recent years, the ambient noise levels have decreased below the rural noise levels recognized by the ITU and that this reduction in the noise floor results in a greater potential for interference to amateur communications.[129] In particular, it observes that the first presentation, "Field Strength Measurements Relative to ARRL Concerns Regarding BPL," indicates that, according to a December 2001 report by NTIA (*2001 NTIA Report*), ambient noise levels measured at 137 MHz in the VHF band have decreased by 10 dB since the ITU noise models were adopted.[130] ARRL submits that this indicates that the actual residential noise floor is now 4 dB below the ITU rural curve. It also points to a (single) measurement by the staff at the FCC Laboratory of noise levels in the MF and HF bands used by the amateurs that showed the ambient noise to be 5-8 dB below the ITU rural curve.[131] It points to slides 11 and 12 of the above presentation and argues that with this reduction in the noise floor, BPL emissions can now be the source of a 25-35 dB increase from the noise floor at 30 meters from the power lines and that this will have a major impact on some amateurs.

53. IBEC states that to provide another data point on background noise levels, it made observations of the background noise level over the frequency range 2-30 MHz at two locations chosen at random, one residential and the other business.[132] IBEC's quasi-peak measurements at these locations show business noise levels 10 dB higher and residential noise levels 20 dB higher than the ITU levels. IBEC does, however, also acknowledge that further investigation is needed to describe the noise environment today.[133]

54. The presentations and measurements mentioned in the comments and in the three additional presentations do not provide a basis for any general conclusions regarding changes in the noise floor.[134] The study in the *2001 NTIA Report* only looked at VHF frequencies 137 MHz and above and this report is therefore not directly relevant to the noise levels on the medium frequencies (MF) or HF frequencies 30 MHz and below that are at issue here.[135] We therefore continue to believe that our reliance on the current noise levels recognized by the ITU is appropriate and that in this regard, the potential for interference from BPL emissions remains the same as we considered in the *BPL Order*. We acknowledge that a compliant BPL system will increase the noise floor within a relatively short distance of the power lines (typically ranging from less than 15 meters to 400 meters, depending on frequency, type of receive

[129] A lower noise floor would allow amateurs to receive signals at lower levels.

[130] ARRL comments at 39; *see also* NTIA Report No. 02-0390, "Man-Made Noise Power Measurements at VHF and UHF Frequencies," Robert J. Achatz and Roger A. Dalke, December 2001 (*2001 NTIA Report)* at 33; *see also* "Field Strength Measurements Relative to ARRL Concerns Regarding BPL" at slide 6.

[131] ARRL also notes that the noise measurements were made at a representative height for amateur radio antennas (10 meters high and 30 meters from the antenna).

[132] IBEC comments at 4-5.

[133] In its reply comments, ARRL argues that IBEC's measurements of the noise floor are flawed, because it appears that IBEC was measuring the noise level of its EMC instrumentation, not the actual noise floor. ARRL reply comments at 6-7.

[134] We further note that ARRL argued at length in its comments that the Commission had proof [from the result on these slides] that the noise floor has decreased and thus the amateur service would be subject to higher levels of interference in this lower noise floor environment. ARRL comments at p. 42. However, in its reply comments filed subsequently, ARRL agreed that the FCC Lab finding is not sufficient justification [that the noise floor has decreased], and that the ITU-recommend noise floor levels are indeed reasonable and typical and that even other competent bodies such as the North Atlantic Treaty Organization (NATO) believe that these ITU noise floor numbers are still valid today. ARRL reply comments at 8 and its Exhibit A at 7.

[135] The medium frequency (MF) region covers frequencies from 300 kHz to 3 MHz.

station and location-specific behavior of the BPL operation), and have determined that this increase is acceptable so long as the system's operation does not cause harmful interference.[136] Under the rules, the Access BPL operator is required to take steps, including using frequency notching or band avoidance as necessary (which amounts to shutting down operations in the affected band), to avoid any such harmful interference that might occur, and/or resolve it if it does occur.

55. ARRL next observes that slide 3 of the "Broadband Over Power Line (BPL) Test Results and Considerations" presentation contains statements that "resolving interference complaints will be difficult/impractical;" and that Part 15 radiated limits were "[a]dequate for most devices, but not for BPL."[137] ARRL states that the difference, as noted in the presentation, is that BPL has a broad bandwidth; it has high emissions over that wide bandwidth; it is exempt from conducted limits except in the AM broadcast band; it is in close proximity to neighboring residential antennas, including those used to receive amateur signals; there are no intervening walls to attenuate interference; and the radiators have a large spatial extent. It submits that these differences were each noted by ARRL in its comments in this proceeding before the *BPL Order*, but that the Commission claimed it believed otherwise. Contrary to ARRL's claim, we did, indeed, recognize all those factors (and others) and considered them in formulating our requirements for Access BPL systems that are in addition to those applied to carrier current systems.[138] We are, and were, aware that amateur receive sites are typically located outdoors in relatively close proximity to power lines and that BPL emissions are likely to be present over all or large portions of the amateur bands. These considerations, as well as similar considerations with respect to other services, led us to require that Access BPL operators be capable of remotely managing their facilities to reduce or eliminate emissions in locations where interference might occur and to require establishment of a database of BPL operations so that licensed radio users could contact the local BPL operator if interference were to occur. We also disagree that resolving complaints from BPL systems is particularly difficult or impractical, in that BPL emissions often create a very distinctive audio tone or pattern of broadband noise burst that is easily recognized and interference from a BPL system can be conclusively identified by simply having the system cease operation for a brief period of time on the affected frequencies.[139]

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[136] The amount of increase in the noise floor diminishes rapidly with distance from the power lines, but depends on a number of other factors as well. The impact of an increase in the noise floor will be greatest for sensitive receivers with antennas located well above the ground in locations with low ambient noise. Noise increases would be smaller if the receiver operates at a frequency at which the local BPL emissions are significantly below the emission limit or if ambient noise levels are higher — as might be expected in a business environment or where higher levels of RF noise are present from other sources. Noise increases would be larger if the receiver operates in a region with ambient noise levels typical of rural or quiet rural areas. We note generally that the consensus in the technical community is that the noise floor has been steadily increasing due to the ever growing proliferation of electronic and electrical equipment that are all capable of generating man-made radio noise. *See* for example, *Radiated and Conducted EMI Emissions in Switch Mode Power Supplies (SMPS): Sources, Causes and Predictions*, by Nagrial, M.H. and Hellany, A. IEEE INMIC 2001, Technology for the 21st Century Proceedings IEEE International, p. 54-61, at http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=995314; and *Indoor Noise Conditions in the FM Broadcast Band*, by Johnston, S. National Association of Broadcasters (NAB) Engineering Conference 2010 at http://m.core-apps.com/2010NAB/events/51f39223ab6d2bfd89cd88a156bd8b9b.

[137] ARRL comments at 41.

[138] *BPL Order* at 21275-21276.

[139] We also note that non-OFDM BPL systems and some OFDM BPL systems have been observed to sound like pulsed broadband noise, which may not be aurally distinctive from the surrounding white noise. However, a system using a noise-like modulation method would appear to create noise-like common power line emissions and could be readily evaluated as a possible source of any interference by briefly switching the signal off or activating the system's notching capability on the frequencies on which the interference was occurring.

56. ARRL raises issues with regard to the presentation "BPL Emission Tests in Briarcliff Manor, NY," arguing that the notches on amateur radio bands in that system were inadequate and that in one case a notched BPL device was filled in by noise from another device operating 0.7 miles away. It further observes that, as shown on slides 19 and 22 of that presentation, BPL audibility in a mobile receiver quickly ends when roads depart from the power lines but could be heard along the lines up to 1.7 miles from the nearest in-band BPL device.[140] ARRL argues that this information shows that localized notching of the amateur bands is not effective in resolving interference. However, it is quite plain from other information on slide 13 of this presentation that the notching feature implemented in the early models of BPL equipment used in the Briarcliff Manor experiment were not functioning properly. We therefore do not consider this information to be a representative example of the performance potential of the notching capabilities of BPL systems. Our staff has also made other observations of notched BPL signals, for example at the Manassas, VA system, where notching capability as required under the rules was implemented and was very successful in eliminating interference.[141]

57. We also note that throughout this proceeding and as new equipment that allows BPL operators to better manage their frequency use at specific locations has become available, we have observed BPL operators taking active steps to locate and avoid interference to amateur operators.[142] Given that identification and resolution of harmful interference can involve expenditures of staff time and resources for Access BPL providers and possibly the temporary disruption of service to their subscribers, these providers have a strong incentive to take *a priori* steps to ensure that they avoid causing interference to the local radio services, including amateurs. Notwithstanding the occasional interference that was found by amateurs from the trial systems that were operated during the early phases of BPL development such as those examined in the staff presentations (and which, in some cases, were operating with emissions levels that were found to exceed the Part 15 limits by amounts ranging from 1 to 4 dB), we have observed, as described by IBEC and CURRENT in their comments, that Access BPL operators are taking effective steps as contemplated in the *BPL Order* to avoid interference to amateur and other licensed services, including working with local amateur operators.[143] Moreover, our own internal records on enforcement matters show only one complaint of interference from Access BPL to fixed licensed operations; that complaint was submitted recently and is under investigation at this time.[144] In summary, we therefore see no new information or reasoning in ARRL's submissions or other information regarding the three additional staff presentations in the preliminary materials released in July 2009 that would warrant changing the current rules and, specifically, we see no need to further restrict the operations of

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[140] ARRL comments at 45.

[141] *See* Letter dated March 2, 2007 from the Commission's Enforcement Bureau to various parties, including Chris Imlay, General Counsel of ARRL.

[142] For example, ARRL reports that BPL manufacturers have [voluntarily] implemented notching of the amateur bands in all of the installed systems. It further indicates that ARRL technical staff has evaluated five different installations using second-generation BPL equipment with 35-dB notch depth applied to the amateur bands and found this to be a successful model to prevent interference problems. ARRL comments at 10, footnote 9. We view these efforts by the BPL industry as an important demonstration of their willingness and commitment to cooperate in avoiding interference to the amateur service under the flexible rules adopted in the *BPL Order*.

[143] CURRENT comments at 2-3.

[144] *See Re: Interference Complaint: IBEC Access Broadband Over Power Line Systems* from ARRL to Kathryn Berthot, Chief, FCC Spectrum Enforcement Division, and Julius Knapp, Chief, FCC Office of Engineering and Technology (filed Dec 29, 2010). The BPL system database (http://www.bpldatabase.org/), which is operated jointly by the United Power Line Council and the Utilities Telecom Council pursuant to the requirement in Section 15.615(a) of the rules (47 C.F.R. § 15.615(a) shows that BPL systems are currently operating in more than 125 zip codes across the United States.

