the service areas of the individual transmitters may overlap to some extent, mutual interference must be minimized by precisely matching (or synchronizing) the carrier frequency or phase between the stations.

3. The *Inquiry* noted that conventional methods of enhancing or extending AM station service areas (*e.g.*, increasing transmitter power, changing a directional antenna pattern, relocating the station, or some combination of these) were often precluded because of current congestion in the AM service and the difficulty in protecting the signals of other stations. The use of supplemental, carefully placed, synchronous transmitters appeared to offer an effective and economical way of improving service to important geographic areas that were poorly served by conventional AM stations, without causing significant interference to other stations. Examples cited included improving the service in communities receiving inferior signals because of anomalous propagation conditions within an AM station's normally predicted coverage area, extending the service area to include communities unable to support their own stations, and providing "ribbons of service" along major highways.

4. We recognized, however, that the use of synchronous AM transmitters posed a number of complex technical and administrative questions. These included the need for appropriate intra-system interference criteria (*i.e.*, among the stations in a particular synchronous network), inter-system interference criteria (*i.e.*, among transmitters in the synchronous network and other co-channel and adjacent channel stations) and various licensing and eligibility requirements. For example, we noted that successful use of synchronous transmitters depends fundamentally on the ability to control the interference that can occur among the stations in the synchronized network.[2] A seemingly minor change in the carrier frequency of one transmitter can cause periodic signal fading and distortion in areas where its signal and the signal of another transmitter on the same frequency are of comparable amplitude. Even where exact phase relationships are maintained between stations, we observed that zones of interference could occur where the signals of the individual stations arrive substantially out of phase with each due to their geographic placement with respect to the point of reception. Accordingly, we noted the importance of designing synchronous systems so that areas of interference occur in largely unpopulated areas if at all possible. Comment was sought on the relative merits of frequency and phase synchronization and on whether there was any significant advantage of one technique over the other.[3]

5. Another intra-system interference consideration discussed in the *Inquiry* was necessary desired-to-undesired (D/U) signal ratios for synchronous transmitters. The traditional D/U ratios for AM stations are set forth in Section 73.37(b) of the Commission's Rules. However, the D/U ratios for synchronous transmitters may vary as a function of transmitter frequency tolerance, transit time (the time required for the signal to reach the receiver from each transmitter location), signal type (groundwave or skywave), the requirements of stereophonic transmission, and the effects of audio processing techniques. As a result, merely maintaining a calculated phase relationship among the carrier frequencies of transmitters in a synchronous network may not produce desired results. The phase relationships of the modulating signals applied to the various transmitters may also need to be controlled. Thus, comment was sought on the effects of transit time and the manner in which program distribution equalization (the delay applied to the various modulating signals necessary to achieve the desired phase relationships) could be employed to minimize its effects.

6. We also requested comment on the most appropriate method for calculating the interference effects of multiple synchronous transmitters. The *Inquiry* encouraged testing to determine the effects of two as compared to three or more synchronous transmitters. Mention was also made of the fact that in the United States, the power of synchronous transmitters is typically rather low in comparison to main transmitter power, but that in Europe this is not necessarily the case. Accordingly, we also requested comment on appropriate power limitations for synchronous transmitters.

7. We also solicited comment on various inter-system interference considerations and, in doing so, indicated that the traditional D/U ratios contained in Section 73.37(a) appeared appropriate as groundwave interference protection criteria, but we sought comment on whether transmitters in a synchronous network should be considered individually or collectively in determining interfer-

ence to and from other stations. Comment was also requested on the relevance of the 50% exclusion rule to computing the interference effects of synchronous transmitters.[4]

8. In addition to the preceding technical issues, we discussed potential licensing and eligibility requirements (*e.g.*, what criteria should determine whether or not synchronous transmitters should be authorized). We also questioned whether the mere desire to increase service area constituted sufficient justification, or whether synchronous transmitters should be authorized only in areas where conventional AM stations were precluded because of interference constraints. Comment was also requested on whether or not limits should be placed on the extent to which coverage could be augmented, and if synchronous operation should be permitted only in those areas within a station's normally protected contour.

