2. LPFM Spectrum Rights and Responsibilities

60. Background. In the *Notice*, we raised issues regarding the spectrum priority of the contemplated classes of LPFM service. We recognized that our resolution of these issues would affect where LPFM stations could locate and the stability of their operations. Additionally, LPFM interference protection rights and responsibilities could affect existing and future FM radio service. The *Notice* proposed a 1000-watt primary service and a 100-watt secondary service. It sought comment on a 10-watt class of LPFM station that would be secondary to all other FM radio services. As proposed, LP100 and LP10 stations would not be permitted to interfere within the protected service contours of existing and future primary stations and would not be protected against interference from these stations. We sought comment on whether LP100 stations should be permitted to select channels without regard to interference received and on the extent to which LP100 stations should protect FM translator and booster stations.

61. Comments: Given our decision not to create a 1000-watt LPFM station class, this summary is limited to the issue of spectrum priorities for LP100 and LP10 stations. The comments were divided on whether LPFM stations should have a primary or secondary regulatory status. Several commenters supported primary status for all LPFM stations, mainly to help ensure their survival.[105] The ACLU of Massachusetts believes that all LPFM stations should be primary, but should be willing to accept higher than normal amounts of interference.[106] The Community Broadcasters Association supported primary status for all LPFM stations as a way to open capital markets for these stations.[107] Some commenters supported a modified form of primary status for LPFM. Amherst Alliance supported a status that would not permit LPFM stations to "bump" other stations, but would also protect LPFM stations from being "bumped."[108] Community Broadcasters commented that LPFM stations should be given primary status with respect to analog stations, but have a secondary status with respect to digital radio stations.[109] Other commenters, including some broadcast licensees, supported a secondary status for LPFM stations.[110] Big City Radio, Inc., for example, stated that LPFM stations should not be permitted to block the relocation of full-power stations forced to relocate their transmitter sites.[111]

Wireless Telecommunications Bureau.

105 *See, e.g.*, Comments of Media Island International at 1; Comments of City of Berkeley, CA at 1; Comments of Citizens Telecommunications & Technology Advisory Board of Seattle at 4; Comments of Jennifer Anne Barrios at 1; Comments of Citizens for Access to the Airwaves at 2.

106 Comments of ACLU of Massachusetts at 98.

107 Comments of Community Broadcasters Association at 1.

108 Comments of Amherst Alliance at 7.

109 Reply Comments of Community Broadcasters at 9.

110 *See, e.g.*, Comments of Bible Broadcasting Network, Inc. at 3; Comments of WATD at 6; Comments of Emmis Communications Corporation at 1; Reply Comments of Cumulus Media, Inc. at 13; Comments of Infinity Broadcasting at 25.

111 Comments of Big City Radio, Inc. at 22.

Mississippi Valley Broadcasters, LLC commented that LPFM stations should be given the same secondary spectrum priority as FM translator stations.[112] According to the Association of Federal Communications Consulting Engineers, LP100 stations should be secondary and not be permitted to displace FM translator stations.[113] Aaron Read commented that Class D FM stations should be secondary to LP100 stations because of their higher power, but that microradio stations should be secondary to Class D.[114] Jeffrey Richman, chief operator of a Class D station, commented that Class D licensees should not be secondary to LPFM licensees.[115]

62. Decision. In crafting interference protection rights and responsibilities for an LPFM service, we seek to balance our vital interest in maintaining the technical integrity of existing radio services with our desire to create a supple and viable community-oriented radio service. First and foremost, we must require that new LPFM stations protect radio reception within the service areas of existing full-service stations, as well as the existing services of FM translator and booster stations. Second, LPFM stations, with their much smaller service areas and fewer service regulations, should not prevent FM stations from modifying or upgrading their facilities, nor should they preclude opportunities for new full-service stations. Additionally, LPFM applications will be required to protect vacant FM allotments. Subject to these constraints, however, we want to foster a stable and enduring LPFM service. Once an LPFM station is built and operating, we wish to permit it to continue operating on its channel, wherever possible, as the radio environment changes around it. We want to minimize, to the extent possible, the situations in which we would require an LPFM station to change its channel or cease operating. This measure of stability, we believe, would assist LPFM station applicants or operators in obtaining financing to construct and operate stations and to better serve their communities. It may also create an incentive for the operation of a first local radio station in many communities or radio service that would be responsive to other unmet needs. We believe the approach set forth below appropriately balances the above objectives.

63. *Protection to existing FM radio services*: Applicants for new or modified LP100 or LP10 facilities will be required to meet minimum station separation distances to protect the service contours of authorized commercial and noncommercial FM stations of all classes, including Class D. In the same manner, they will be required to protect the existing service of FM translator and booster stations and LP100 stations. We will also require LPFM applicants to protect full-service FM, FM translator and LP100 facilities proposed in applications (for example, FM minor change applications) filed before a public notice announcing an LPFM application filing window. Applications filed after the release date of an LPFM window notice will not be protected against LPFM applications filed in that window. However, full-service applicants will not be required to protect the facilities proposed in LPFM

112 Comments of Mississippi Valley Broadcasters at 8.

113 Comments of the Association of Federal Communications Consulting Engineers at 13. The comments of National Public Radio also contend that LPFM stations should not be permitted a higher priority than FM translator stations, Comments of NPR at 23-27. The National Association of Broadcasters, while opposing the creation of any LPFM service, submits that FM translators and boosters must be protected against new LP100 stations, Comments of NAB Volume One (August 2, 1999) at 63-64.

114 Comments of Aaron Read at 2.

115 Comments of Jeffrey Richman at 1.

applications. We believe this approach fairly balances the interests of full-service and LPFM applicants. LPFM station proposals to operate on channels 201-220 will also be required to protect television stations operating on TV Channel 6. Applicants for LP100 stations will not be required to protect authorized LP10 stations or LP10 application proposals, given the relatively smaller service areas of LP10 stations.[116] Station separation requirements for these various purposes are described in paragraphs 68-72 and 114 and the separation distances are presented in the tables in the attached rules.

64. The extent of interference protection from LPFM stations to existing FM, LPFM and FM translator and booster service generally will be that afforded by minimum station separation requirements. These were designed to provide the same degree of interference protection that full-service stations provide each other.[117] We have added a 20-kilometer buffer to the separations for protecting co-channel and first adjacent channel full-service stations. This buffer will help to protect FM radio facilities that were modified or upgraded in a manner that would create a short-spacing with an operating LPFM station. LPFM stations will not be required to eliminate interference caused to FM stations by their lawful operations. They will, however, be required to eliminate interference caused by operations that violate the terms of the station's authorization or the Commission's Rules; for example, radiation of excessive emissions outside of the station's authorized channel. LPFM station operators will also be required to respond to complaints of "blanketing" interference (*see* paragraph 113.). They will also be subject to international agreements regarding the elimination of interference to primary Canadian or Mexican broadcast stations. Until these agreements are modified, we believe it is appropriate to apply to LPFM stations the international provisions applicable to FM translators, which operate at comparable power levels.

65. *LPFM rights and responsibilities with respect to subsequently modified, upgraded or new full-service FM stations.* We are not adopting for the LPFM service many of the regulations applicable to full-service stations; for example LPFM stations will not be required to have a main studio. LPFM stations also will service much smaller areas than full-service stations. For these reasons, we do not believe that an LPFM station should be given an interference protection right that would prevent a full-service station from seeking to modify its transmission facilities or upgrade to a higher service class. Nor should LPFM stations foreclose opportunities to seek new full-service radio stations. Accordingly, operating LPFM stations will not be protected against interference from subsequently authorized full-service facility modifications, upgrades, or new FM stations. Because we will not protect LPFM from future FM facilities, we will not require LPFM applicants to meet minimum distance separation requirements to protect their service areas against interference received. However, as a guide to LPFM applicants, the attached rules includes minimum station separation distances necessary to protect an LPFM station's 60 dBu contour.

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116 In this regard, LP10 stations will be authorized on a secondary basis to LP100 stations. However, interference protection from LP10 stations to LP100 stations will be limited to the extent of the protection afforded by the station separation requirements.

117 The minimum separation distances governing LPFM stations authorizations are based on the same protection criteria used to derive the minimum separations among full-service FM stations; *i.e.*, the same desired-to-undesired signal strength ratios applied at a station's protected contour and the assumption that a protected station operates at the maximum height and power permitted for its class.