BPL systems to protect licensed services.

B. Measurement Distance Extrapolation Issues

1. The Extrapolation Factor

58. *Overview.* In the *BPL Order*, the Commission set forth guidelines for measurement of the emissions from Access BPL systems.[145] These guidelines, *inter alia*, specify that emissions from Access BPL devices operating below 30 MHz are to be measured for compliance with the radiated emissions limits in Section 15.209 of the rules.[146] Those limits are based on measurements made at 30-meters horizontal (lateral) distance from the device under test.[147] However, for practical reasons associated with measurement in the field, the Access BPL measurement guidelines recommend that measurements should normally be performed at a horizontal separation distance of 10 meters from the overhead power line, and they also indicate that measurements can be performed at 3 meters if necessary because of ambient emissions, safety or practical considerations.[148] The field strength of radiated emissions does, however, decrease with increasing distance from the emitter due to propagation loss. Because of this attenuation with distance, the field strength of emissions from a device measured at the 3-meter or 10-meter distances specified in the guidelines will generally be higher than those measured at the 30-meter distance on which the emission standard is based. In order to apply the emissions standard consistently, the measurement results must be adjusted to account for distance attenuation when measurements are made at a distance other than 30 meters.

59. The Commission specified distance extrapolation factors to convert the BPL emissions measurements for frequencies below and above 30 MHz to appropriate values for tests made at the 3-meter and 10-meter distances recommended in the BPL measurement guidelines. For BPL operations on frequencies below 30 MHz, the frequency range at issue here, some commenters in the initial phase of this proceeding, including ARRL, recommended the use of an extrapolation factor of 20 dB/decade, while others recommended an extrapolation factor of 40 dB/decade.[149] The Commission concluded in the *BPL Order* that "[g]iven the lack of conclusive experimental data pending large scale Access BPL deployments," it would "continue the use of the existing Part 15 distance extrapolation factors" specified in the rules, *i.e.*, 40 dB/decade for frequencies below 30 MHz and 20 dB/decade for frequencies at or above 30 MHz, but with the distance measured as the slant-range distance from the overhead power line to the center of the measurement antenna rather than horizontal (lateral) distance from the nearest point of the overhead power line carrying the BPL signals to the center of the measurement antenna, as illustrated in Figure 1 of Appendix C, *infra*. This is the horizontal (lateral) distance between the center of the measurement antenna and the vertical projection of the overhead power line carrying the BPL signals down to the height of the measurement antenna when measurements are taken at a point that is perpendicular to the power lines.[150] It further stated that "if new information became available that alternative emission

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[145] *See Guidelines* in Appendix C of the *BPL Order,* at 21339-21343.

[146] *See* 47 C.F.R. § 15.611 and 47 C.F.R. § 15.209.

[147] *See* 47 C.F.R. § 15.31(f).

[148] The common concurrence of power lines and roadways means that the specified distance to conduct measurements will often occur in those roadways on obviously unsafe places, or inside privately-owned properties.

[149] *BPL Order* at 21310.

[150] *Id.* The slant-range distance is the diagonal distance from the center of the measurement loop antenna, which is to be at 1 meter above ground level, to the overhead power line to which the BPL device is coupled, typically several meters above ground. The slant-range method reflects the actual measurement distance from the measurement antenna to the BPL-carrying power line whereas the horizontal distance method used with other Part 15 devices in (continued....)

limit/distance standards or extrapolation factors would be more appropriate," it would revisit this issue at another time.[151]

60. ARRL filed a petition for reconsideration of the Commission's decision in the *BPL Order* to use 40 dB/decade as the extrapolation factor for frequencies below 30 MHz.[152] In support of its argument that an extrapolation factor of 20 dB/decade should be used, ARRL also submitted, through *ex parte* comments, reports on three studies conducted by the United Kingdom's Office of Communications (OFCOM) and a standard by the Special International Committee on Radio Interference (CISPR) regarding emission measurements for BPL systems and a proposal for a sliding scale extrapolation factor based on a 1996 CISPR standard.[153] The first OFCOM study, "*OFCOM, Ascom PLT Measurements in Winchester (May 11, 2005)*" (Winchester Study) reported measurements of an underground *Access BPL trial system* in Winchester, United Kingdom.[154] In that study, OFCOM concluded that the electromagnetic field attenuates at a rate between *20 dB and* 25 dB/de*cade* at this BPL installation. The second OFCOM study, "*OFCOM, DS2 PLT Measurements in Crieff (May 11, 2005)*" (Crieff DS2 Study) reported measurements of an Access BPL trial system in Crieff, United Kingdom. That study concentrated only on the benefits of programmable notches in the equipment and did not provide any data on distance extrapolation.[155] The third OFCOM study, "OFCOM, *Amperion PLT Measurements in Crieff (May 11, 2005)*" (Crieff Amperion Study) reported measurements of an overhead, pole-mounted Access BPL trial system, also in Crieff, United Kingdom.[156] In the Crieff Amperion Study, OFCOM concluded that the emitted field attenuates at a rate of 28 dB/decade.

61. Subsequent to the filing of the report on the Crieff Amperion Study into the record of

(Continued from previous page) ———————————

this case is less than the actual distance to the emitter. *See* illustration of slant-range distance in Appendix C, *infra.* For example, if the measurement antenna is located 10 meters horizontal distance from the nearest point directly under the overhead power line carrying the BPL signal, at a height of 1 meter, and the power line is 11 meters above the ground, the slant range distance from the antenna to the power line is 14.14 meters. As such, because the slant range distance is longer than the horizontal distance to the nearest point directly under the overhead power line carrying the BPL signal (in this example, approximately 140% of the horizontal distance), the permissible emission levels at the measurement distance are reduced when this method is used. Therefore, even though we apply the general emission limits in Part 15 to Access BPL devices, these devices are not allowed to emit as much as other Part 15 devices that must be measured *in situ* and that radiate primarily from a height much greater than 1 meter, due to the application of slant-range distance to calculate the extrapolated emission level. This is another example of the more conservative regulation placed on Access BPL devices as part of the BPL framework the Commission adopted in 2004.

[151] *BPL Order* at 21310.

[152] *See* ARRL Petition for Reconsideration (filed Feb. 7, 2005 in ET Docket 04-37); *see also*, ARRL Petition for Issuance of Further Notice of Proposed Rule Making and for Amendments of Regulations (filed Oct. 18, 2005) in ET Docket No. 04-37.

[153] *See* ARRL *ex parte* Citation of Additional Authority comments (ARRL *ex parte comments*), filed July 8, 2005 in ET Docket 04-37, at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6518006426.

[154] *OFCOM, Ascom PLT Measurements in* Winchester (May 11, 2005) at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6518006428. Note that the FCC recommends making measurements no closer than 10 meters from the power line for safety reasons.

[155] *OFCOM, DS2 PLT Measurements in Crieff* (May 11, 2005) at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6518006429.

[156] *OFCOM, Amperion PLT Measurements in Crieff* (May 11, 2005) at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6518006427.

this proceeding, Amperion submitted comments stating that this report "reflects information that is inappropriate for the public domain, especially the way it is inaccurately represented."[157] Amperion argued that there are "discrepancies in the report," which it attributes to "[OFCOM's] unfamiliarity with the equipment and the hurried nature in which the testing was conducted." These discrepancies include that 1) OFCOM operated the BPL equipment at its maximum power levels, which was above the much lower level used for normal operations, without explaining that in the report, and 2) the system was not configured to comply with the Commission's limits.[158]

62. ARRL's proposal for a sliding scale extrapolation factor referenced a 1996 CISPR Standard.[159] That standard, which was published in 1996 well before Access BPL was developed, evaluates radio noise generated by high-voltage converter power stations and similar high-voltage installations and discusses methods on how to reduce radio noise from inherent power line components, such as mercury arc and thyristor valves. ARRL pointed to a graph in the standard which shows calculated values of the field strength attenuation of emissions from a vertical electrical dipole antenna as a function of the distance on a horizontal plane for different frequencies.[160] Based on this graph, ARRL proposed a formula which effectively constitutes a sliding-scale calculation for an extrapolation factor that varies with frequencies.[161]

63. On reconsideration, the Commission found the OFCOM studies and the CISPR standard unpersuasive in that there was no "new" or convincing information not already known, and affirmed its decision to use the existing Part 15 distance extrapolation factor of 40 dB/decade attenuation rate in the measurements of BPL emissions on frequencies below 30 MHz.[162]

64. In *ARRL v. FCC, supra*, the court found that the Commission did not offer a reasoned explanation for its dismissal of empirical data that was submitted *ex parte* by ARRL, *i.e.*, the three OFCOM studies and additional ARRL analysis intended to suggest that an extrapolation factor of 20 dB/decade may be more appropriate for Access BPL.[163] The court ordered the Commission either to "provide a reasoned justification for retaining an extrapolation factor of 40 dB/decade for Access BPL systems sufficient to indicate that it has grappled with the 2005 studies, or adopt another factor and provide a reasoned explanation for it."[164]

65. The Commission acted to respond to the court's directive in the *RFC/FNPRM*. Therein,

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[157] *See* Amperion comments (filed May 20, 2005 in ET Docket 04-37) at http://fccweb01w/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6517611850, at 2-3.

[158] We note that operating the BPL equipment at maximum or typical power levels does not affect the determination of the attenuation characteristics of the signal.

[159] *Radio Interference Characteristics of Overhead Power Lines and High-Voltage Equipment – Part 2: Methods of Measurement and Procedure for Determining Limits,* CISPR 18-2, Amendment 2, (1996), (*CISPR 18-2*) at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6518006430.

[160] ARRL *ex parte* comments at 6. *See also, CISPR 18-2* at 20.

[161] The formula ARRL recommended to the Commission to calculate extrapolation is as follows: Distance at 30 meters = distance at slant range – 20 log (30/slant range) – 20 log (15/frequency in Megahertz). ARRL *ex parte* comments at 6.

[162] *See BPL Reconsideration Order* at 9318.

[163] *ARRL v. FCC* at 241.

[164] *Id.*, at 242. The court did not separately address ARRL's contention that the Commission failed to consider a sliding scale extrapolation factor, assuming that it was properly before the Commission on reconsideration. *Id.*

it provided a more detailed explanation of its reasons for selecting 40 dB/decade as the extrapolation factor for frequencies below 30 MHz and in particular why it does not believe that the studies and technical proposal submitted earlier by ARRL provide convincing information that it should use an extrapolation factor that is different from (and, specifically, less than) 40 dB/decade as required in the second element of the court's directive in *ARRL v. FCC*.[165] In summary of that explanation, the Commission stated that:

> 1) There were no significant studies that examined the very large number of measurements that would be needed to address the different site characteristics that affect the attenuation of emissions below 30 MHz;
> 2) The studies submitted by ARRL in its 2005 *ex parte* provided only anecdotal information on two different types of installations (overhead and underground) from two single sites and also had certain methodological shortcomings; and
> 3) With respect to its proposal for a sliding scale extrapolation factor, ARRL did not provide an explanation as to how its formula was derived or how to use it to determine the extrapolation factor, nor did it provide a rationale for selecting such a formula or information as to the relationship between the performance of emissions from BPL technology and the specifications for reduction of power line noise adopted in the standard.