9. Additionally, we sought comment on whether synchronous transmitters should be authorized only to the original "parent" AM station licensee, whether the authorization of synchronous transmitters as either a major or minor change to an AM facility application and on what circumstances should render such applications major or minor in character. Lastly, comment was requested on whether synchronous transmitters should be counted for purposes of determining compliance with the multiple ownership "rule of twelve" and whether local ownership "duopoly" rules should be applied. The tentative conclusion proposed was that they should not be considered as additional stations in either case.[5] Nevertheless, comment was sought on whether the public would be served by providing exceptions to these rules.

SUMMARY OF COMMENTS

10. In response to the *Inquiry*, we received twenty-two comments and one reply comment.[6] While many of these comments expressed optimism over the potential benefits of synchronous transmitters, others enumerated a variety of technical and operational difficulties.

11. The comments of Price Communications Corporation (Price), licensee of Station KKOB, Albuquerque, New Mexico, were representative of both the benefits and difficulties associated with synchronous operation. Price observed that even in a perfectly (phase) synchronized system, severe receiver distortion occurred when vehicular receivers moved through areas where main and synchronous transmitter signal strengths were of sufficient amplitude to cause mutual interference. Price described what it calls the "Paradox of the Period", where interference between two closely (frequency) synchronized transmitters is acceptable for much of the time, except when the two transmitters eventually drift out of phase. Then, the null between the two signals can last for hours, resulting in considerable mutual interference.[7] Price concluded that the cost of achieving phase synchronization and program equalization distribution was high, and that the preferred alternative was to authorize nominally synchronized transmitters (i.e., those meeting the frequency stability tolerances applicable to non-synchronized transmitters) having substantially less power than the main transmitter. In such a case, Price noted that interference between transmitters may occur more frequently but would be subjectively less bothersome.

12. Greater Media, Inc. (Greater Media) also supported the proposal to allow general use of synchronous transmitters, although its opinion differed somewhat from that of Price. It concluded that based on domestic and European data, phase synchronization appeared to be superior to frequency synchronization as a general rule, although the latter may be appropriate for use in highly populated areas where receiver automatic gain control can compensate for the effects of differing signal strengths. Other commenters similarly affirmed the superiority of phase synchronization, but suggested that optional use of frequency synchronization be permitted in appropriate circumstances.

13. The issue of appropriate intra-system standard for synchronous operation was not well developed in the comments. Price urged that AM station licensees be given the freedom to determine the amount of interference between synchronized transmitters and the most appropriate means of controlling it. Advanced Broadcast Consultants, Inc. (ABC, Inc.) suggested that synchronous transmission facilities be designed to the same standards as the primary station, and therefore satisfy the protection ratios currently set forth in Section 73.37(a) of the Commission's Rules. Greater Media encouraged the Commission to adopt the European method of determining needed protection ratios which uses a statistical method based on subjective impressions of reception quality from transmitters in the synchronized group. However, no consensus on this matter was apparent.

14. Comments on the effects of frequency tolerance, transit time and other signal characteristics on intra-system signal protection ratios were expressed only in general terms. No specific relationships were identified or discussed. Experiences with program distribution equalization seemed encumbered with difficulties and inconclusive, and in several cases problems were discussed in achieving synchronization.

15. The matter of inter-system (or inter-station) interference criteria, however, received considerable comment. Generally, the parties recommended that synchronous transmitters be afforded protection similar to that provided the primary station, and that they should not extend the interference contour of the parent station. Thus, the use of the current daytime and nighttime signal strength prediction methods set forth in the rules was deemed appropriate. As a result, synchronous transmitters would be evaluated individually for their contribution to interfering signal components determined by the RSS method. There was a consensus that synchronous transmitters should be regarded simply as extensions of the primary transmitter, and as such, comply with all current regulations.