66. We expressed our desire to provide a measure of stability to operating LPFM stations. For this purpose, we will permit LPFM stations to continue operating even though they would cause interference within the protected service contours of a subsequent authorized FM service, including new stations and facilities modifications or upgrades of existing stations. In such situations, the LPFM operator would decide whether interference received to its service would permit the station to continue operating on its channel. However, we must make one exception to this policy. FM stations have a core responsibility to service their principal communities. Therefore, we will not permit an operating LPFM station to cause interference within a commercial or NCE FM station's 3.16 mV/m (70 dB) contour. This issue can only arise in connection with a subsequently filed full-service new station or modification application. If grant of such an application would result in predicted interference within the 3.16 mV/m (70 dBu) contour of the proposed station, the affected LPFM station will be provided an opportunity to demonstrate that interference is unlikely to occur within this contour due to, for example, terrain shielding. If the LPFM station fails to make a sufficient showing, it will be directed to cease operations upon the commencement of program tests by the commercial or NCE FM station.

67. We recognize that actual interference within the 3.16 mV/m contour might still be possible where the LPFM station has demonstrated that it is unlikely. In these circumstances, a complaint of actual interference must be served on the LPFM station and filed with the Commission, attention Audio Services Division. The LPFM station must suspend operations within twenty-four hours of the receipt of a complaint unless the interference has been eliminated by the application of suitable techniques and to the satisfaction of the complainant. An LPFM station may resume operations only at the direction of the Commission. If the Commission determines that a complainant has refused to permit the LPFM station to apply remedial techniques that demonstrably will eliminate the interference without impairment of the original reception of the full-service station, the licensee of the LPFM station will be absolved of further responsibility. As a practical matter we believe that in many cases involving FM station modifications or upgrades, interference to new or expanded areas will be offset by the conservative separation distances met by the LPFM station when it was initially authorized, particularly because of the 20-kilometer interference protection buffer.

3. Minimum Distance Separation Requirements

68. Background. The *Notice* tentatively concluded that minimum distance separation requirements for LPFM stations would provide the most efficient means to process a large number of applications while ensuring the overall technical integrity of the FM service. We proposed minimum spacings to protect full-service station operation on the same channel, first-adjacent channel and intermediate frequency (IF) channels. We proposed to exclude third-adjacent channel protection and questioned the need for second-adjacent channel spacing requirements. We noted that the use of a contour overlap methodology could significantly delay the implementation of the LPFM service because it would require substantial preparation on the part of applicants and the Commission and would increase the processing burden on the staff. The *Notice* included spacing tables for the proposed LPFM classes based on the interference protection ratios that underlie full-service radio separations and the assumption that stations operate at the maximum height and power for their station class. We sought comment on the accuracy of the specific values listed in these tables. In addition, we requested comment as to whether alternate approaches, including contour overlap methodology and/or more sophisticated terrain modeling programs, should be used at a later time, based on our initial experience in authorizing LPFM service.

69. Comments. No comments challenge any of the specific values listed in our proposed minimum distance separation tables. However, one commenter, Summit American, Inc. (Summit), suggests an alternate methodology based upon a full service station's 44 dBu F(50,50) protected service contour, instead of the 60 dBu contour that defines the protected service contours for all NCE and many commercial stations. The 44 dBu contour is cited by Summit as the "extent of listenable service for the average listener," based upon the comments filed by USADR, one of the proponents of an in-band-on-channel digital audio broadcasting (IBOC DAB) system. In support of the definition of service beyond that protected by the Commission, Summit cites the Commission's FM translator interference rules which define interference as affecting an area where there is reception of "a regularly used signal."[118] Although it does not calculate distance separations, the North Carolina Association of Broadcasters and the Virginia Association of Broadcasters (NCAB/VAB) echo Summit's concerns and argue that our separation requirements should protect actual service areas beyond protected contours.[119] Several commenters urged either the use of a contour overlap methodology or a combination of contour overlap and separation requirements in order to accommodate the licensing of additional LPFM stations.[120]

70. Decision. We recognize that a distance separation methodology will preclude new LPFM stations in some areas. However, we are not persuaded that the potential benefit of some additional stations is substantial enough to warrant the preparation of more complex and costly engineering exhibits based on contour protection and the resulting delays in the authorization of LPFM service. Therefore, we are adopting minimum separation requirements for the LPFM service as the means of protecting full service commercial and noncommercial educational stations.[121] We also adopt spacing rules to protect FM translator stations and other LPFM stations, as well as a spacing table for LPFM stations operating on Channels 201 through 220 with respect to protection of TV Channel 6.[122] As we proposed in the *Notice*, we will not establish minimum separations between LPFM stations that operate two or three channels apart. Special case spacing tables are also being adopted for Puerto Rico and the U.S. Virgin Islands. Additionally, appropriate spacings will be used for the approximately 20 "grandfathered superpowered" stations operating in the reserved band.[123] These spacing tables are set

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118 *See* Comments of Summit (August 2, 1999) at 2-4; *see also* Comments of USADR (August 2, 1999), Exhibit A at 3.

119 *See* Comments of NCAB/VAB (August 2, 1999) at vii-ix.

120 *See, e.g.*, Comments of Dr. C. William Chignoli at ¶ 3.

121 Unlike full service commercial and noncommercial educational stations, we are not adopting spacing requirements for stations removed three channels from the LPFM frequency (third adjacent channel), for reasons which will be explained in a subsequent section.

122 Currently, noncommercial educational stations operating in the reserved band (Channels 201 to 220, or 88.1 MHz to 91.9 MHz) must provide protection to reception of television channel 6 in accordance with the provisions of 47 CFR § 73.525. We have decided that LPFM stations should also protect reception of TV Channel 6. This issue is covered in greater detail in ¶ 114 below.

123 Superpowered stations will be protected under the distance separations for the class of station that most closely approximates its facilities. This determination will be made based upon the stations 1 m V/m reference contour and the procedures for determining class listed in §73.211. A listing of correct reserved band superpowered stations is included in Appendix B.

forth in the new rules, in Appendix A. LPFM applicants should be mindful of the fact that the minimum separation distances being adopted will not protect LPFM stations against interference from the full service stations, but are designed to prevent the LPFM station from causing interference to the protected service areas of full-service FM and other protected stations. However, as a guide to LPFM applicants, we are including in the rules a table giving the minimum separations necessary to avoid interference within the LPFM station service areas.

71. The minimum distance separation requirements that we adopt here for LPFM stations do not apply to full-service stations and FM translators. To prevent subsequently filed FM translator stations from causing interference to existing LPFM stations, we will expand the current FM translator interference protection rules to include a requirement that previously authorized LPFM stations be protected. As noted above, we will permit a full service station to modify its facility in a manner that reduces these separations to LPFM stations. However, in such cases we generally will not require the LPFM station to cease operation. Instead, the affected stations will have to bear any interference caused by facilities changes, such as an FM transmitter site move. However, so as to reduce the potential impact on the affected stations, the spacing rules we adopt today include a 20 km "buffer" for co-channel and first-adjacent channel LPFM-to-full-service-FM stations. This additional separation is included for two reasons. First of all, we recognize that the FM band is not static. For example, broadcast stations often change transmitter sites to provide better service to their communities and service areas. Same-station-class transmitter site moves are generally less than 20 km from the original site. Therefore, inclusion of the 20 km buffer spacing allows full-service stations room to move while also reducing the potential impact on existing LPFM stations. Second, and equally important, the additional separation affords the LPFM station an increased likelihood that its operation would not cause interference within a full service station's community of license. This additional 20 km separation will apply only to the initial establishment of the LPFM station. Subsequent site moves by the LPFM station would either need to meet this distance separation requirement, or if the existing spacing were already less than this amount due to a prior site move by a full service station, the spacing could not be less than the currently existing separation.

72. *International Coordination Provisions.* We are also adopting provisions for LP10 and LP100 stations which lie within 320 km of the Canadian or Mexican borders, consonant with existing international agreements between the respective countries. We will apply the existing FM translator rule, 47 CFR § 74.1235, and current international coordination procedures to LPFM stations in these areas.[124] In the attached rules, we include distance separation tables that were intended to ensure compliance with the appropriate international agreements. We will adopt these tables to the extent that foreign stations are provided the appropriate protection. We have also derived similar tables for LP10 stations. We will only accept LPFM proposals that meet these distances. Such proposals will be coordinated as required by the pertinent agreements. In addition, LP10 and LP100 applicants in the U.S.