66. In the *RFC/FNPRM*, the Commission also observed that since its adoption of the *BPL Reconsideration Order*, reports had become available on two new technical studies addressing attenuation of BPL emissions with distance, one by NTIA in October 2007 that described a second phase of its simulation study on the potential for interference from Access BPL systems (*NTIA Phase 2 Study*) and the other by the Federal Republic of Brazil (*Brazil Study*) in June 2008 that presented the results of a measurement study of BPL emissions.[166] In addition, it noted that the IEEE working group on power line communications technology electromagnetic compatibility was working on a standard for EMC testing and measurements methodology for BPL equipment and installations (IEEE P1775/D2) that included a provision for determining extrapolation (distance correction) factors on a site-by-site basis using *in situ* measurements as part of its work on that standard.[167]

67. In view of these new studies and consistent with its stated intention in the *BPL Order* to revisit the extrapolation factor if new information became available and the opportunity provided by the Court's remand of the extrapolation factor, the Commission decided to conduct further

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[165] *See RFC/FNPRM* at 9679-9680. The Commission's explanation of its consideration of the OFCOM reports in the *RFC/FNPRM* responded to the court's directive that the Commission explain that it had "grappled with the empirical data" in those reports. That explanation describes the rationale underlying its succinct conclusion in the *Reconsideration Order* that those reports provided no new information that would provide a convincing argument for modifying the extrapolation factor. *BPL Reconsideration Order* at 9317-18. In paragraphs 71-91 below, we revisit our decision on the extrapolation factor. We maintain our finding that 40dB/decade is the appropriate value for this distance adjustment and provide additional analysis and rationale for our decision and address the arguments of the amateurs for selection of a more conservative value.

[166] *See RFC/FNPRM* at 9680-9681; *see also Potential Interference From Broadband Over Power Line (BPL) Systems to Federal Government Radiocommunications at 1.7 – 80 MHz, Phase 2 Study, Volume I*, National Telecommunications and Information Administration (NTIA) Report 08-450, October 2007 ("*NTIA Phase 2 Study*"), at http://www.ntia.doc.gov/osmhome/reports/2007/bpl2007.html; and Federal Republic of Brazil, *Radio Interference Tests from Broadband Power Line Communication Systems*, ITU Radio Communication Group WP-1A, Document 1A-32-E, June 9, 2008 ("*Brazil Study*") at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520190420. Both of these studies have been added to the record of this proceeding.

[167] IEEE 1775-2010 was published on Jan 7, 2011. *See* para. 11 and footnote 40, *supra.*

rulemaking to review its decision on the extrapolation factor.[168] It requested that interested parties submit additional comment and information on the BPL extrapolation factor and specifically asked that such comment and information address 1) the three studies and proposal for a sliding scale extrapolation factor submitted previously by ARRL as part of its *ex* parte filing of July 8, 2005 in this proceeding, 2) the *NTIA Phase 2* and *Brazil* studies with respect to their findings on the extrapolation factor for BPL systems, and (3) the existing slant-range method as it pertains to the effective field attenuation rate in a horizontal distance context. The Commission further requested submission of any other new empirical studies or information that may provide information regarding the BPL distance attenuation extrapolation factor. The Commission stated that its goal in this review is to provide BPL measurement procedures that will adequately ensure compliance with the Section 15.209 emissions standard for emissions at or below 30 MHz without placing unfair or undue compliance burdens on equipment manufacturers and users. In conducting this review, the Commission indicated that initially it continued to believe the existing 40 dB/decade extrapolation factor, in conjunction with the slant-range distance method, was reasonable and appropriate for adjusting measurements of BPL emissions on frequencies below 30 MHz.

68. As discussed above, the Commission also recognized that there is considerable variability around the 40 dB/decade value at different sites. The result of this variability is that the actual attenuation at some sites could be less than 40 dB/decade and using the current extrapolation factor at such sites could produce an adjusted measurement that would be less than the level that would be measured at the standard 30-meter measurement distance specified in Section 15.209. The Commission therefore requested comment on whether it would be desirable to modify the value of the BPL extrapolation factor to be 30 dB/decade or some other value.[169] It observed that extrapolated emission levels based on a 30 dB/decade extrapolation factor when applied to slant distance would be comparable to the extrapolated emission levels based on a 20 dB/decade extrapolation factor applied to horizontal (lateral) distance.[170] Recognizing that reliance on a 30 dB/decade extrapolation factor could increase the compliance burden for BPL equipment and systems that are tested at locations where the attenuation rate is in fact in the range of 40 dB/decade or greater, the Commission clarified that in all cases, measurements of Access BPL equipment and systems will be allowed to be made at the 30-meters distance specified in Section 15.209 and that where possible, the Commission's staff will make measurements at this distance when testing for compliance.[171]

69. In its comments, ARRL argues that the Commission's "attempt in the Further Notice to justify the 40 dB/decade extrapolation factor adopted in the Access *BPL Order* and affirmed in the [*BPL*] *Reconsideration Order* is insufficient."[172] It contends that the explanation provided in the *RFC/FNPRM* relies on calculations premised on flawed scientific methodology and disregards empirical measurements. Representatives of the Access BPL industry support maintaining the 40 dB/decade standard. In this regard, Ambient states that the continued use of the 40 dB/decade distance provides the most accurate extrapolation value, within a round-off resolution of 5 dB/decade,

[168] *RFC/FNPRM* at 9680-9681.

[169] *Id.* at 9679, 9682-9683.

[170] This is true for measurement distances greater than 12 meters laterally from the pole. At measurement distances less than 12 meters, the extrapolated emission levels based on the proposed 30 dB factor applied to slant distance are much more stringent than extrapolated levels based on a 20 dB factor applied to horizontal distance. *See* Figure 3 in Appendix D of the *RFC/FNPRM* at 9693.

[171] *See RFC/FNPRM* at 9682-9683.

[172] ARRL comments at 17-18. Individual amateur radio operators submitting comments indicate that they support ARRL's position on these matters.

for compliance measurements in typical overhead BPL geometries.[173] Arkados Group, Inc. (Arkados), the HomePlug Powerline Alliance (HomePlug) and Intellon Corporation (Intellon) argue that prompt case-by-case resolution of any actual interference complaints is the preferable solution to the issues underlying ARRL's objections, rather than adopting an "overly exclusive" new rule that could stunt the growth of new innovative technologies that hold great promise for broadband and smart grid applications.[174] IBEC submits that it has not experienced any issues with licensed services that could not be addressed within the framework of the existing BPL rules.[175]

70. ARRL and several representatives of the Access BPL industry oppose our proposal to modify the extrapolation factor to be 30 dB/decade, albeit it for differing reasons.[176] While ARRL contends that a 30 dB/decade factor would be too lenient, Arkados and HomePlug contend that making the regulatory environment even more restrictive without strong justification would have severe implications for the government's initiative to provide cleaner and greener energy.[177] SPiDCOM Technologies, S.A. (SPiDCOM) submits that a reduced extrapolation factor would directly reduce the performance of all BPL devices such that it would be difficult if not impossible to provide a marketable product for Access BPL, SmartGrid BPL and In-home BPL markets.[178] No new empirical studies of the attenuation rate of emissions from power lines on frequencies below 30 MHz were submitted into the record of this proceeding.[179]

71. *Discussion.* After consideration of the most recent information and comments on this matter and further deliberation on all of the studies and information in the record, as described above, we are retaining the 40 dB/decade extrapolation factor for frequencies below 30 MHz. As discussed further below, there are several reasons that lead us to this conclusion. Initially, we observe that the 40 dB/decade extrapolation for frequencies below 30 MHz has served successfully in our program to control emissions from radio frequency devices for many years. We also observe that, while ARRL contends that 20 dB is the only scientifically correct and valid value for an extrapolation factor, the studies and information before us show considerable differences in extrapolation factors under various powerline system configurations and usage conditions. We conclude that there is no single "correct" value for an extrapolation for RF emissions from power lines, and instead find that the compelling and reasonable

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[173] Ambient reply comments at 1. Ambient also submits 416 pages of simulation data showing that the extrapolation factor varies from 34 to 47 dB/decade for frequencies from 5 to 30 MHz. *Id.* at 4.

[174] Arkados reply comments at 2, HomePlug reply comments at 2; Intellon reply comments at 2.

[175] IBEC comments at 2.

[176] SPiDCOM comments at 2, UPLC comments at 6.

[177] Arkados comments at 2, HomePlug comments at 3.

[178] SPidCOM comments at 2.

[179] On Jan 11, 2010, ARRL submitted in *ex parte* a draft field test report by the Communications Research Centre, Canada that describes measurements of radiated emissions from In-House BPL devices: *Measurements of EM Radiation from In-House Power Line Telecommunications (PLT) Devices Operating in a Residential Environment,* Communications Research Centre, Canada, Field Test Report, Draft 2.3, March 24, 2009. The draft indicates that this report was conducted to determine the extent of potential interference of these devices to broadcast services operating in residential environments. The report noted that the study found an average of 18.2 dB/decade attenuation rate from the side of the house to locations outside the house for the In-House BPL devices tested. However, the report does not present a theoretical discussion or other analysis of the physical properties of the electrical wiring and its layout in the homes tested that would be expected to produce this result. Inasmuch as this draft report describes measurements of emissions from In-house BPL systems, it is not relevant to the discussion of Access BPL systems due to the physical differences in the operating configurations of the two types of systems.

solution is to use the existing Part 15 extrapolation factor that both has a scientific basis and has stood the test of time for a wide variety of devices and systems. We also note that, as discussed below, using the slant range method in performing measurements has the effect of reducing the extrapolation factor to approximately 20 dB. We consider too, that the extrapolation factor used with BPL measurements is only one element in a comprehensive set of rules that are designed and intended to minimize the risk of harmful interference from BPL operations and to put in place appropriate measures to eliminate such interference if it should occur. In that context, the rules require that harmful interference be corrected under any circumstances. Measurements for examination of compliance are important, to be sure, but interference must be corrected even if measurements indicate that the BPL operations at the site are compliant. While ARRL asserts that an extrapolation factor that is too lax will lead to widespread instances of harmful interference that should be corrected *ex ante* as opposed to *ex post*, we have seen little evidence of harmful interference being caused under the rules as adopted with a 40-dB extrapolation factor.