16. Agreement also was noted in the matter of the maximum output power appropriate for synchronous transmitters. No one disputed the general conclusion that the maximum power of a synchronous transmitter should not exceed the power of the primary station. ABC, Inc. suggested that a minimum power of 100 watts be required of synchronous transmitters and that the radiation efficiency of synchronous transmitter antenna systems meet a minimum efficiency standard of 241 mV/m/kW at 1.0 km. However, Tidewater Radio Show, Inc. (Tidewater) disputed this view, arguing that given the wide variety of situations in which synchronous transmitters could be employed to enhance service, a policy of no minimum power would be more consistent with the Commission's

policy in conferring post-sunset authority.[8] Tidewater believes that such a flexible approach would be more consistent with the Commission's objective in encouraging the use of synchronous broadcasting technology.

17. There was also a consensus among the commenters on the various licensing and eligibility issues raised in the *Inquiry*. All agreed that synchronous transmitters should be authorized only to the licensees of the primary station, that they should not be counted for purposes of determining compliance with multiple ownership regulations, and that application of "duopoly" restrictions would be inappropriate, since synchronous transmitters were logical extensions of the primary station.

18. The question was raised as to whether or not use of synchronous transmitters would constitute a major or minor change in facilities. Recommendations on this matter were based on the anticipated net effect of such operation, if an equivalent change were made by modifying the primary station facilities. Thus, if the intent was to better serve an area experiencing signal degradation within a station's normally predicted service contour, the use of a synchronous transmitter was regarded as only a minor change in station facilities. However, use of such transmitters to expand the normally predicted service area was considered a major change that should be subject to the normal major modification procedures, including public notice and cutoff provisions.[9]

19. In sum, the *Inquiry* appears to have been useful in soliciting direction on eligibility and authorization issues associated with the use of synchronous transmitters, but less successful in resolving some of the technical issues. This fact was noted by several of the commenters. The Association of Federal Communications Consulting Engineers (AFCCE) concluded that despite the availability of advanced circuitry and techniques said to be capable of providing a high degree of synchronization and delay equalization, recent results have been disappointing. AFCCE believed that the reports submitted by stations with experimental authorizations lack sufficient technical detail to permit reliable forecasts of the interference impact of synchronous transmitters on other licensees. As a result, AFCCE recommended that the inquiry stage of this matter be extended, that further experimental operation be conducted, and that the rule making stage be deferred until sufficient experience has been gained to permit the development of appropriate technical rules.

20. The opinion of NAB largely coincided with that of AFCCE. NAB concluded that while there have been positive elements in the reports submitted to the Commission by those licensees holding experimental authorizations, the record established to date does not demonstrate consistent success with current synchronization technology, and therefore, does not warrant proceeding to the rule making stage at this time.

21. The comments of the Association for Broadcast and Engineering Standards (ABES) are consistent with those of AFCCE and NAB; that is, that contemporary technology is not yet capable of designing a synchronous AM transmission system that is economically feasible and capable of reducing inherent technical problems to acceptable levels.[10]

DISCUSSION

22. After carefully considering the comments, the Commission concludes that while this proceeding has produced additional beneficial information concerning synchronous AM transmission, remaining technical uncertainties appear to preclude meaningful rule making activity at this time. The record indicates the use of a variety of different approaches to achieving transmitter synchronization, each with varying degrees of success. More importantly, no particular approach to synchronization emerged as being consistently efficacious, even in the absence of economic considerations. The record does mention several emerging technologies (*e. g.*, satellite and fiber optic links) that may provide an economical and effective means of achieving phase synchronization. However, none of these have yet been tested in conjunction with AM broadcast operation. Since the applicability of the various current and new technologies to the unresolved technical issues related to AM transmitter synchronization may take some years to determine, we believe the prudent course of action is to terminate this proceeding without action.