[124] Pursuant to § 74.1235, FM translators within 250 km of the Canadian border may be authorized if the 34 dBu F(50,10) interfering contour does not exceed 60 km in any direction from the transmitter site. FM translators located within 125 km of the Mexican border will be permitted to operate with an ERP not to exceed 50 watts, provided that the 34 dBu F(50,10) interfering contour does not extend more than 32 km toward the Mexican border, and the 60 dBu F(50,50) service contour cannot extend more than 8.7 km from the transmitter site in the direction of Mexico. FM translators located further than 125 km from the Mexican border, but less than 320 km from the border, may operate with the maximum ERP permitted for LP10 and LP100 stations, however, the location of the 60 dBu contour must lie more than 116.3 km from the Mexican border.

Virgin Islands should be aware that international coordination may be required with the British Virgin Islands in some instances.

4. Second and Third Adjacent Channel Protection

73. Background. In the *Notice* we sought comment on the interference protection criteria to be used to govern the authorization of low power radio services. We stated that low power stations would be subject to existing co-channel and 1st-adjacent channel protections but that to the extent possible we were inclined to authorize low power service without any 2nd- and 3rd-adjacent channel protection standards.[125] We stated our belief that a strong case could be made for not requiring 3rd-adjacent channel protection to or from any of the contemplated classes of LPFM stations. We indicated that such an approach would entail little risk of interference to existing radio service. We noted that areas of potential interference to a full power station would be very small and occur only in the immediate vicinity of the low power transmission facility. We further indicated that such interference would generally only occur if the low power station were located at, or very near, the outer edge of the full power station's service contour where the full power station's signal is the weakest. We noted that 3rd-adjacent channel protection was eliminated for certain grandfathered and short-spaced full power stations in 1997.[126] On balance, we stated that creating opportunities for a new LPFM service should outweigh any small risks of interference to and from LP1000 and LP100 stations.[127]

74. With regard to 2nd- adjacent channel protection, we noted that "grandfathered" short-spaced FM facilities were permitted to modify their facilities without regard to 2nd- and 3rd- adjacent channel spacings during the period from 1964 to 1987, and from 1997 to the present. We indicated that no interference complaints were received as a result of those modifications and found that the small risk of interference was outweighed by improved service. Similarly, we noted that we have been willing in the past to accept small amounts of potential 2nd- and 3rd-adjacent channel interference in the noncommercial FM service where such interference is counterbalanced by substantial service gains.[128] We sought comment on the state of receiver technology and the ability of receivers to operate satisfactorily in the absence of 2nd-adjacent channel protection. We also sought comment on the impact of eliminating 2nd- adjacent channel protection on the possible conversion of existing analog radio services to a digital mode, in particular with regard to in-band-on-channel (IBOC) technology. In this regard, we noted that one IBOC proponent, USA Digital Radio Partners, L.P. (USADR), suggested that 2nd-adjacent channel signals from analog FM stations in the existing radio environment would not pose an interference threat to its digital IBOC signal.[129]

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125 *See Notice* at ¶ 42.

126 *See Report and Order* in MM Docket No. 96-120, 12 FCC Rcd 11840, 11847-49 (1997) (*Grandfathering of Short-Spaced Stations R&O*).

127 *See Notice* at ¶ 45.

128 *See* Educational Information Corporation, 6 FCC Rcd 2207 (1991).

129 *See Notice* at ¶ 47.

75. Comments. Three technical studies of FM receivers were filed in response to the *Notice*. These studies were: 1) *FM Interference Tests, Laboratory Test Report,* Thomas B. Keller, Robert B. McCutheon, Consumer Electronics Manufacturers Association (CEMA), 1999, conducted under the auspices of National Public Radio (NPR), CEMA and the Corporation for Public Broadcasting (CPB) (CEMA study); 2) *Technical Studies and Reports* filed by the National Association of Broadcasters (NAB study); and 3) *Receiver Evaluation Project* conducted by Broadcast Signal Lab, LLP for the National Lawyers' Guild, Committee on Democratic Communications (NLG study).[130] The Commission's Office of Engineering and Technology also completed a study of FM receivers that was placed in the record of the proceeding (OET study).[131] In addition, NAB and CEMA filed supplementary technical information in their reply comments and a *Technical Analysis of the Low Power FM Service* by Theodore S. Rappaport (August 26, 1999) was submitted by the Media Access Project as part of its replies (Rappaport study).

76. *CEMA Study and Comments*. CEMA states that the purpose of its study is to document the sensitivity of consumer FM receivers to interference from other FM band signals. CEMA tested 16 consumer receivers, including 5 automobile radios, 5 "Home Hi Fi" tuners or receivers, 3 portable stereo systems, 2 portable radios and one "Walkman" radio. These receivers were tested under a number of conditions including co-channel, and 1st-, 2nd-, and 3rd- adjacent channel interference. CEMA asserts that its tests indicate that the FCC's proposal to eliminate 2nd- and 3rd- adjacent channel protections could result in significant interference to current and future FM service and threaten the deployment of future digital audio radio services. It therefore recommends that the 2nd- and 3rd-adjacent channel (and intermediate-frequency related) protections be maintained.

77. CEMA's test results are as follows:

- The current FCC co-channel desired to undesired (D/U) signal protection ratio of 20 dB results in an average audio signal-to-noise (S/N) ratio of 24 dB. To achieve what CEMA regards as the desired target audio quality level, *i.e.*, 45 dB, an additional 22 dB of protection is needed.[132]

- The current FCC 1st-adjacent channel protection ratio of 6 dB results in an average S/N ratio of 36 dB. To achieve the 45 dB S/N level, an additional 11 dB of protection is needed. Tests also show potential analog-to-digital interference.

- The current 2nd-adjacent channel protection ratio of -40 dB results in an average S/N of 28 dB, while at a D/U ratio of –30 dB the average S/N ratio is 35 dB.

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130 The NLG study was funded by NLG, UCC, et al., and several others.

131 *See Second and Third Adjacent Interference Study of FM Broadcast Receivers*, OET Report FCC/OET TRB-99-1, prepared by William H. Inglis and David L. Means, July 1999.

132 CEMA target level was an audio Weighted Quasi-Peak (WQP) S/N ratio of 45 dB. It indicated that NPR had established the 45 dB audio S/N ratio for quality broadcasting on a previous project. *See* CEMA's *Laboratory Test Report* at p.1.

- The current 3rd-adjacent channel protection ratio of -40 dB results in an average S/N of 36 dB. Based on this finding, CEMA argues that the 3rd-adjacent protection should be maintained.

- Intermodulation tests show that the current intermediate frequency (IF) protection requirements are required to avoid both IF interference and local oscillator interference.[133]

78. *NAB Study and Reply Comments*. As part of its comments, NAB submitted a technical study of FM receivers. In addition, it provided extensive tabular and geographical data illustrating what it believed would be the impact of various LPFM operations on existing FM broadcast service. NAB states that the receiver study was conducted to determine the susceptibility of modern FM receivers to co- and adjacent-channel signals and to determine the potential for interference to existing FM stations should a new low power FM service be authorized. NAB tested a total of 28 FM radios. This sample included 8 automobile, 5 component, 5 portable, 5 personal and 5 clock radios. In its reply, NAB argues that its sample is the only one of those used in the four studies that fairly represented all receiver categories.

79. In conducting its study, NAB chose a 50 dB audio S/N ratio as its performance measure. It considered interference to occur when the audio S/N ratio was degraded to this level. For radios that could not attain a 50 dB audio S/N ratio in the absence of an interfering signal, interference was judged to occur when the audio S/N ratio was degraded by a factor of 5 dB. NAB's test results demonstrate that receivers are most sensitive to co-channel interference and are progressively less sensitive to interference as the spacing between the desired and undesired frequencies increases. Based on its performance measure, NAB indicates that 15 to 22 of the 28 receivers in its sample would experience interference from signals on 3rd-adjacent channels at the current -40 dB D/U protection ratio.[134] NAB also indicates that 22 to 23 receivers in its sample would experience interference from signals on 2nd-adjacent channels. NAB therefore concludes that FM receivers generally do not perform up to the current FCC interference standards and that the Commission's assumptions that these restrictions could be eliminated for LPFM stations are incorrect.

80. In its reply comments, NAB also criticizes the receiver samples used in the other technical studies. It argues that only its study tested five different categories of receivers and a full price range of receivers in all categories. It also argues that OET and CEMA did not test clock radios and OET did not test personal radios, while CEMA only included one personal radio in its sample. NAB further asserts that while NLG tested all categories, its sample was too small to derive any general conclusions. NAB notes that all of the studies agree that automobile radios and, in some cases, component receivers, tend to be more effective at rejecting adjacent channel interference than clock, personal and portable radios.[135] However, NAB asserts that all of the studies confirm that modern FM receivers do not perform as well as the existing FCC protection criteria for 2nd- and 3rd-adjacent channel interference assume.