72. In addition, we note that there is no support from any of the commenting parties that modifying the extrapolation factor to 30 dB/decade in order to take a more conservative approach that would compensate for the variability in the attenuation rate would provide a more appropriate extrapolation factor. We therefore are not adopting that change. To provide clarity for those conducting measurements for compliance of Access BPL equipment and systems with the Section 15.209 emissions standards, we are specifying the extrapolated values of compliant emissions levels at 3-meter and 10-meter horizontal (lateral) distance from the nearest point of the overhead power line carrying the BPL signals for typical heights of medium voltage power lines in the BPL measurement guidelines.[180] We are also adopting our proposal for a new method for determination of site specific extrapolation factors in measurements of emissions from BPL systems.

73. Looking more closely at this issue, we find that ARRL has not provided convincing information that the value of the measurement distance extrapolation factor for Access BPL should be reduced from 40 dB/decade to 20 dB/decade or some other number close to that value. While ARRL offers detailed and lengthy submissions of information on propagation of RF energy below 30 MHz and critiques of the studies, analyses and information provided by others, including this Commission, that information does not provide any new insights on radio propagation that would alter our decision. Moreover, its arguments for a 40 dB/decade standard do not account for two key factors that affect the significant attenuation of RF energy in this region of the spectrum: factors in the emissions process (such as ground effects and the presence of multiple power lines and their position on the pole) and the significant variability in attenuation rate across different installation sites.[181]

74. With regard to the OFCOM studies, ARRL maintains that if a single extrapolation number is to be specified in the Commission's rules, the OFCOM Winchester Study establishes that extrapolation should be 20 dB/decade in the spectrum region from 10 to 30 meters. However, ARRL concedes that at lower frequencies, the extrapolation factor could be specified at a higher level, if the Commission wishes to use a frequency/distance based formula.[182] CURRENT argues on the other hand that "Figure 19 of the OFCOM Winchester report shows that over the frequencies of 1.5 to 9 MHz, the extrapolation is consistently greater than 30 dB/decade" and "the data at 3 and 10 meters show an extrapolation rate closer to 35-40 dB/decade." CURRENT also contends that "[a]ll of these data are suspect [because] the

[180] The revised measurement guidelines are set forth in Appendix D below.

[181] The ARRL's presentation of its modeling of a 1000-meter line emitter does show results for emissions at 1 meter height, and those results show that losses from the ground do increase the decay rate, *see* ARRL comments, Appendix C at 15.

[182] ARRL reply comments at 19.

researchers conducting the study used a BPL-equipped substation adjacent to an open tract, and took their measurements in the open space; [further], a close look at the published map shows a low-voltage line running exactly parallel to the measurement path; that line appears to be carrying BPL signals and could well have contaminated the measurements of emissions from the power line that was the subject of the test."[183] It further submits that none of the studies that ostensibly bear on the extrapolation question, *i.e.*, OFCOM Winchester, OFCOM Crieff, *Brazil Study*, *NTIA Phase 2 Study*, and CISPR 18 unambiguously point to a specific value that the Commission could adopt. As we discussed in the *RFC/FNPRM*, the OFCOM Winchester study at best provides only anecdotal information that, not withstanding its methodological shortcomings, is not sufficient to describe the very large number of measurements that would be needed to address the general case in which different site characteristics significantly affect the attenuation of emissions below 30 MHz.

75. ARRL next argues that during the period in which the Commission adopted and affirmed the 40 dB/decade standard, the Commission had evidence that 40 dB/decade is not the correct extrapolation factor. In this regard, ARRL points to slide #19 of the Briarcliff Manor presentation which "recommended" that the Commission should, if it intended to permit BPL on overhead MV power lines, adopt a height correction factor and a "20 log R extrapolation factor."[184] It contends that there is no reference to this "FCC-Laboratory" recommendation" anywhere in the *RFC/FNPRM*, or heretofore by the Commission whatsoever. ARRL also asserts that "instead, the Commission attempts in the *RFC/FNPRM* to justify its decision for retaining the 40 dB/decade factor by citing studies that were not even in existence at the time of the *BPL Reconsideration Order*."[185] We find these arguments to be unpersuasive. First, it is important to recognize that there is no "FCC-laboratory recommendation" as characterized by ARRL. The Commission is under no obligation to discuss in a rulemaking proceeding every staff observation or opinion provided during the course of internal deliberations. We observe that the 20 dB/decade extrapolation factor was part of one of three options presented on slide #19. The presentation offered no specific analysis or measurement data supporting this extrapolation factor. Rather, as specified on the slide, the authors offered it as a way to postpone and/or reduce the interference potential of BPL systems. Additionally, as noted by Arkados and HomePlug, none of the five FCC staff presentations actually examined the path loss extrapolation factor, but rather, they examined other technical issues such as the effect of the distance down the power line, differences in radiated field strength due to the detector that was employed, effect of measurement receiver antenna height, audible interference and antenna polarization.[186] We therefore did not, (and still do not) consider that the information on which the provided option on slide #19 was based to be sufficient or compelling such that it should override or supersede other information that we also considered in the extrapolation factor decision. As UTC

[183] CURRENT comments at 6. Because OFCOM made its measurements for the purpose of showing the distance attenuation of BPL signals of the particular BPL signal source under test away from the power line carrying that BPL emitter, if there are other power lines also carrying BPL signals nearby, the test data may not be valid as the measurements may have been made at a point closer to, or overlapping with, another BPL signal source.

[184] *See* Briarcliff Manor presentation at slide #19.

[185] ARRL comments at 48.

[186] Arkados comments at 4; HomePlug comments at 4. Arkados, HomePlug and Intellon report that a recent study by the Communications Research Center, Canada, found that the path loss coefficient to be 36 dB per decade at 37.8 MHz, with a shadowing standard deviation of 3.39 dB. Arkados comments at 8; HomePlug comments at 8; Intellon comments at 7. The study they reference is: Jeffrey A. Pugh , Robert J. C. Bultitude and Philip J. Vigeron, *Path Loss Measurements With Low Antennas For Segmented Wideband Communications at VHF*, October 23-25, 2006, Communications Research Center, Ottawa, available at http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4086379. Inasmuch as this study measures propagation at 37.8 MHz, which is above the MF and HF bands, it findings are not relevant to our decision on an extrapolation factor for frequencies below 30 MHz.

observes, the staff presentations merely included a 20 dB/decade extrapolation factor as one option among many for regulating BPL operations in the HF bands; the presentations did not find that a 20-dB extrapolation factor represented the actual rate of decay, nor did they contain any underlying information or analysis that would support such a finding.[187] Further, with respect to ARRL's assertions regarding our use of new studies in the *RFC/FNPRM* as *ex post facto* evidence, it apparently overlooks our quite specific statement therein[188] that our decision to adopt the 40 dB/decade standard was based on information available at the time of the decision, not newly available information.[189]

76. With regard to the new studies identified in the *RFC/FNPRM*, ARRL contends that the major flaw in the *NTIA Phase 2 Study* is that the modeling used does not fully account for the way that field strength decays at angles other than 90 degrees. ARRL further argues that with respect to height, the report errs in its attempted justification of the 5 dB height correction above 30 MHz but not below, and it justifies 40 dB/decade by disregarding 20 percent of the data points.[190] On the other hand, CURRENT quotes the *NTIA Phase 2 Study* as stating: "[a]t or above 10 MHz, the simulation results show good agreement between the rate that field strength decays and the [40 dB/decade] distance extrapolation rate in the Part 15 rules."[191] HomePlug also agrees that the *NTIA Phase 2 Study* clearly demonstrates that the 40 dB/decade extrapolation factor is the correct value at or above 10 MHz, and much closer below 10 MHz than figures used in the studies submitted by ARRL.[192] We observe that NTIA's modeling in its *Phase 2 Study* indicates that the field along a complex power line model is highly varied, with areas of greater and lesser field strength produced by cancellation and reinforcement effects.[193] However, there are some regularities, including field strength maxima at multiples of wavelengths along the power line, which is the reason why we adopted the requirement for measurements at multiple points along the power lines in our BPL measurement guidelines. In addition, as discussed above, ARRL's own modeling shows that the magnetic field (measured below 30 MHz) does not vary greatly with height.[194] Further, we agree with NTIA's position that "the 80th percentile values eliminate the localized peaks that are unlikely to be encountered by a radio receiver randomly located in close proximity to an Access BPL power line."[195] Thus, we find that the *NTIA Phase 2 Study* is not flawed as argued by ARRL.

77. ARRL next contends that the *Brazil Study* is deficient in that it does not identify the test equipment used, the model number of the BPL equipment, the location of the testing, and how the BPL signal was coupled to the power line, making it difficult to evaluate the accuracy of the report.[196]

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[187] UPLC reply comments at 4.

[188] The Commission specifically stated in the *RFC/FNPRM* that it did not rely on NTIA's more recent Phase 2 simulation results to justify its earlier decision. *RFC/FNPRM* at 9678.

[189] While our decisions in the *BPL Order* and *BPL Reconsideration Order* were not based on the *NTIA Phase 2 Study* and the *Brazil Study*, as affirmed in the *RFC/FNPRM*, when we reviewed the issue anew therein, it was entirely appropriate to consider the information from these two studies in explaining our tentative conclusion in reviewing this matter that the 40 dB/decade standard should be retained.

[190] ARRL reply comments at 19-20.

[191] CURRENT comments at 6.

[192] HomePlug comments at 7.

[193] *See* Figure 4-2 in *NTIA Phase 2 Study*, at section 4.2.2.

[194] *See* para. 36 and footnote 83, *supra*.

[195] *See NTIA Phase 2 Study* at Section 2.3.2.

[196] Exhibit B to ARRL comments at 2.

CURRENT states that despite its weaknesses, including unstated set-up conditions (*e.g.* cable height) and too few data points, the *Brazil Study* shows attenuation over distance in excess of 40 dB/decade, and that to the extent of its reliability, it supports the Commission's decision. IBEC agrees with ARRL that these results and the network configurations in this study do not resemble those used in North America and considers them of limited application.[197] We recognize these concerns regarding the *Brazil Study*. In addition, like the OFCOM studies before it, the *Brazil Study* would, in the best of circumstances, provide only anecdotal information on the attenuation rate of BPL emissions as it only conducted measurements at a single location, rather than the very large number of sites that would be needed to develop a generalized description of that parameter. As we stated in the *RFC/FNPRM*, these studies do, however, provide an indication that BPL emissions tend to attenuate at rates that vary substantially across different sites, and that those rates can be much higher than the 20 dB/decade suggested by ARRL. In fact, the *Brazil Study*, while not individually probative, provides support for a much higher extrapolation factor than the similarly insubstantial OFCOM studies provided by ARRL.