23. This action notwithstanding, we wish to express our commitment to cooperating with the broadcast industry in exploring ways of deriving the maximum possible benefits from transmitter synchronization technology. Accordingly, we will generally continue to authorize experimental authorizations to those AM station licensees who wish to investigate further the potential benefits of synchronous operation, and will revisit this matter when the circumstances appear appropriate.

24. Accordingly, IT IS ORDERED that MM Docket No. 87-6 IS TERMINATED.

25. This action is taken pursuant to authority contained in Sections 4(i) and 303 of the Communications Act of 1934, as amended.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX

Parties filing comments in MM Docket No. 87-6:

Advanced Broadcast Consultants, Inc.

Association for Broadcast Engineering Standards

Association of Federal Communications Commission Consulting Engineers

Blue Hen Broadcasting, Inc.

Corporation for Public Broadcasting

Ethnic Radio of Los Banos, Inc.

First State Broadcasting, Inc.

FM Systems, Inc.

Greater Media, Inc.

Harris Corporation, Broadcast Products Division

Lookingglass Prairie Limited Partnership

National Association of Broadcasters
National Public Radio
Radio Carlsbad, Inc.
Radio Enterprises of Ohio, Inc.
SatLok Systems, Inc.
Southwest Radio Corporation
Texas Cost Broadcasters, Inc.
Tidewater Radio Show, Inc.
Tribune Broadcasting Company
Vir James, P.C.
WDUN Radio, Inc.

Reply comments:

Southwest Radio Corporation

FOOTNOTES

[1] *See, Notice of Inquiry*, MM Docket No. 87-6, 2 FCC Rcd 1389 (1987).

[2] The "network" is that group of individual transmitters operated collectively to distribute the service of the primary AM station.

[3] The terms "frequency synchronization" and "phase synchronization" refer to synchronization techniques that differ primarily in terms of degree of accuracy. Two transmitter carriers are considered to be frequency synchronized if their frequencies are within 0.1 Hz of each other. Thus, some drift within the 0.1 Hz tolerance would be considered acceptable. If the two carriers are phase synchronized, they would be exactly in phase with each other, or separated in phase by some fixed amount.

[4] The "50% exclusion rule" is contained in Section 73.182(l)(2) of the Commission's Rules. It indicates that the Root-Sum-Square (RSS) value of interfering signals will not be considered to be increased when a new interfering signal is added which is less than 50% of the RSS value of the interference from existing stations, provided that the new interfering signal is not stronger than any previous signal included in the RSS computation.

[5] *See* Section 73.3555 of the Commission's Rules which limits the multiple ownership of broadcast stations.

[6] Initially, comments filed in response to the *Inquiry* were due on May 4, 1987, with reply comments due on June 3, 1987. However, during the pendency of the proceeding, three petitions were received that sought additional time for comments and reply comments, on the basis that the proposed extension was necessary for additional testing of synchronous transmission systems. Ultimately, the comment and reply comment periods were extended to May 8, 1988 and June 8, 1988, respectively.

[7] This problem is characteristic of frequency synchronization that approaches phase synchronization in terms of accuracy. Desirable phase relationships are sustained for considerable periods of time, but adverse phase relationships also become more pronounced.

[8] In some cases, post-sunset operating authority limits the power to 2 or 3 watts.

[9] The National Association of Broadcasters (NAB) argued that while synchronous operation may be useful in providing enhanced service within a station's regular service contour or enable AM "daytimers" to provide service to a greater number of people without the interference consequences associated with additional transmitter output power, it should not be used to extend a station's service area.

[10] We would note that two of the commenters, SatLok Systems, Inc. (SatLok) and FM Systems, Inc. (with which SatLok is associated) describe a new satellite-based, phase-lock synchronization system said to provide accurate frequency or phase synchronous operation at a reasonable cost. However, this system has yet to be tested by AM stations.