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133 *See* Comments of CEMA at ii-iii, and *Laboratory Test Report* at pp. 1-7.

134 *See* Comment of NAB Vol. 2 at 22-26.

135 *See* Reply Comments of NAB at 8.

81. *NLG Study*. The NLG study examined a sample of 10 consumer FM radios. These radios were grouped in three broad categories as follows: 1) 3 higher priced radios (generally above $150); 5 lower priced radios ($20 to $150); and 3) 2 factory installed car radios. Based on its test results, NLG observed that car radios and higher priced radios performed "far better than one would predict based on the FCC interference ratios" and that "substantial signal strengths were required to cause 2nd, 3rd, and 4th adjacent channel interference.[136] It also observed that the performance of lower priced radios tended to "straddle" the FCC interference protection standards.

82. NLG indicated that it was difficult to establish a definition of unacceptable interference, noting that its tests demonstrated that even the best receivers showed measurable, often imperceptible, increases in distortion in the presence of extremely low level undesired signals. It stated while the traditional practice is to establish a standard based on an absolute level of noise or distortion, such as a 3% increase in distortion or a S/N ratio of 30 dB, actual FM listening conditions are dependent on such variables as reception conditions, baseline radio performance without interference, and the various sounds and effects that interference can create. NLG stated that these variables make it difficult to scientifically derive a universal measure of unacceptable interference. NLG indicated that in testing radios, it found that the distortion and noise performance of each radio exhibited a "transition zone" where the radio would suddenly fail to receive the desired signal. It used these transition zones to make comparisons between radios, between forms of undesired signal modulation, and between interference from signals on adjacent channels.[137]

83. The NLG study's findings are as follows:

- More aggressive modulation of the undesired signal did not cause a significant increase in interference and that this was especially true for signals on 2nd, 3rd, and 4th adjacent channels. Less costly radios were more susceptible to modulation induced interference than more costly radios.

- The response of all radios tested for co-channel and first adjacent channel interference matched or exceeded the FCC interference protection ratios.

- Higher priced radios tend to withstand 2nd-adjacent channel interference better than lower priced radios. Higher priced radios and car radios withstood undesired signal levels higher than the FCC interference protection standards. The poorest performing radios were susceptible to 2nd-adjacent channel undesired signal levels that were as much as 50 dB lower than the levels that affected the best performers.

- 3rd-adjacent channel interference was slightly less challenging to most radios than 2nd- adjacent

136 *See* Executive Summary of the NLG study.

137 NLG stated that while the transition zone in its distortion and noise tests did not pinpoint the conditions under which a listener would decide a signal is undesirable to listen to, it was the most identifiable characteristic common to the radios in its tests.

channel interference. Higher priced radios and car radios tended to fare better than lower priced radios.

84. *OET Study*. The OET study examined four broad categories of FM receivers: 1) small, inexpensive receivers with integral antenna; 2) small, moderate-cost receivers with antenna connection; 3) dash-mount automobile receivers; and 4) moderately expensive audio component receivers. In the OET study, 21 FM receivers were tested. These included 5 small, moderate-cost receivers with antenna connections (portable and "boom-box" receivers), 7 automobile receivers, and 9 moderately expensive audio component receivers ("component" or home stereo type receivers). No inexpensive receivers with integral antennas were selected for the test sample because of the difficulty of providing test signals at accurately controlled levels to this type of device.[138] The OET study found that nearly all the receivers in the sample appear to meet or exceed the current 40 dB 2nd-adjacent channel protection requirement and to exceed the 3rd-adjacent channel protection by a wide margin. The OET study indicated that there was about an 8-10 dB improvement in overall performance with regard to interference immunity with regard to 3rd-adjacent channel signals as compared to 2nd-adjacent channel signals. The study also investigated the effect of reducing the maximum FM deviation on the interfering signal and found that a small improvement in 2nd- and 3rd-adjacent channel interference immunity can be expected for most receivers.

85. *Rappaport Study*. The Rappaport study[139] analyzes the other research, and concludes that LPFM will not cause unacceptable levels of service to existing FM broadcast stations. Rappaport indicates that the submitted technical studies support elimination of 2nd- and 3rd-adjacent channel protection for low power radio and that the small additional interference that would be induced by LPFM is miniscule in comparison to the already existing FM interference levels.[140] Rappaport also asserts that there was a clear bias in some of the technical studies to overstate potential LPFM interference. He indicates, for example, that NAB omitted automobile radios (which make up over 20% of the radios sold and over 44% of the radios listened to by the public) from its LPFM impact study and made up a "worst-case" radio based on measurements from different radios. Spectrum studies are also included that, according to Rappaport, indicate hundreds of LPFM stations may be deployed at power levels between one and 100 watts and serving tens of millions of listeners while having minimal interference impact on tens of thousands of listeners at most.

86. Rappaport states that NAB's and CEMA's tests appear to be designed to show how poorly FM receivers perform compared with the FCC interference protection ratios. He argues that these protection ratios were developed to ensure that stations were not built too close together, thereby providing acceptable reception by early generation of radios. He argues that today's receivers drift less, have more reproducible electrical characteristics and better detection capabilities. He states that the fact that modern receivers do not meet the FCC protection ratios while still providing good consumer performance demonstrates that the protection ratios are overly stringent. Rappaport argues that FM receiver performance is based on actual real world environment, consumer expectations, and design/cost

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138 *See* OET study at 3.

139 Theodore S. Rappaport conducted this study on behalf of MAP. *See* ¶ 75.

140 *See* Rappaport study at 2.

tradeoffs, and has nothing to do with how the FCC assigns station licenses.[141] Rappaport argues that studies show that consumers are pleased with FM radios that have much less protection immunity than assumed by the FCC protection guidelines, and thus LPFM can be easily implemented since LPFM will introduce only a small amount of additional interference.

87. Rappaport notes that the FCC regulations require that out-of-band emissions on the 1st-adjacent channels be at least 25 dB below the main carrier but that in practice they are 30 dB below this level. He therefore suggests that if LPFM transmitters are certified for proper operation as suggested, there is no reason to expect interference except for blanketing conditions.

88. Rappaport indicates that the interference potential of LPFM stations is as follows:

LPFM Power (Watts)	Interference Radius (mi.)	Interference Area (sq. mi.)	Service Radius (mi.)	Service Area (sq. mi.)
1	0.04	0.01	1.1	4.0
10	0.14	0.06	2.0	12.1
100	0.44	0.60	3.5	38.5

89. Rappaport also argues that several conditions must exist for interference to occur, such as: the LPFM station must be at the coverage fringe of the incumbent station; the listener only wishes to listen to a station 2 or 3 channels above or below the LPFM station; and the listener is using a poor performing radio like a clock radio. However, even in these circumstances, Rappaport asserts that, in many instances, the listener may be able to eliminate the interference by adjusting the position of the clock radio or boom box for good reception. Rappaport further argues that the percentage of people experiencing interference from a low power station is much less (0.24% to 1.56%) than the people that would be served by a low power station.[142]

90. Rappaport also criticizes several aspects of the receiver studies by NAB and CEMA. For example, he indicates that despite CEMA's claims, its receiver sample is not representative of the population of receivers in use. He also states that neither NAB or CEMA weighted their results to take into account the high proportion of listening (44%) that occurs in vehicles and that this failure over-emphasized the poor performance of certain other radios. Rappaport also does not believe that the quality criteria selected were appropriate. He notes that NAB chose a quality threshold that was impossible for the majority of its receivers to meet. He states that this suggests either the performance metric was unrealistic, or that there was an intentional effort to select inferior radios. He argues that choosing a fixed quality threshold creates testing and sampling problems. Rappaport argues that in an

141 *See* Rappaport study at 12.

142 The percentage values cited reflect differences in LPFM power levels from 1 watt to 100 watts and are based on the average population density for the 60 cities studied in the *Notice*. Rappaport acknowledges that results will vary from city to city. Rappaport Study at 23-24.

academic setting, the design of NAB's and CEMA's tests would be considered flawed and the results from such tests would be disregarded.[143] Rappaport also states that none of the four tests gives a complete picture of receiver performance because they all used only a limited range of desired input signals.