78. ARRL states that it also provided a number of modeled studies showing that 40 dB/decade is not the correct factor to apply below 30 MHz.[198] It submits that these studies also showed that at angles upward from radiating power lines, field strength did increase with height and that the correlation between measurements made at 1 meter in height, 10 meters horizontally from an overhead power line, and the field strength at 30-meters distance, at upward angles where amateur HF antennas are most likely to be located, was very close to 20 dB/decade.[199] We agree with ARRL that emissions radiating upwards from overhead power lines are likely to attenuate at lower rates than emissions radiating horizontally and lower to the ground. In cases where an amateur antenna is located on a tower above the height of the power lines, as is typical of fixed amateur stations, we would expect that the level of any emissions received by that antenna might typically be higher than emissions received by a similar antenna located below the height of the power lines, all other things the same, because the path to the tower-mounted antenna will be less affected by the ground. However, our Access BPL rules provide for protection of such antennas by the absolute application of the prohibition against causing harmful interference in Section 15.5 of the rules.[200] Also we would generally expect that if a BPL installer sees a tower-mounted antenna, the installer would take steps to avoid interference to it before the system commences operation. In any case, for safety reasons, our rules provide for measurement of Access BPL systems from locations relatively close to the ground, where attenuation rates are likely to be higher, rather than at heights similar to power lines.[201]

79. ARRL argues a number of technical points to support using the free-space (or near free-space) 20 dB/decade attenuation rate associated with line sources. It provides a technical description that in the radiating "near-field" region of a large emitter (at distances beyond $\lambda/2\pi$, where λ is the

[197] ARRL comments at 48, IBEC comments at 2.

[198] ARRL comments at 49. ARRL does not specifically identify these studies.

[199] ARRL comments at 52-54. ARRL also points out that few if any HF antennas are located at the 1 meter height at which test may be made under the Access BPL measurement guidelines. We further note that while fixed amateur HF antennas are indeed typically mounted higher than 1 meter, most mobile HF antennas are likely to be mounted on vehicles at heights of approximately 1-2 meters.

[200] 47 C.F.R. § 15.5.

[201] ARRL itself recognizes the wisdom of making measurements close to the ground and generally supports the Commission's measurement guidelines, including measuring with a loop antenna at frequencies below 30 MHz, as it states in its May 2004 comment in this proceeding "ARRL understands and accepts the safety reasons that it is not practical to make measurements *in-situ* at heights typical of power lines." *See* ARRL comments May 2004, Exhibit D at 27, http://webapp01.fcc.gov/ecfs2/document/view?id=6516182983.

wavelength of the emission)[202], 1) the field strength does not decay uniformly with distance; 2) the field strength does not have a 377-ohm E (electric) to H (magnetic) field relationship; 3) the fields are not planar but rather follow a cylindrical Bessel function; 4) emissions along the emitter develop standing waves in which the magnitude of the fields varies up and down with distance; and 5) the average of varying fields follows a 1/R or 20 dB/decade attenuation rate with distance.[203] ARRL also notes that there are two types of near-field, reactive and radiating, and that in the reactive near-field region often assumed to be bounded by a distance of $\lambda/2\pi$ from the radiator, the fields do decay more rapidly than in the far field.[204] Again, we agree with ARRL on all of these technical points of well-documented RF propagation theory. While we did not explain our earlier decisions on Access BPL at the level of detail that involved mentioning these factors (and do not believe that it is routinely necessary to explain propagation considerations which are a matter of accepted electromagnetic physics theory), we did consider them in our decision. In fact, they were an intrinsic element of our deliberations. As a result, we included provisions in the Access BPL measurement guidelines for testing along the power lines at specified intervals where emissions would be expected to be highest.[205] We also considered that ground absorption and other environmental effects present near the surface that limit RF propagation typically result in attenuation of emissions in the MF and HF bands at rates much higher than the 20 dB/decade free space model, especially at the 1 meter height specified in the Access BPL measurement guidelines.

80. ARRL contends it is illogical to conclude that, if a 20 dB/decade extrapolation is appropriate at 30.001 MHz, the extrapolation somehow suddenly jumps to 40 dB/decade at 29.999 MHz. It submits that the sliding scale formula it had suggested in its petition for reconsideration took into account the fact that some increase in the extrapolation factor was indeed seen in its analyses at 3.5 MHz, so some adjustment for a 20 dB/decade factor versus frequency decreases to 3 MHz is appropriate. ARRL argues that while 40 dB/decade may be appropriate in the reactive near field (within a distance of $\lambda/2\pi$), the arbitrary specification of 40 dB/decade from 3 to 30 MHz is not supported by electromagnetic physics theory or any accurate engineering in the proceeding to date. While ARRL is correct with regard to the physics of this issue, as CURRENT observes, "regulation is often a matter of drawing bright lines through gray lines."[206] The Commission commonly uses "bright line" standards in its rules to provide clarity, simplicity, predictability and ease of applicability.[207] The "bright line" difference in the extrapolation factors for under and over 30 MHz is intended to provide clear guidance in a region of the spectrum where there is considerable variability in the predictability of results. We continue to believe that the current "fixed line" or "bright-line" approach for the different extrapolation factors above and below 30 MHz is appropriate for practical and administrative purposes.[208]

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[202] The wavelength λ of an electromagnetic waveform is given by $\lambda = V/F$, where V is the speed of light and F is the frequency of the waveform. As an example, the wavelength of a 10 MHz signal is about: $3\times10^8 / 10\times10^6 = 30$ meters.

[203] ARRL comments at 49-50 and Exhibit C to ARRL comments.

[204] *Id.*, at 56.

[205] *See BPL Order*, Appendix C (Measurement Guidelines) at 21340.

[206] CURRENT Technologies comments at 11-12.

[207] *See* for example, 47 C.F.R. §§ 15.107 (a), 15.207 (a), or 15.250 (d). In each of these sections, a different limit applies to each band of frequencies, despite their adjacency.

[208] Courts have found that, in complex areas of regulation, an administrative agency often "must create bright lines to separate prohibited and permissible activity. We defer to this line-drawing provided the interpretation is both reasonable and consonant with Congress' intent." *Beazer East, Inc. v. United States Environmental Protection Agency, Region III*, 963 F.2d 603, 610 (3rd Cir., 1992).

81. ARRL next observes that the NTIA 2004 comments the Commission relied on in part in some decisions made in the *BPL Order* provided "significant analyses that showed that if a large number of BPL emitters are deployed, they will raise the worldwide levels of man-made noise."[209] It submits that these analyses all presumed that the field strength of a BPL system is 29.54 dBμV/m at 30-meters distance and that the angles that will be propagated from overhead BPL lines are all upward from the [power] line, not downward toward the ground. It contends that for the *NTIA Phase 1* modeling of sky wave propagation to have had any merit at all, the test methods used must have determined accurately the point of maximum emissions above the power lines and they did not. ARRL submits that its analysis of the NTIA model showed that if a 40 dB/decade extrapolation is used, the test will not accurately reflect the actual maximum emissions from these systems, *i.e.*, the emissions above the power lines will attenuate at 20 dB/decade. ARRL is incorrect in its speculative statement that the NTIA model used the 29.54 dBμV/m at 30-meters distance value in accounting for upward propagation when it estimated the impact of BPL emissions on the levels of background man-made noise. While NTIA did not measure emissions above the power lines, we would not expect its staff to undertake such a hazardous task. Moreover, measurements above the power lines are not necessary to the estimation method NTIA used. The NTIA model does appropriately account for higher levels of radiation above the power line in the far-field gain pattern input calculated from the VOAAREA power line modeling used in the *Phase 1 Study*.[210] Conversely, ARRL does not provide any information to support its assertion that the model used by NTIA does not properly estimate the attenuation rate of emissions that might contribute to sky wave propagation. It merely asserts that "ARRL's analysis of the NTIA model showed that if a 40 dB/decade extrapolation is used, the test will not accurately reflect the actual maximum emissions from these systems."[211]

82. We also observe that in its *Phase 2 Study*, the NTIA estimates that under conditions of low solar activity that produce the lowest aggregate BPL signal via ionospheric propagation relative to the local noise floor at any geographic point, approximately 916,000 overhead BPL devices alone could be deployed before realizing a 1-dB increase in the noise floor.[212] NTIA also found that under high solar activity, more than 1.35 million overhead BPL devices would be required to raise the noise floor by 1 dB.[213] However, most Access BPL installations have a combination of overhead and underground devices, making the number of BPL devices that can be deployed before a 1-dB increase in the noise floor occurs much higher than the numbers listed above, depending on the particular combination of overhead and underground BPL devices.[214] Further, if BPL exclusive overhead installations reach such numbers, the Commission could consider whether a change in its rules to account for a change in the noise floor is appropriate at that time.

83. ARRL's arguments regarding propagation and the extrapolation factor also address the behavior of RF fields. It again points to provisions in the rules specifying that at frequencies above 30 MHz, 20 dB/decade is used at the measurement extrapolation factor while at frequencies below 30

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[209] ARRL comments at 52.

[210] VOAAREA is one of the software tools in the NTIA/ITS Voice of America Coverage Analysis Program (VOACAP) HF Propagation Prediction software suite. The same tool was used in all of the NTIA modeling reports (*NTIA Phase 1 Study*, *NTIA Technical Appendix* and *NTIA Phase 2 Study*). We would, in fact, expect the attenuation rate to be much less than 40 dB/decade in skyward directions.

[211] ARRL comments at 52.

[212] *See NTIA Phase 2 Study* at Section 5.4.1, Figure 5-4.

[213] *Id.*, at Figure 5-3.