91. He indicates that while it is difficult to compare the different receiver studies, they demonstrate that car radios are much more robust to interference and are typically designed to meet the FCC 2nd- and 3rd- adjacent protection ratio (-40 dB D/U ratio). He indicates that other radios do not require this level of protection because, unlike automobile radios, they do not experience severe fading nor do they move rapidly towards an interfering signal.

92. Rappaport also criticizes NAB's mapping study. He states that this study seriously over-counted the number of people potentially affected by LPFM interference by counting affected people multiple times, using the worst possible receiver performance, inventing a "worst radio," and omitting interference from incumbent FM stations.[144] Finally, Rappaport indicates that IBOC proponents' concerns about 2nd-adjacent channel operation by LPFM are unwarranted.

93. Decision. We find that the record in this proceeding thus far, including the technical data and other studies submitted, supports a conclusion that any risk of interference from LPFM stations of 100 watts or less is small and, on balance, is outweighed by the benefits of this new service. We conclude that it is not necessary to apply 3rd-adjacent channel protection requirements to or from such stations. As discussed below, we believe that 100-watt LPFM stations operating on 3rd-adjacent channels will not result in significant new interference to the service of existing FM stations. Nor do we believe such operations are likely to have an adverse effect on digital IBOC signals.[145]

94. In considering the issues relating to potential interference from LPFM operation, we first observe that all of the technical studies before us have certain limitations that make direct comparison of the study results difficult. Most significantly, all of the studies used different measures to determine when interference occurs and the quality of service to be protected. This fact explains somewhat the differences in the conclusions drawn by the various studies.[146] As NAB indicates, the significant differences among the studies were not in the measurements or in the performance of the radio receivers tested, but rather in the criteria used to decide whether the effects of an interfering signal caused harm to

143 *See* Rappaport Study at 41.

144 *See* Rappaport Study at 47-54.

145 For example, in the *Notice* we referenced the view of USADR, an IBOC technology proponent, that "because of the design of the USADR IBOC system, digital reception is essentially not susceptible to 3rd-adjacent channel interference...." *Notice* Appendix C at ¶ 53.

146 For example, CEMA and NAB, in their studies, conclude that 2nd- and 3rd-adjacent channel protections are needed and should be retained to protect against interference while the OET and NLG studies suggest that these interference protections may not be needed in certain circumstances.

the desired signal.[147] We generally concur with this assessment.

95. Both CEMA and NAB used an audio signal-to-noise criterion to define acceptable FM service.[148] CEMA used a S/N value of 45 dB based on an earlier study by NPR. NAB chose a 50 dB S/N criteria. NAB states that an audio S/N of 50 dB is necessary for interference-free reception.[149] NAB indicates that an estimate of the appropriate S/N can be made from the FCC co-channel desired-to-undesired (D/U) interference ratio of 20 dB. It states that the FCC co-channel protection ratio of 20 dB should produce an audio S/N ratio of approximately 50 dB for monophonic reception.[150]

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147 *See* Reply Comments of NAB, Appendix B, Pickholtz/Jackson Review at iii.

148 In this regard, NAB criticizes the OET study for its use of harmonic distortion measurements rather than the more traditional S/N measurements employed in the NAB and CEMA studies. We believe that this criticism is unwarranted. Both S/N and harmonic distortion measurements can be used to satisfactorily measure interference to FM receivers. Both of these techniques quantify in an accurate and repeatable manner the amount of energy produced by the interfering signal in the receiver's audio output. However, there are advantages and disadvantages to each approach. While it is true, as NAB and their consultants have suggested, that harmonic distortion measurements are relatively less sensitive – that is, they produce a smaller change in measured results for a given change in undesired-to-desired signal ratio – the change in distortion is well within the resolution capability of the measuring equipment. On the other hand, distortion measurements provide an advantage over S/N measurements in that they measure the effect of interference on audio output in the presence of the desired signal's modulation, thus capturing any audio intermodulation effects that might be caused by interaction of the desired and interfering signals. S/N measurements, in contrast, require that the desired signal's modulation be removed to measure the interference component, thus missing any opportunity to capture this effect.

We also note that there are slight differences between the NAB and CEMA S/N measurements. In measuring S/N, the value actually measured is (S+N)/N. To make this measurement, one first establishes a reference by measuring the total level of the unimpaired desired signal at baseband and any system noise also at baseband, then removing the desired baseband signal and measuring the relative level of the baseband noise in the presence of the impairment. So the ratio actually reported is *unimpaired* S+N to *impaired* N. Because of shifts in the reference level noted when impairments are introduced (shifts in either direction, apparently caused by either receiver desensitization or the contribution of noise, or both), CEMA chose to re-establish the reference level in the presence of the impairment while NAB did not. Thus, CEMA's reported ratio is actually *impaired* S+N to *impaired* N.

NAB also implies that the test methodology used in the OET study is faulty. NAB makes this claim based on its assertion that the OET test results are significantly different from its results and the results of the other studies when those other results are interpolated to NAB's 50 dB S/N criteria. We find NAB's argument in this regard specious and unpersuasive. Interpolating all test results, except one, to a given criteria and then commenting that the one test result not interpolated is different does not call into question OET's test methodology in our opinion but rather NAB's analysis. In this regard, a direct comparison between OET's test results at 3% distortion and measured and interpolated results at 50 dB S/N is not appropriate and provides no basis for calling into question the validity of OET's tests. We note that OET measured the S/N performance of one of the receivers in CEMA's sample and obtained the same results as CEMA.

149 *See* Comments of NAB Vol. 1 at 28.

150 NAB also cites ITU Recommendation 641, which specified an audio S/N of 50 dB assuming that receivers can produce a S/N of 56 dB without interference, in support of its S/N choice of 50 dB. Recommendation 641, "Determination of Radio-Frequency Protection Rations for Frequency-Modulated Sound Broadcasting," 1986, ITU, (continued....)

96. We do not find the audio S/N criteria suggested by either CEMA or NAB to be appropriate interference criteria for today's FM radio service. FM radio stations provide stereophonic not monophonic service. While a 20 dB D/U ratio yields a *monophonic* audio S/N of about 50 dB, according to an earlier study by NAB, for *stereophonic* transmissions, the 20 dB protection ratio yields an audio S/N of only about 30 dB.[151] While NAB and CEMA may desire that FM radio service be protected to higher levels of service, based on NAB's earlier study and the results of the technical studies before us herein, we do not believe that the existing interference protection standards, *e.g.*, the 20 dB co-channel interference requirement, generally provides for protection to such levels.

97. We also believe that accounting for both stereo performance and the FCC's current interference protection standards explains why many of the FM receivers tested did not meet the criteria chosen by CEMA and NAB, or did exhibit performance degradation higher than NAB's and CEMA's expectations. For example, the majority of receivers (17 of 28) chosen by NAB did not meet its 50 dB S/N criteria with *no* interference present and with the "strongest" desired signal.[152] Similarly, CEMA reports that none of its sample receivers "came near meeting the target S/N" of 45 dB at the FCC's co-channel standard of 20 dB.[153] NLG, in its study, states that "receiver performance data show that all receivers produce some measurable increase in noise at undesired signal levels below the FCC ratio reference levels." We therefore fail to see how 50 or 45 dB can be an appropriate measure when most radios do not perform at this level, even in the absence of any interference as was the case in NAB's tests. We have no reason to find that the vast majority of current FM receivers do not provide satisfactory service to the public and therefore believe that a lower value or measure of acceptable performance would be more appropriate for interference purposes. We believe that this is especially the case if we are to consider all categories of FM receivers, including lower cost models, such as clock, portable and personal units, as suggested by some of the commenting parties.

98. Another limitation of the studies was the relatively limited sample of FM receivers examined. The relatively small samples examined in each of the studies makes it difficult to draw statistical inferences with regard to the general population of FM receivers. However, the studies do clearly indicate that current FM radios exhibit a wide range of performance with regard to audio reception quality and interference rejection. While a 50 dB, 45 dB, or even 40 dB reception quality level, as suggested by Rappaport, may be expected for certain types of radios, such as automobile radios and home stereos, clearly from the data presented these levels of performance are not the norm for other

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Geneva, Switzerland. *See* Comments of NAB Vol. 2 at 8.

151 *See* NAB's Subjective Evaluation of Audio Degraded by Noise and Undesired FM Signals, Lawrence C. Middlekamp, November 17, 1982.