[214] *Id.*

MHz 40 dB/decade is used and presumes this difference is because above 30 MHz, measurements are made in the far field, while below 30 MHz, measurements are made in the near field.[215] ARRL submits that the way that fields vary in the reactive and radiating near field regions differ. It asserts that in the reactive near field region, bounded by a distance of $\lambda/2\pi$, field strength decays at a 40 dB/decade rate and in the radiating near field region beyond that boundary, fields generally develop a standing-wave pattern that diminishes with distance, but one that, on the whole, varies at a 20 dB/decade rate. It argues that the inadequacy of the present BPL rules is due to the fact that the rules assume that all areas below 30 MHz are in the "near field" region without differentiating between reactive and radiating near field phenomena. It submits that a 40 dB/decade extrapolation factor beyond the reactive near field region is flawed and at distances of 10 meters or more from the radiating source, all points are outside the reactive near field boundary for all frequencies above 4.78 MHz.[216]

84. In its reply comments, CURRENT argues that ARRL rests much of its argument regarding the reactive and radiating near field propagation characteristics on a logical error.[217] It observes that ARRL supposes two contradictory propositions to be simultaneously true that: 1) Access BPL systems comprise large radiating systems and 2) the far field region begins very close to the antenna. It submits that correcting this error yields a much larger extrapolation factor than ARRL acknowledges. In this regard, CURRENT states that if the first point is true, that is, if BPL-equipped power lines function as large, distributed antennas, then the near field extends well beyond 30 meters from the line.[218] It submits that in that case, all extrapolation takes place in the near field and the attenuation with distance is much steeper in the near field than beyond it, so that regardless of what happens farther out, 40 dB/decade is a conservative estimate in the near field. CURRENT notes that on the other hand, if ARRL's second proposition is true, that is, if the far field begins very close to the antenna, it follows that the antenna must be functioning similarly to a point source, in which case the extrapolation factor is close to 40 dB/decade.

85. The arguments of ARRL and CURRENT concerning the technical validity of using 40 dB/decade as the extrapolation factor for measuring emissions on frequencies below 30 MHz demonstrate the complexity involved in describing and estimating field strengths in the near-field regions of emissions. ARRL is generally correct in its technical presentation of the theory of such fields, *i.e.*, that emissions decay in the reactive near field at a rate of 40 dB/decade within a distance of $\lambda/2\pi$ from the source and then in the radiating near field out to $2D^2/\lambda$ at a rate of 20 dB/decade. The very long lengths of typical power line segments therefore would not be expected to affect the decay rate of field strengths relative to reactive near field phenomena and therefore at distances greater than 10 meters all frequencies above 4.78 MHz will generally be outside the reactive near field boundary. However, ARRL's description of the behavior of fields also shows that while the attenuation rate in the radiating near field is

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[215] ARRL comments at 56-58.

[216] ARRL notes that for large line radiators, the calculation of the reactive near field distance is more complex, but states that it can be approximated by assumption of a line source radiator. ARRL submits that for these radiators, within the region of $\lambda/2\pi$, the fields do not decay at 40 dB/decade as they do for physically small radiators, but generally decay up close at approximately 20 dB/decade. It states that beyond the reactive near-field region, the calculated field strength shows a standing wave, but the peaks of that standing wave, or the average of the fields of the standing wave, decay at a 20 dB/decade rate. ARRL comments at 57.

[217] CURRENT reply comments at 10-11.

[218] CURRENT observes that the generally accepted boundary beyond which points are not considered as being in the radiating near field is $2D^2/\lambda$, where λ is the wavelength of the emission and D is the largest physical dimension of the radiating element, CURRENT reply comments, Appendix A at i. In the case of a BPL system, $2D^2/\lambda$ will typically be much farther than the 30 meter reference distance for the BPL emission limit specified in Section 15.209 of the rules (this measure does not properly describe the near field boundary in the case of emitters as long as power lines, *see* for example, ARRL reply comments, Appendix A at 7-8.)

generally on the order of 20 dB/decade (in the free-space or near free-space case), there are standing wave patterns and other phenomena that make predictions unreliable. In addition, when measuring relatively close to the ground (at the 1-meter height specified for measurements at frequencies below 30 MHz), the proximity to and variation of ground features and other conditions cause great variability in signal levels.[219] ARRL recognizes these ground effects, but argues that licensed services should not be protected only at ground level and that to do this the extrapolation factor should take into account the normally encountered antenna height of the victim receiver. Given that BPL measurements will be made close to the ground for the safety and practical reasons indicated above and the propagation characteristics that are likely to be present in ground environments, we therefore continue to believe that there is justification for presuming that the expected attenuation rate of measured emissions at frequencies below 30 MHz is greater than 20 dB/decade. We also agree with ARRL that licensed services should be protected in all cases and in this regard, the regime of rules we have established for Access BPL systems, as discussed above, provides that protection.

86. To further support its argument for an extrapolation factor of 20 dB/decade, ARRL submits a paper analyzing the industry standards for radiated emissions below 30 MHz.[220] It states that there are very few such standards because regulations for most unlicensed devices control conducted emissions below 30 MHz and radiated emissions above 30 MHz. It argues that all of these standards stipulate that electric fields or magnetic fields be extrapolated at 20 dB/decade, except in the reactive near-field region, nominally considered to be bounded by a distance of $\lambda/2\pi$ from the radiating source.[221] On the other hand, HomePlug observes that these standards basically confirm that there are multiple views of what the extrapolation factor should be, and that it is generally greater than 20 dB/decade in the near field, and often 40 dB/decade or more on the lower end of the frequency range. HomePlug asserts that in fact, the various documents mentioned by ARRL demonstrate that there are different standards with multiple extrapolation factors -- a fact that HomePlug asserts support the current rule.[222] IBEC states that use of the slant-range approach in determining extrapolated values of the emission standard is a fair compromise that contemplates the geometry of measuring emissions from power lines in close proximity to the lines.[223]

87. We observe that none of the standards mentioned by ARRL apply to Access BPL equipment and the specific environments in which these devices operate, as discussed above.[224] In particular, even

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[219] ARRL comments at 57.

[220] ARRL comments at 58 and Exhibit D to ARRL comments.

[221] ARRL lists the following standards: 1) ANSI C63.12:1999 American National Standard Recommended Practice for Electromagnetic Compatibility Limits; 2) Telcordia GR-1989 Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment; 3) CISPR 18-2 1986 Radio interference characteristics of overhead power lines and high-voltage equipment -- Part 2: Methods of measurement and procedure for determining limits; 4) CISPR 11 Industrial, scientific and medical equipment -- Radio-frequency disturbance characteristics -- Limits and methods of measurement; and 5) 47 C.F.R Part 18 Industrial, Scientific and Medical Equipment (ISM).

[222] HomePlug reply comments at 5. For example, although CISPR 11 uses a 20 dB/decade extrapolation factor, CISPR 18-2 suggests an extrapolation factor of 33 dB/decade for frequencies below 30 MHz.

[223] IBEC comments at 5. It also believes that distances measured to determine the slant range should be to the closest radiating wire on the power pole. The amended rules provide for determination of the slant range distance from the power line carrying the BPL signals.

[224] For example, CISPR 11 and FCC Part 18 are only applicable to ISM equipment. Telcordia GR 1089 is only applicable to telecommunications systems. ANSI C63.12 is not a standard but merely a recommended practice. CISPR 18 only evaluates radio noise generated by high-voltage converter power stations and discusses methods on (continued....)

though ARRL insists that the CISPR 18 standard does apply to BPL as it would apply to any source of RF noise,[225] we note that CISPR has been working on the subject of an emission standard for BPL as far back as 2000 under CISPR Subcommittee G. The work to develop a standard specific to BPL has continued in CISPR Subcommittee I, however, this work has been recently reset to its preliminary stage due to the complex issues surrounding RF emissions at frequencies below 30 MHz, with signal attenuation being highly variable depending on the localized environment, as we discussed above.[226] Moreover, we find that the record in this proceeding has established a substantial body of information that supports the use of 40 dB/decade in conjunction with slant-range distance to adjust the emissions level for test results obtained in accordance with the measurement standards we have adopted for Access BPL.

88. In addition, as we discussed in the *RFC/FNPRM*, the slant-range distance method in the Access BPL measurement guidelines works with the 40 dB/decade factor to yield extrapolated emissions level values that have the effect of imposing a more conservative emissions standard than would be derived using the horizontal (lateral) distance from the nearest point of the overhead power line carrying the BPL signals.[227] In this regard, at the relatively short distances at which Access BPL emissions are to be measured, *i.e.*, distances 30 meters or less, applying the slant-range measurement method in the extrapolation of the measurements effectively reduces the compliant emission levels for BPL systems with respect to the horizontal distance from the power line. This reduction results because at any given horizontal distance from the power line, the slant-range distance is longer than the horizontal distance. The relationship is one of basic plane geometry that occurs due to the height of the power line on which the BPL signal injector is installed.[228] When extrapolated values at 40 dB per decade of slant-range distance are plotted against the horizontal distance, the effective extrapolated emission level curve more closely follows the emission level curve based on a 20 dB per decade extrapolation factor at horizontal

(Continued from previous page)

how to reduce radio noise from inherent power line components, such as mercury arc and thyristor valves. Although CISPR 18-2 discusses the attenuation of noise sources with distance from the power lines, we note that this standard states (and ARRL points out) that "an attenuation factor of 33 dB/decade is somewhat valid for frequencies between 1.7 MHz and 30 MHz." *See* CISPR 18-2, Section 2.3.5.1; *see also* Exhibit D to ARRL comments at 5.

[225] *See* ARRL *ex parte* comments filed January 11, 2010 at 3.

[226] *See* the work of CISPR Subcommittee I at http://www.iec.ch/cgi-bin/procgi.pl/www/iecwww.p?wwwlang=E&wwwprog=sea1112.p&committee=CIS%2FI&class=&refno=&type=&date.

[227] The rules for testing Part 15 devices specify that "[t]o the extent practicable, the device under test shall be measured at the distance specified in the appropriate rule section. The distance specified corresponds to the *horizontal* [emphasis added] distance between the measurement antenna and the closest point of the equipment under test, support equipment or interconnecting cables as determined by the boundary defined by an imaginary straight line periphery describing a simple geometric configuration enclosing the system containing the equipment under test." 47 C.F.R. § 15.31(f). However, for Access BPL devices operating on overhead power lines, the Commission adopted the slant range method due to the location of the BPL device on a power pole that is typically several meters above ground and above the measurement antenna. *See Guidelines* in Appendix C of *BPL Order* at 21339-21343 and Figure 1 in Appendix D, *infra*.