152 Only 3 of the 28 receivers met the criteria of providing a S/N of 56 dB in the absence of interference. In addition, in its reply comments, NAB argues that the one of the only classes of receivers that come close to meeting its proposed 50 dB standard, i.e., automobile radios, should be excluded and treated separately because they operate in a mobile environment and therefore require higher protection. NAB argues that an additional 30 dB of margin is needed in the protection ratios to account for multipath fading and other considerations of mobile operation. See Reply Comments of NAB at 15-16.

153 CEMA also indicates that its sample did not meet its target S/N at the FCC's 1st-, 2nd-, and 3rd-adjacent channel protection ratios.

types of radios, such as portable, personal and clock radios. In addition, all of the studies found that automobile radios and home stereo/component receivers tend to be more effective at rejecting adjacent channel interference than clock, personal and portable radios.[154] Based on our examination of the studies, we find that automobile radios and home stereo/component receivers generally are able to provide -40 dB rejection of 3rd-adjacent channel signals and therefore generally will provide acceptable service in the absence of 3rd-adjacent channel protection. We also recognize that some poorer quality receivers may experience some additional interference as a result of eliminating the 3rd-adjacent channel protection for LPFM stations. We note, however, that these classes of radio may also experience some degree of interference from co- and 1st-adjacent channel stations operating within the existing protection requirements. We also believe that consumers generally understand that there are performance differences among the classes of radios and that they accept the fact that lower cost radios may provide more limited service capabilities, as suggested by Rappaport. We therefore believe that our decisions with regard to LPFM service should not be constrained solely by the performance limitations of lower cost radios any more than we should use those radios to redefine existing FM radio service. In this regard, we believe that good engineering practice suggests that evaluations of the potential impact of new interference from low power FM stations should not be based on either the worst or best performing radios.

99. The NAB study generally bases its analyses on median receiver performance, and the CEMA study generally uses average performance to describe its results. In addition, since the studies use different measures of when interference occurs, it is difficult to directly compare the test results. Nonetheless, we believe that there is sufficient consistency in the study results to support some decisions in this matter, particularly with regard to the need for 3rd-adjacent channel protection.

100. The OET and NLG studies generally conclude that FM receivers provide for adequate rejection of interference on 2nd- and 3rd-adjacent channels.[155] The OET study, for example, finds that nearly all receivers in its sample appear to meet or exceed the 2nd-adjacent channel protection and exceed the 3rd-adjacent channel protection criteria by a substantial margin, i.e., exceed the -40 dB criteria by 8 to 10 dB.[156] On the other hand, CEMA and NAB argue that their studies show that these adjacent channel

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154 *See* Reply Comments of NAB at 8.

155 The OET study did not, however, include small, inexpensive receivers with integral antennas, such as clock and personal radios. Similarly, the NLG study employed a sample of only 10 radios and, as pointed out by NAB, it is difficult to draw general conclusions for the FM receiver population from such a small sample.

156 The above conclusions of the OET report that "nearly all the receivers in the sample appear to meet or exceed the 40 dB 2nd-adjacent channel criterion and exceed the 3rd-adjacent channel protection criterion by a substantial margin" reflect measurements taken at the 1% distortion level. NAB, in its reply comments, asserts that for the OET study, interference was considered to exist when the desired audio from the receiver contained 3% or more distortion than with no interfering signal present. NAB states that it assumes this to be the case because if 1% distortion were the interference point there would be no point in collecting 3% data. NAB's assumption is incorrect. The 1% and 3% levels were merely two points at which data were collected. The 1% level corresponds to a point at which most listeners would not be able to perceive any degradation in performance. On the other hand, the 3% distortion represents a level at which most listeners would perceive a difference in the received signal. The 3% distortion level was also chosen after informal consultations by FCC staff with the test firm hired by NAB, which stated that it recommended this value as a test point.

protections should be retained. A careful review of CEMA's results, however, shows that CEMA's median receiver provides about -40 dB of rejection of 3rd-adjacent channel interference and that the average 3rd-adjacent channel performance is about 3 to 7 dB better than 2nd-adjacent channel performance for its sample.[157] Similarly, while we question the validity of NAB's interference criteria, its test results also show 3rd-adjacent channel performance to be substantially better than 2nd-adjacent (*i.e.*, 8 to 10 dB) -- the same margin of improvement as found in the OET study. [158]

101. We also find that the area in which any additional interference would be likely to occur from an LPFM station operating on a 3rd-adjacent channel at maximum facilities of 100 watts and antenna height of 30 meters above average terrain would be very small. For example, even using NAB's median receiver performance test results for its three "worst" FM radio categories, *i.e.*, clock, personal and portable, we find that the area where such receivers could potentially experience degradation from interference is small, generally 1 km or less from an LPFM antenna site. This interference analysis is shown in the following table:

102. LPFM Potential Interference Radius[159]

Receiver Category	Desired Signal Level		
	-45 dBm	-55 dBm	-65 dBm
Clock	0.3 km	0.7 km	2.1 km
Portable	1.0 km	0.9 km	1.0 km
Personal	0.4 km	0.5 km	0.5 km

157 CEMA reported average rather than median performance. Its findings showed an average S/N ratio of 34 dB at the -40 dB D/U level.

158 NAB's study shows median receiver performance values at different desired signal levels. These median values are as follows:

Desired Signal Level	Median 2nd Adjacent	Median 3rd Adjacent
-45 dBm	-17.0 dB	-26.8 dB
-55 dBm	-23.7 dB	-32.0 dB
-65 dBm	-30.5 dB	-39.7 dB

159 These interference estimates are calculated in accordance with the FM engineering charts in Section 73.333 of the rules, 47 CFR § 73.333.

103. Further, we believe that this analysis provides a conservative estimate of actual interference potential of LPFM given NAB's performance criteria and the fact that NAB's sample included some of the poorer performing radios among the four studies.[160] In addition, as pointed out by Rappaport and others, whether interference in fact occurs to FM listening is dependent on a number of factors, besides the performance of the FM receiver. These include, among other things, the actual reception conditions, such as the location and position of the radio, the frequency and location of both the desired and undesired stations, and the type of program material being transmitted and received. CEMA notes, for example, that when the desired signal is modulated with rock music the interference was masked in its 2nd- and 3rd-adjacent channel subjective tests.[161]

104. Accordingly, we find that 100-watt LPFM stations operating on 3rd-adjacent channels will not result in significant new interference to the service of existing FM stations. Furthermore, we find that any small amount of interference that may occur in individual cases would be outweighed by the benefits of new low power FM service. With regard to 2nd-adjacent channel protection requirements, it appears that the risk of interference from LPFM signals on 2nd-adjacent channels may be somewhat higher. We find that this would also be true with regard to LPFM stations at power levels higher than 100 watts and antenna heights higher than 30 meters. Therefore, we will retain 2nd-adjacent channel protection requirements.

5. Other Technical Standards and Provisions

105. Background. In the *Notice*, we sought comment on which Part 73 technical operating requirements for full-service stations should be applied to LPFM stations. In general, most commenters stated that, although some requirements must remain to ensure a quality service, the LP100 and LP10 stations should be held to less stringent requirements than full service stations. While we do not want to overly burden LPFM operators, we nevertheless believe that the technical rules set forth below should apply to the LPFM stations. By doing so, we will not only facilitate technically sound LPFM operations and the use of available equipment, but will permit LPFM stations to engage in services such as those obtained through the multiplexing of FM subcarriers. There are some requirements applicable to full-service stations which we believe can be relaxed or not applied. Accordingly, we will apply certain rules to LP10 stations that apply to existing stations that operate with ten watts transmitter power output (TPO) or less.[162] The following paragraphs set forth the principal technical requirements and provisions for

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160 As indicated above, NAB defines interference as a degradation in audio S/N performance of 5 dB. Using this measure, all five personal radios and two of the five portable radios tested by NAB could be considered to provide no service at all beyond the –45 dBm level, since they all exhibited a greater than 5 dB degradation in performance when the desired signal was reduced below –45 dBm even with no interference present. Therefore, it is questionable whether interference estimates for these radios using NAB's methodology are meaningful.

161 *See* CEMA study at 6.

162 In contrast, *effective radiated power (ERP)* refers to the power which is radiated from the antenna. ERP incorporates the transmission line loss – the power loss of the cable used between transmitter and antenna – and the gain of the antenna. Thus, it is possible for the effective radiated power to be greater than the transmitter power output (TPO), by using an antenna with a gain greater than 1.0. For simple systems, the ERP = TPO x (antenna gain) x (efficiency of transmission line), where the antenna gain and efficiency are decimal numbers (not in decibels = dB). In most cases, the antenna manufacturer or the transmission line manufacturer should be able to provide this information

LPFM stations. These technical matters were generally non-controversial to parties who filed comments in this proceeding. Other technical requirements for LPFM stations are given in the rules appendix.

106. *Power/Height restrictions*. Several commenters expressed the desire to operate facilities at heights in excess of those specified as the maximum/minimum facilities for the class. This would enable stations to use existing structures at sites where the localized elevation is such that the 30 meter HAAT would be exceeded regardless of the height of the structure. One commenter, the Arkansas Broadcasters Association, believes we should impose strict maximum height restrictions on LPFM stations since, due to the nature of the Commission's F(50,10) interference prediction curves, equivalent 1 mV/m (60 dBu) reference contours do not always guarantee proportionally sized interfering contours.[163] Although Arkansas Broadcasters is correct in this regard, we are not persuaded that this is of sufficient magnitude to warrant strict height restrictions on LPFM stations. Rather, we will allow LPFM stations to exceed the class-defined upper height restrictions as long as there is an offsetting decrease in the station's effective radiated power. For this purpose, we will authorize equivalent height and power combinations to produce the 60 dBu contour generated by the maximum and minimum permitted facilities for the LP100 and LP10 stations; *e.g.*, the maximum LP100 facilities of 100 watts and 30 meters produce a 60 dBu contour at a distance of 5.6 km.[164]

107. We recognize that computing a station's HAAT requires access to terrain database and numerous calculations.[165] Therefore, in order to streamline the application process, the staff will utilize a computer program to calculate the antenna HAAT based upon information provided by the LPFM applicant (the coordinates of the proposed antenna, the site elevation above mean sea level, and the antenna height above ground level (AGL)). If the calculated HAAT is less than or equal to 30 meters, the LPFM station will be authorized to operate with any ERP within the maximum and minimum limits for its class.[166] If the HAAT is calculated to exceed 30 meters, the permit will specify maximum and minimum ERP values that would produce the reference 60 dBu contours.[167]

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163 *See* Comments of ABA at 14.

164 As a practical matter, this allowance will limit LP100 stations to 450 meters HAAT and LP10 stations to 100 meters HAAT. These HAAT values would produce equivalent maximum class contours for stations operating with 1 watt ERP, the lowest value we will authorize.

165 Antenna height above average terrain (commonly abbreviated HAAT) does not refer to the height of the antenna above ground level. The antenna height above average terrain is a measure of the height of the antenna relative to a generated average terrain level . The average terrain level is computed by considering the terrain along 8 or more evenly spaced radials centered at the antenna site. For each of these radials, the ground elevations at 50 or more evenly spaced points are determined and averaged. Then, the radial terrain averages are averaged together to determine the height of the average terrain above mean sea level (AMSL). The antenna height above average terrain (HAAT) is the difference between the height of the antenna (AMSL) minus the average height of the terrain AMSL.

166 The Commission's prediction of coverage methodology does not account for HAAT's below 30 meters. In such cases, 30 meters is assumed when contour distances are determined.

167 We will specify ERP to the nearest watt. This differs slightly from the full service FM rounding procedures. *See* 47 C.F.R. § 73.212.

108. *Directional antennas.* Under our current rules, full service FM stations may specify directional antennas to avoid interference to other stations. Such facilities are subject to several strict installation and pattern requirements.[168] Processing these applications is staff intensive. Construction permits for directional facilities generally contain numerous conditions. Since we are relying on a minimum distance separation methodology – rather than a contour-based approach -- to provide interference protection, we see no need for stations to employ directional antennas. Accordingly, to simplify applicant requirements and facilitate application processing and ensure that service can be implemented as expeditiously as possible, we will not authorize directional antennas for LPFM stations.

109. *Transmission standards.* The *Notice* asked whether different transmission standards should be employed for an LPFM service; for example, whether the bandwidth could be reduced from 200 kHz to some smaller value as a means of reducing the potential interference from LPFM stations. To ensure technically sound station operations, we have decided to apply to LPFM several transmission standards presently in use for commercial and noncommercial educational FM stations. In most cases, these standards will be met through the use of type certified equipment without need for further adjustment by the LPFM licensee. LPFM stations will be required to adhere to the 200 kHz channel bandwidth applicable to full service stations, as well as the out-of-channel signal attenuation requirements in 47 CFR § 73.317, the center frequency drift limits in 47 CFR § 73.1545(b), and the limits on modulation in 47 CFR § 73.1570(a) and (b). In addition, LPFM stations may, at their option, engage in monophonic or stereophonic broadcasting. LPFM stations may also transmit additional information via inaudible subcarriers during those periods when the audible FM signal is on the air.

110. *Antenna polarization*: We will permit LP10 and LP100 stations throughout the FM band to use horizontally polarized, vertically polarized, or circularly or elliptically polarized antennas, as desired by the applicant. We note that vertical-only polarized antennas have been used in the noncommercial educational FM service to protect reception of TV Channel 6 for nearly 15 years now, without adverse impact. This will afford LPFM stations a wider selection of antennas for use at LPFM stations.[169]

111. *Protection of AM radio radiation patterns*: LPFM applicants should also be aware that antenna structure construction within 3.2 km (2 miles) of a directional AM station or 0.8 km (0.5 miles) of a nondirectional AM station will subject the LPFM station to the requirements of 47 CFR §73.1692. This section requires the affected AM station to make before and after measurements of its installation to insure that the new antenna structure does not aversely affect the signal pattern through reflections of the AM signal produced by the new structure. The LPFM applicant is financially responsible for conducting the measurements and any corrective measures that may need to be undertaken. The measurements can be quite expensive to conduct, and correction even more so. Therefore, we encourage LPFM applicants to locate the antenna more than 3.2 km from any directional AM station, or more than 0.8 km from any AM nondirectional station.[170]

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168 *See* 47 C.F.R. § 73.316.

169 Manufacturers of suitable antennas can provide assistance in determining the antenna gain of a particular antenna, and also the input power needed to emit a specified effective radiated power.

170 LPFM applicants may use the AM Query on the Internet to determine whether an AM station lies within (continued....)

112. *Tower Height/FAA Coordination Requirements.* Any proposal before the Commission that specifies an antenna supporting structure in excess of 61 meters above ground level is subject to the Commission's requirements for antenna structure registration requirements. Certain lower structures located close to air facilities are also subject to these requirements.[171] All structures subject to registration requirements must obtain an FAA Determination of No Air Hazard for the structure before the tower may be registered. In a letter dated June 1, 1999, the FAA expressed some concern regarding the impact LP1000 stations may have upon nearby air facilities. No specific questions were raised regarding the lower powered facilities. Since we are not authorizing an LP1000 service at this time, we will continue determining compliance with our tower registration requirements in the manner set forth above.

113. *Blanketing Interference.* For one year after the commencement of transmissions with new or modified facilities, all FM stations are required to take remedial action to resolve blanketing interference complaints occurring within the immediate vicinity of the antenna site.[172] A station's specific blanketing interference radius is defined by our rules.[173] The blanketing contour for an LP100 station would extend approximately 125 meters from the transmitter site and a 10-watt LP10 blanketing contour would extend 39 meters. Thus, the blanketing area of either type of station is very small. We conclude that LPFM stations should be required to resolve blanketing interference complaints in the same manner applicable to full power stations. Although the potential for blanketing interference from LPFM stations may be quite limited, affected parties are entitled to relief from such interference caused by a new source of radiation, whether it is a full-power commercial station or a new low power community broadcaster. Accordingly, we will apply the requirements in § 73.318 to all LPFM stations.[174]

114. *Potential Television Channel 6 Interference.* Presently, noncommercial educational FM

3.2 km of a particular set of coordinates. The query may be accessed at http://www.fcc.gov/mmb/asd/amq.html#sprung5 .

171 For towers less than 61 meters in height, FAA approval is not required if the structure is more than eight kilometers from the nearest air facility. If the structure is within eight kilometers of an air facility, FAA notification is not required if the height of the structure, when considered along with the distance to the air facility and elevation of the antenna site, satisfies a "slope" calculation. (These criteria are independent of the ERP of the facility.)

172 High strength RF signals, which emanate from the antenna before they are dissipated over space, are capable of covering, or blanketing, the reception of all other FM stations and possibly TV stations and other electronic communications, regardless of frequency, by simply overpowering the receiver's tuner. Thus, the name "blanketing interference."

173 *See* 47 C.F.R. § 73.318.

174 To a degree, Section 73.318 lacks detail regarding the exact requirements of licensees. However, over the years a clear interpretation of the rule has been developed by the Mass Media Bureau. The Commission proposed to codify this policy further in MM Docket 96-62, which is currently pending. *See In the Matter of Amendment of Part 73 of the Commission's Rules to More Effectively Resolve Broadcast Blanketing Interference, Including Interference to Consumer Electronics and Other Communications Devices,* 11 FCC Rcd 4750 (1996). We will apply the rule in accordance with the established precedents.

applicants are required to consider the impact of their operations on reception of television Channel 6, which operates on a frequency band (82 to 88 MHz) just below the FM band (88 to 108 MHz) in accordance with the provisions of 47 CFR § 73.525. Determining the affected interference area pursuant to this section usually requires complex calculations and detailed contour studies. Given the very limited potential for interference caused by LPFM stations, in order to simplify processing and lessen the filing burden on applicants, we will utilize a spacing table to protect TV Channel 6 stations. The values given in the table utilize the protection ratios of § 73.525 and worst case facilities for the TV Channel 6 and the LP10 and LP100 stations.[175] On this basis, we do not anticipate that interference will occur. However, we will require LPFM applicants to correct any complaints of interference caused to Channel 6 reception in accordance with our blanketing interference requirements (as are Channel 6 complaints regarding full service stations). In most cases, this will require the installation of simple filters on affected television sets. LPFM applicants will not be required to coordinate their proposals with any potentially affected Channel 6 television station.

115. *Radio Reading Services.* Several radio reading services have expressed concerns about interference from LPFM stations to their service to persons who are blind or who have low vision.[176] Programming provided by radio reading services is transmitted on subcarrier frequencies of a broadcast station, which are not audible on a standard radio. As the subcarrier frequencies are transmitted within the 200 kHz bandwidth of the broadcast station, they receive the same protection from interference as does the main broadcast programming. Thus, insofar as the transmitted subcarrier signal is concerned, there will be no increase in interference. With respect to subcarrier receivers used by the radio reading service audience, the Commission does not set technical standards for radio receivers. Thus, we cannot consider whether additional interference might affect SCA reception in the vicinity of an LPFM station, or whether different receiver construction could reduce possible interference. However, we note that the 20 km buffer between LPFM stations and co-channel or 1st-adjacent channel full service FM stations adopted in this *Order* should afford additional protection to subcarrier reception than was proposed in the *Notice*.[177]

116. *Transmitter Certification.* In the *Notice*, we tentatively concluded LPFM stations should utilize only transmitters deemed "type certified" by the Commission's Office of Engineering and Technology (OET) to ensure the integrity of the FM radio spectrum. Type certification would prevent the use of transmitters with excessive bandwidth or modulation, spurious emissions, excessive power output, or insufficient frequency stability, which could cause interference to other existing stations. A large majority of commenters concurred with this conclusion. A few licensed amateur radio operators felt that they should be exempt from this requirement, asserting that many amateurs were capable of creating suitable equipment.[178] However, we remain concerned about the significant potential for interference caused by non-type certified transmitters, particularly given the interference-protection

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175 This methodology is similar to that used in the FM translator rules. *See* 47 C.F.R. § 74.1205. The FM translator table was used in Appendix D of the *Notice*, "Spectrum Availability Analysis."

176 *See, e.g.*, Comments of National Association of Radio Reading Services at 1.

177 *See* ¶ 65, adding 20 km buffer.

178 *See, e.g.*, Comments of John Benjamin and Charles Coplein at 6; Comments of Spencer Graddy Clark at 6.

standards we are adopting. Nor do we believe that type certification of equipment by the manufacturer will add appreciably to the cost of equipment for a low power broadcast radio station. Accordingly, we will adopt the certification requirement as proposed in the *Notice*.[179] We emphasize that the use of non-type certified transmitters will not be tolerated. Use of non-type certified transmitters will subject the licensee to enforcement action including, but not limited to, fines.

117. *Unattended Operation.* We anticipate that many LPFM stations will be run as "attended operations," since the transmitter sites will be located at the source of program origination. However, LPFM stations may also be operated in "unattended" mode. During these times, there may be no personnel at the studio or transmitter site to monitor operation. LPFM stations that will operate unattended will be required to advise the Commission by simple letter of the unattended operation, and provide an address and telephone number where a responsible party can be reached during such times. The responsible party must be able at all times to turn off the transmitter within 3 hours of receiving notice from the FCC that the equipment is not functioning properly. In addition, we encourage the use of monitoring equipment that can automatically shut off the transmitter within 3 hours if a fault (such as operation at excessive power operation or center frequency drift) occurs.[180] Finally, during periods when the LPFM station is not transmitting programming on its regular channel, the transmitter must be turned off.

118. *Station Logs.* Station logs provide a mechanism for verifying proper operation of a station, as they require the licensee to examine the operation before making a log entry. Logging requirements for LPFM stations will be minimal. The station log for LPFM will contain only the following entries:

1) Daily observation of proper function of tower obstruction lighting (if required by Section 17.47 of the Commission's Rules);
2) Dates and a brief explanation regarding station outages due to equipment malfunctioning, servicing or replacement;
3) Any operation not in accordance with the station license;
4) Receipt of weekly EAS (Emergency Alert System) test;
5) Name of person making the entry.

119. These minimal requirements will not impose any significant burden on LPFM licensees. Except for any required daily tower lighting checks, entries need only be made when necessary. Logs must be retained for two years from the date of the last entry, and station logs must be made available to FCC personnel upon request.

120. *Environmental Requirements.* As with any applicant for a Commission license, an LPFM proponent will have to certify compliance with the environmental requirements of Section 1.1307

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179 *See* 47 C.F.R. § 2.907.

180 For additional information about unattended operation, please refer to the information sheet *Unattended Operation of Radio and Television Broadcast Stations*, which may be retrieved on the Internet through the address http://www.fcc.gov/mmb/asd/decdoc/engrser.html#UNATTEND .

of our rules. In order to facilitate the preparation and processing of LPFM applications, we will simplify the environmental compliance worksheets included in the current FCC Form 301 to account for the low operating power of LPFM stations.

121. *Radio Astronomy Installation Notifications.* Low power FM broadcast stations will be required to coordinate with and provide protection to the radio quiet zones at Green, West Virginia and at Boulder, Colorado, as is required for full service FM stations by Section 73.1030. In addition, low power FM applicants in Puerto Rico will need to coordinate with Cornell University regarding the radio coordination zone on that island. This requirement is necessary to ensure that research work at these installations will not be disrupted. Because of the low power and antenna height of LPFM stations, we anticipate that this requirement will affect very few applicants.[181]

F. Application Processing

1. Electronic Filing

122. Background. The Commission recently mandated the electronic filing of broadcast applications after a transition period of six months from the date that each form becomes available for filing electronically.[182] Likewise, we proposed in the *Notice* to require that LPFM applications be filed electronically.[183] We stated that mandatory electronic filing could speed the introduction of LPFM service by enabling the staff to process more quickly and efficiently the large number of LPFM applications that we expect to receive. In addition, we indicated that electronic filing software could be designed to assist applicants with technical issues related to their applications, such as determining what frequencies are available based on current information in the Commission's database. We requested comment as to whether Internet access is sufficiently universal to warrant mandatory electronic filing of LPFM applications.

123. Comments. Commenters that addressed the matter generally support the use of electronic filing, but are divided as to whether it should be mandatory. Metro Detroit Broadcasting Corporation (Metro) opposes mandatory electronic filing on the ground that it would disadvantage minority groups due to a "significant race-gap" in Internet access.[184] In addition, Metro argues that permissive electronic filing would provide time for interested parties to develop proficiency in using an

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181 In addition, as also detailed in § 73.1030, the Mass Media Bureau staff will coordinate action with the Enforcement Bureau if an application is predicted to place a signal strength of 80 dBu or more over an FCC monitoring station. As with current practice, there is no pre-filing notification requirement.

182 1998 Biennial Regulatory Review—Streamlining of Mass Media Applications, Rules and Processes, Report and Order in MM Docket No. 98-43, 13 FCC Rcd 23056 (1998) ("*Streamlining R&O*").

183 *Notice*, 14 FCC Rcd at 2504-06.

184 Comments of Metro at 12-13. Metro also express concern that mandatory electronic filing would create barriers for small businesses. Comments of Metro at 12. The eligibility criteria we are adopting for LPFM applicants, however, will exclude for-profit businesses. *See* ¶ 17-20.