[228] The geometric relationship between horizontal and slant distances is that of a right triangle in which the hypotenuse is equal to the square root of the sum of the squared lengths of the other two sides, *i.e.*, $h = \sqrt{(x^2 + y^2)}$. For example, using a 40 dB per decade distance extrapolation factor, the maximum permitted emission level at a horizontal distance of 10 meters from the power line is 48.6 dBμV/m. However, for that same horizontal distance of 10 meters, the slant distance is 14.9 meters (assuming the power line is 12 meters in height, thus the measurement height with the antenna at 1 meter from the ground would be 11 meters) making the maximum permitted emission level to be only 41.7 dBμV/m, a level that is 7 dB more stringent. This means that instead of being able to emit up to 48.6 dBμV/m, an Access BPL device could only emit 41.7 dBμV/m, a level 7 dB less than if horizontal distance as specified for other Part 15 devices was used in the calculation of extrapolated levels. *See* illustrations and formulae in Appendix E, *infra*.

distances than the emission level curve based on a 40 dB per decade extrapolation factor at horizontal distances.[229] NTIA's modeling results in its *Phase 2 Study* effectively reflect this observation.[230] Also, given that the Access BPL measurement guidelines require compliance measurements to be taken at 30 meters or less, the effect of the slant-range distance provision is significant at all distances where the extrapolation factor can be used.[231] As shown in Appendix E, *infra*, the extrapolated Access BPL emissions level based on the existing 40 dB/decade factor and the slant-range measurement approach is very close (within a 5 dB range for typical medium-voltage power line heights) to the level that would result from use of the 20 dB/decade extrapolation factor with the traditional horizontal measurement distance.[232]

89. ARRL and several of the commenting parties address our request for comment on whether it would be desirable to modify the extrapolation factor to be 30 dB/decade or some other value to account for the considerable variability around the 40 dB/decade expected attenuation value at different sites. Our intent was that this lower value would apply a more conservative approach that would compensate for those cases where the actual attenuation is less than 40 dB. In opposing this plan, ARRL asserts that the Commission is not apparently convinced by its own *ex post* argument justifying use of 40 dB/decade, as it immediately thereafter abandoned that argument and proposed instead to adopt an equally unjustified 30 dB/decade extrapolation factor in what appears to be the "King Solomon" approach rather than a real scientific analysis. ARRL rejects the approach underlying the 30 dB/decade proposal and argues that the Commission is obligated to adopt a scientifically valid extrapolation standard, which it contends is 20 dB/decade.[233] The UTC and CURRENT also oppose such a change, stating that the Commission was correct to select 40 dB/decade as the distance extrapolation and that we should maintain that value. UPLC argues that a 30 dB/decade value would be inappropriate and that a reduced value would impose a significant compliance burden on Access BPL systems.[234] CURRENT argues that the Commission's original selection of 40 dB/decade is well supported by the record and that the mere possibility of other supportable conclusions, especially if based on other studies, does not warrant a change.[235] CURRENT and the UTC further submit that the now-demonstrable lack of interference reports from CURRENT's

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[229] *See* illustration in Figures 1-3 in Appendix E, *infra*.

[230] *See NTIA Phase 2 Study*, at Section 2.5. NTIA found that "the Commission's modification to the rules for distance extrapolation [by using slant distance instead of horizontal distance for Access BPL devices] resulted in good agreement between the extrapolated field strength level and the rate in which field strength decays from the overhead MV power line."

[231] *RFC/FNPRM* at 21280. Because the slant range distance is dependent on the height of the power line on which the Access BPL equipment is installed, the extrapolated emission levels vary the most when the horizontal distance between the center of the measurement antenna and the nearest point directly under the overhead power line carrying the BPL signal is between 5 meters and 20 meters, with the maximum difference between the slant range and horizontal approaches at around 10 meters. *See* illustrations in Exhibit E, *infra*.

[232] Appendix E, *infra*, shows that for power line heights of 10 meters, the extrapolated emission level using 40 dB/decade in conjunction with slant distance is 4.4 dB less stringent than the use of 20 dB/decade with horizontal (lateral) distance, when the measurement antenna is placed at a horizontal distance of 10 meters from the nearest point directly under the overhead power line carrying the BPL signal. For power line heights of 12 meters, the extrapolated emission level using 40 dB/decade in conjunction with slant distance is 2.7 dB less stringent than the use of 20 dB/decade with horizontal distance, when the measurement antenna is placed at a horizontal distance of 10 meters from the nearest point directly under the overhead power line carrying the BPL signal.

[233] ARRL comments at 59.

[234] UPLC comments at 5-6.

[235] CURRENT comments at 8.

extensive operations supports not changing the extrapolation standard.[236]

90. It is plain from the record that reducing the extrapolation factor to the more conservative 30 dB/decade level to compensate for those situations in which the actual attenuation is less than 40 dB/decade would not satisfy the concerns of any of the parties to this matter or otherwise provide any benefits that would improve our Access BPL measurement guidelines. Contrary to ARRL's misapprehension, our consideration of a reduction in the extrapolation factor was not intended as a "compromise" approach in consideration of the wide variations in the studies and data before us. Rather, it was a recognition of the uncertainty or inexactness inherent in the information available and the amount of analysis undertaken at the time, and a signal of our openness in reconsidering the issue in that light.

91. Taking into consideration the above evaluations and all of the additional information before us now, we believe that the most compelling path points to retaining the 40 dB extrapolation factor. In this regard, we first observe that we have used this extrapolation value successfully with measurements at frequencies below 30 MHz in our program to control emissions from radio frequency devices for many years. This includes not only consumer products, but also industrial, scientific and medical equipment that may use thousands of watts of power and couple radio noise onto power lines that can radiate for significant distances. In addition, while ARRL asserts that there is only one scientifically correct and valid answer of an extrapolation factor of 20 dB, the studies and information before us show considerable differences in extrapolation factors under various system configurations and usage condition. We therefore conclude that there is no single "right" value for the extrapolation factor that accurately reflects environmental conditions in all cases, and instead find that the most appropriate decision is to use the existing value in the rules that both has a scientific basis and has stood the test of time for a wide variety of devices and systems. We also consider that, as observed in the discussion above, using the slant range to perform measurements has the effect of reducing the extrapolation factor to approximately 20 dB. In addition, the attenuation factors that are typically present when making measurements close to the ground, as specified in the BPL rules, tend to increase the signal loss above that which occurs from the spreading of energy in free space propagation. Finally, while one can debate the propriety and scientific validity of any particular extrapolation factor, we must consider that the extrapolation factor is but one element in the context of an overall set of rules that are designed to minimize the risk of harmful interference and to put in place appropriate measures to eliminate such interference if it should occur. Whether the extrapolation factor is 20 dB or 40 dB or somewhere in between is far less important than the fact that harmful interference must be corrected under any circumstances. While ARRL asserts that an extrapolation factor that is too lax will lead to widespread instances of harmful interference that should be corrected *ex ante* as opposed to *ex post*, we have seen little evidence of harmful interference being caused.[237] Accordingly, we are not modifying the extrapolation factor for the emissions standard for frequencies below 30 MHz to compensate for the variability in the field strength attenuation rate at different locations.

92. We also are reiterating here the clarification we issued in the *RFC/FNPRM* that measurements of BPL equipment and systems should be made at the 30-meters distance specified in Section 15.209 unless circumstances such as high ambient noise levels or geographic limitations are present, in which case, a 3-meter or 10-meter horizontal distances indicated in the BPL measurement guidelines may be used.[238] We are further clarifying that measurements made at the 30-meter distance

[236] CURRENT comments at 8; UPLC comments at 5. We note that CURRENT's operations are mainly above 30 MHz on overhead MV lines.

[237] As noted above, the BPL system database shows that BPL systems are currently operating in 125 zip codes across the United States.

[238] No extrapolation of the emissions level is needed for measurements made at the 30-meter distance specified in the standard.

specified in the Section 15.209 emissions standard will prevail over measurements made at shorter distances and that where possible and practical, the Commission's staff will make measurements at this distance when testing for compliance.[239] As indicated above, to provide additional clarity in our compliance requirements, we are also amending the BPL measurement guidelines to specify the extrapolated values of the emissions level for compliance at 3-meter and 10-meter horizontal distances from the nearest point of the overhead power line carrying the BPL signals for typical heights of medium voltage power lines. These clarifications of the existing rules as well as the adoption of the definition for slant-range distance would assist the industry in ensuring compliance of BPL systems without imposing additional regulatory costs.

2. Site-Specific Extrapolation Factors

93. In the *RFC/FNPRM*, the Commission proposed to allow parties testing BPL systems for compliance with the radiated emissions limits to determine distance correction factors on a site-by-site basis using a new *in situ* measurement procedure designed specifically for Access BPL.[240] This plan, which was based on a concept under consideration in the IEEE Working Group P1775/D2 effort at that time and which has been finalized since,[241] would allow entities conducting measurements of Access BPL systems and equipment to determine an extrapolation factor specific to a site by fitting a straight line to measurements of field strength in dBμV/m vs. logarithmic distance in meters from the nearest conductor carrying BPL emissions, where the extrapolation factor would be taken as the slope of that line.[242] The Commission indicated that the site-specific extrapolation factor would be an alternative to the extrapolation factor specified in the BPL measurement guidelines and would be replacing the existing method using only two data points for determining site-specific extrapolation factors currently in the rules.[243] The proposed alternative method would only be applicable to Access BPL devices operating on frequencies below 30 MHz.

94. Under the proposal in the *RFC/FNPRM*, entities conducting measurements would determine an extrapolation factor specific to the site by fitting a straight line to measurements of field strength in dBμV/m vs. logarithmic distance in meters from the nearest conductor carrying BPL emissions, where the extrapolation factor would be taken as ten times the slope, n, of that line. The slope n any point on the straight line in μV/m would be:

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[239] CURRENT states that while it has no objection in principle to measurement of BPL emissions at 30 meters, it does foresee possible problems in practice. In this regard, CURRENT submits that a suitable test site would have to be removed from power lines (apart from the one under test) by a distance of several times 30 meters. Such a location will be difficult to find in a built-up environment, so studies may have to take place in rural areas. CURRENT comments at 11. We agree with this observation and caution parties taking measurements at 30 meters (and also at closer distances) to take into account the presence of other nearby power lines which may also be carrying BPL signals or be a source of ambient noise.

[240] Section 15.31(f)(2) of the rules currently allows the results of measurements performed at frequencies below 30 MHz to be extrapolated on a site-specific basis, specifying that test results are to be extrapolated to the standard distance by making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor, *see* 47 C.F.R. § 15.31(f)(2).

[241] *See* IEEE 1775-2010 at Annex A, p. 41-43.

[242] *See RFC/FNPRM* at 9682-9684.

[243] Currently, for frequencies below 30 MHz, the rules stipulate that "[w]hen performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade)." 47 C.F.R. § 15.31(f)(2).

$(20\log E_r - 20\log E_2)/(10\log D_2 - 10\log D_r)$

where E_r is the measured field strength at distance D_r

The field strength in dBμV/m at any distance D along the best straight line fit is estimated from the value of *n* as:

$$20\log E_r = 20\log E_2 + n(10\log D_2 - 10\log D_r)$$

The extrapolation factor would be derived from a best straight line fit determined by a linear least squares regression calculation from measurements made at four or more lateral distances from the overhead line, starting at no less than 6 meters from the lateral plane and spaced from each other by at least 3 meters. If these measurements allow a straight line with a negative slope to be calculated or drawn with reasonable fit (the minimum regression coefficient of multiple correlation would be 0.9), the best straight line fit would be used to calculate field strength at the 30-meters standard measurement distance in the rules according to the equation above. If the four measurements do not fall near any straight line or negative slope, measurements at a new distance would be added until a reasonable fit to a straight line is indicated. In addition, measurements that obviously show a "null" or other "outlier" value would be ignored.[244] Parties employing site-specific extrapolation values would be required to provide a record of the measurements under the above procedure and to submit those measurements and their derivation of the *in situ* values with any measurements with compliance submissions to the Commission.

95. Several commenting parties representing the Access BPL industry support our proposal to establish a special procedure for determining site-specific extrapolation factors for use in measuring emissions from BPL systems and equipment. In particular, CURRENT, HomePlug, IBEC, Intellon Corporation (Intellon) and UTC support allowing BPL systems operators to develop their own *in situ* BPL extrapolation factors on a voluntary basis as a means to provide them with flexibility in demonstrating compliance with the rules.[245] IBEC states that in certain cases it may be advantageous to create special procedures to address unique site-related issues. It submits that these special procedures should be implemented at the option of the equipment manufacturer, who should also bear the responsibility for justifying the procedures and ensuring that they meet the requirements and intent of the rules.

96. ARRL opposes the establishment of a procedure for determining site-specific extrapolation factors for Access BPL measurements, arguing that our proposal "is flawed and unacceptable, based on an incomplete IEEE standard which is still under development, and not yet published."[246] It further observes that the IEEE draft standard has been the subject of a number of negative comments in the ballot process, which must yet be addressed by the IEEE's working group.[247] With regard to methodology, ARRL argues that measurement at only four points (as proposed in the IEEE draft standard) cannot

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[244] "Outliers" are high and low values that fall well out of the range of typical values.

[245] CURRENT comments at 8, HomePlug comments at 4-5, IBEC comments at 3, Intellon reply comments at 5 and UPLC comments at 7. CURRENT indicates that it supports this proposal so long as the manufacturer also retains the option of applying the fixed extrapolation factor in the rules.

[246] ARRL comments at 18.

[247] We note that the IEEE did adopt a standard for determining site-specific extrapolation factors in measuring emissions from BPL systems (IEEE 1775-2010 Standard, published on Jan 7, 2011) that includes the methodology proposed in the draft standard. However, we also note that the IEEE EMC Society did not support that standard, citing deficiencies on procedural and substantive grounds; nonetheless, IEEE 1775-2010 remains a published and valid standard, sponsored and supported by the Power System Communications Committee of the IEEE Power & Energy Society and the Standards Committee of the IEEE Communications Society.

determine the actual extrapolation value, because any attempt to apply any measurement of extrapolation to the power lines' complex environment is a recipe for inaccuracy and would encourage "cherry picking" the results. It contends that this would allow those doing the measurements to provide any value of extrapolation that they want in either direction.[248]

97. In their reply comments, HomePlug and Intellon submit that contrary to ARRL's position, the IEEE draft standard on Access BPL site-specific extrapolation values currently is under review by a large and competent body of experts who have studied and validated the *in-situ* measurement procedures.[249] They state that even as a draft, this standard represents the most recent collaborative work to accurately measure radiation specifically from power lines carrying BPL signals.

98. We continue to believe the availability of a site-specific approach for determining values for extrapolation of measurements of Access BPL emissions on frequencies below 30 MHz is a desirable and useful alternative to the fixed extrapolation factor. The option to use site-specific values can substantially alleviate the measurement concerns associated with the standard extrapolation factor and the variability in attenuation rates that may be observed in the field, and particularly where measurements at a site may plainly not appear to conform to the 40 dB/decade standard.[250] We also recognize ARRL's concerns that a site-specific option could be abused by careful selection of measurement points. However, we find that our proposed approach that requires four measurements spaced at least 3 meters apart with provisions for additional measurements where a straight line with a negative slope is not approximated by the four initial measurements, is sufficient to develop a reliable indication of the attenuation rate at a site. In particular, we believe the requirement in this new procedure that the measurements used to develop the extrapolation value approximate a straight line with a negative slope as determined through the linear least squares regression method (with a minimum regression coefficient of multiple correlation of 0.9) will adequately guard against the "cherry picking" concern mentioned by ARRL. Where such a line cannot be approximated, we will also require that measurements be made at a different perpendicular position along the power line very nearby or at the same perpendicular position but on the opposite side of the line from the first set of measurements.

99. This new site-specific procedure will replace the existing Section 15.31(f)(2) alternative for Access BPL that only requires two measurements. This plan conforms substantially to the IEEE P1775-2010 standard which has been developed, as HomePlug and Intellon point out, by a body of experts. We observe that a straight line best fit of multiple data points using the least squares regression technique is not a new idea developed by the IEEE standard, it is a well-established and commonly used statistical method. We note that in the *RFC/FNPRM,* we proposed to derive the extrapolation factor from a best straight line fit determined by a linear least squares regression calculation from measurements made at four or more lateral distances from the overhead line, starting at no less than 6 meters from the lateral plane and spaced from each other by at least 3 meters; at that time, the IEEE standard was in a state

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[248] ARRL comments at 54. ARRL also submits a paper in Exhibit C of its comments describing that near-field measurements contain a high degree of variability and that a few meters along the line will make a significant difference in the rate at which the signal strength decays perpendicular to the line, making any measurement unreliable for determining an extrapolation value, even at ground level. ARRL argues that, based on the conclusions of its Exhibit C, it is not possible to measure actual signal levels in the complex *in-situ* environment surrounding the power lines, unless a very large number of measurements can be made; thus, 4 measurement points as proposed by IEEE will not yield an accurate, reliable or predictable extrapolation number, ARRL comments at 55 and Exhibit C.

[249] HomePlug reply comments at 4-5, Intellon reply comments at 5.

[250] For example, development of a site-specific extrapolation value might be needed if the equipment that has been tested and found to comply with the emissions limit at other sites is found to be out of compliance as installed at the site under test.

of transition and we were merely proposing a measurement concept. We now observe the IEEE P1775-2010 has finalized its standard to specify that measurements be made at four or more lateral distances from the overhead line, starting at no less than 3 meters from the lateral plane and spaced from each other by at least 3 meters. We are adopting the distances as specified in the IEEE published standard for the new site-specific measurement procedure. This procedure is an improvement over the current procedure for determining site-specific extrapolation factors in Section 15.31(f)(2) of the rules, which requires only two measurement points without any specific separation distance, as stated above. We caution parties responsible for certification measurements to bear in mind that the objective of the site-specific procedure is to plot enough data points to draw a valid extrapolation curve; accordingly, in some situations the number of measurement points may need to exceed the recommended minimum for the resulting extrapolation to be valid.[251] Further, as we stated in the *BPL Order* and the *BPL Reconsideration Order*, operators of Access BPL systems are responsible for eliminating any harmful interference that may occur or must cease operation upon notification by a Commission representative that the device is causing harmful interference.[252] Accordingly, we are amending our rules as set forth in Appendix C to establish a new method for determining site-specific extrapolation values for Access BPL measurements as described herein. Because this is an alternative method intended to facilitate compliance measurements which may be used at the BPL operator's discretion, the requirement provides benefits without imposing additional regulatory costs. The benefits of having this additional method would enable BPL operators to better adjust the operating parameters of BPL devices according to specific installation sites that might not conform to the standard extrapolation value, which could lead to cost savings and reduced interference potential. Additional provisions of this procedure are set forth in the revised Access BPL measurement guidelines in Appendix D.

100. We will not allow the site-specific procedure to be used at locations within 30 meters of a power pole with a ground conductor where the Access BPL signals devices are carried on a neutral/grounded line of the power system. In this regard, we are concerned that emissions from a grounding conductor mounted on the side of a power line pole could combine with the emissions from the overhead neutral power line to produce false indications of the attenuation rate that would distort the slope of the extrapolation curve. Accordingly, we are amending our rules as set forth in Appendix C to establish a new method for determining site-specific extrapolation values for Access BPL measurements as described herein. Additional provisions of this procedure are set forth in the revised Access BPL measurement guidelines in Appendix D.

C. The Access BPL Database

101. ARRL contends that the BPL database is virtually useless due to errors, omissions and listings of systems that are not operating any longer and systems that have never been placed in operation. It cites as an example an incident in which it sent an e-mail message to the person listed in the database for the Manassas, VA, BPL system, it found the e-mail contact was invalid and follow-up e-mail messages to the City of Manassas went unanswered.[253] In its reply comments, the City of Manassas submits that when the system operator, Comtek, transferred operation of the system to the city, the contact was not updated immediately but the error was corrected promptly in April 2009 when the city was notified by ARRL that the listing was incorrect.[254] We agree with ARRL that the database should be

[251] A valid extrapolation curve would have a minimum regression coefficient of multiple correlation of 0.9.

[252] *BPL Order* at 21276; *BPL Reconsideration Order* at 9327.

[253] ARRL comments at 59-60.

[254] City of Manassas, VA comments at 1-2. The City of Manassas also states that amateurs in Northern VA knew who to contact regarding its BPL system.

maintained with accurate, up-to-date information. Our staff contacted the database manager, UTC, about ARRL's concerns and in its reply comments, UTC affirms that the database has been and is being reviewed periodically to ensure that the information is currently accurate.[255] We do note that while it is important that the database be up-to-date in all respects, it is most important that operating and soon-to-be operating systems not be omitted and we do not have information that such systems were not or are not listed. We therefore encourage UTC to continue to be diligent in its management of the database and other interested parties to work with UTC in providing information to ensure that the records in the database are accurate and up-to-date.

IV. PROCEDURAL MATTERS

102. *Final Regulatory Flexibility Analysis.* As required by the Regulatory Flexibility Act, 5 U.S.C. § 603, the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) of the possible significant economic impact on small entities of the proposals suggested in this document. The FRFA is set forth in Appendix B.

103. *Paperwork Reduction Act.* This document contains no new or modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13. In addition, therefore, it does not contain any new or modified "information collection burden for small business concerns with fewer than 25 employees," pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. 3506(c)(4).

104. *Congressional Review Act.* The Commission will send a copy of this Second Report and Order in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. 801(a)(1)(A).

V. ORDERING CLAUSES

105. Accordingly, IT IS ORDERED that pursuant to pursuant to the authority contained in Sections 4(i), 301, 302, 303(e), 303(f) and 303(r) of the Communications Act of 1934, as amended, 47 USC Sections 154(i), 301, 302, 303(e), 303(f) and 303(r), this Second Report and Order is hereby ADOPTED and Part 15 of the Commission's Rules ARE AMENDED as set forth in Appendix C, effective 30 days after publication in the Federal Register.

[255] UPLC reply comments at 8.

106. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Second Report and Order, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary