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

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In the Matter of	)	
	)	
Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems	)	ET Docket No. 04-37
	)	
Carrier Current Systems, including Broadband over Power Line Systems	)	ET Docket No. 03-104
	)	

SECOND REPORT AND ORDER

Adopted: October 20, 2011 **Released: October 24, 2011**

By the Commission:

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I. INTRODUCTION

1. In this Second Report and Order (Second Order), we fundamentally affirm our rules for Access Broadband over Power Line (Access BPL) systems. We also make certain minor modifications to improve and clarify the rules. These rules provide an appropriate balance between the dual objectives of providing for Access BPL technology that has potential applications for broadband and Smart Grid while protecting incumbent radio services against harmful interference.[1]

2. The Commission adopted rules for Access BPL systems in 2004[2] and affirmed those rules in 2006.[3] The BPL rules were challenged by the national association for amateur radio, formally known as the American Radio Relay League (ARRL) in the United States Court of Appeals for the District of Columbia in *ARRL v. FCC*.[4] In *ARRL v. FCC*, the court directed the Commission to: 1) make part of the rulemaking record unredacted versions of several staff technical studies which the Commission considered in promulgating the rules, 2) provide a reasonable opportunity for public comment on those studies, and 3) provide a reasoned explanation of its choice of the extrapolation factor[5] for use in measuring radiated emissions from Access BPL systems. In response, the Commission issued a *Request for Further Comment and Further Notice of Proposed Rulemaking* in this proceeding (*RFC/FNPRM*).[6] In the *RFC/FNPRM*, the Commission took its first step in responding to the directives of the court in *ARRL v. FCC* and also took that opportunity to review the Access BPL extrapolation factor and propose certain changes to the BPL technical rules that appeared appropriate in view of new information and further consideration of this matter. In this Second Order, we complete our action addressing the court's concerns and our proposals in the *RFC/FNPRM*. We find that the information submitted in response to the *RFC/FNPRM* does not warrant any changes to the emissions standards or the extrapolation factor. We are, however, making several refinements to our Access BPL rules. In particular, we are: 1) modifying the rules to increase the required notch filtering capability for systems operating below 30 MHz from 20 dB to 25 dB; 2) establishing a new alternative procedure for determining site-specific extrapolation factors generally as described in the

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[1] A "smart grid" electricity network includes an intelligent monitoring system that keeps track of all electricity flowing in the system from suppliers to consumers providing real-time or near-real-time load information to permit improved transmission management. It also can utilize two-way digital technology to control appliances at consumers' homes to reduce peaks and even out demand, to save energy, to reduce cost, and to increase reliability and transparency.

[2] *Report and Order* in ET Docket Nos. 04-37, 03-104 *(Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems, Carrier Current Systems)*, 19 FCC Rcd 21265 (2004) (*BPL Order*).

[3] *Memorandum Opinion and Order* in ET Docket Nos. 04-37, 03-104 *(Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems; Carrier Current Systems, including Broadband over Power Line Systems)*, 21 FCC Rcd 9308 (2006) (*BPL Reconsideration Order*).

[4] *American Radio Relay League, Incorporated, v. Federal Communications Commission (ARRL v. FCC)* 524 F.3d 227 (D.C. Cir. 2008).

[5] Because the field strength of radiated emissions decreases with increasing distance from the emitter due to propagation loss, an "extrapolation" factor is used to adjust the measurement results to account for the difference in attenuation, when measurements are made at a distance other than the specified distance in the rules.

[6] *Request for Further Comment and Further Notice of Proposed Rulemaking* in ET Dockets No. 04-37 and 03-104 *(Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems; Carrier Current Systems, including Broadband over Power Line Systems)*, 24 FCC Rcd 9669 (2009) (*RFC/FNPRM*).

RFC/FNPRM, and 3) adopting a definition for the "slant-range distance" used in the BPL measurement guidelines to further clarify its application.[7] We find that the benefits of the above changes to the rules outweigh their regulatory costs, as discussed herein.

3. Throughout this proceeding and in its appeal to the court, the ARRL has argued that more restrictive technical standards are needed to protect the amateur radio service from interference caused by leakage of radiofrequency (RF) emissions from Access BPL systems. We initially crafted rules for BPL systems that were based on our existing emission standards for carrier current communications systems – narrow-band devices that couple RF energy onto power line wiring for communication purposes – with a number of additional requirements to promote avoidance and resolution of harmful interference to licensed services that might occur in the context of BPL operations.[8] We subsequently affirmed those rules in response to petitions for reconsideration by various parties, including ARRL.[9] In this process, we have specifically rejected as unnecessary repeated requests by ARRL for tighter emissions controls on Access BPL operations. In response to the court's direction, we provided opportunity in the *RFC/FNPRM* for interested parties to address the BPL technical rules and the information developed by our staff that we considered in establishing those rules, explained our rationale for the extrapolation factor used in measuring BPL emissions, expressed our tentative satisfaction with the extrapolation factor adopted, while soliciting comment on whether another value would be more appropriate, and proposed a procedure for determining site-specific extrapolation factors. Herein, we complete our response to issues raised under the court's directive.

II. BACKGROUND

4. In the *BPL Order*, the Commission adopted rules to regulate the operation of Access BPL systems as unlicensed, unintentional radiators.[10] These BPL systems, which are a form of carrier current system,[11] deliver high speed Internet and other broadband services over the utilities' medium-voltage delivery power lines to homes and businesses; electric utility companies also use Access BPL devices to monitor and manage various elements of their electric power distribution operations as part of "Smart Grid" applications. In adopting the rules for these devices and systems, the Commission observed that BPL could provide a means to expedite the availability of broadband Internet service to consumers and businesses in rural and other underserved areas, introduce additional competition to existing broadband services, promote continued U.S. leadership in

[7] Because Access BPL devices are mounted on overhead power lines and the measurement antenna is at a lower distance closer to the ground, the actual distance from the power line to the measurement antenna is greater than the horizontal distance from the pole on which the BPL device is mounted to the measurement antenna. The correct distance for measurement is therefore the "slant range" diagonal distance measured from the center of the measurement antenna to the nearest point of the overhead power line carrying the Access BPL signal being measured.

[8] *BPL Order*, 19 FCC Rcd 21265 (2004).

[9] *BPL Reconsideration Order,* 21 FCC Rcd 9308 (2006).

[10] An unintentional radiator is defined in the rules as a device that intentionally generates radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction. *See* 47 C.F.R. § 15.3(z). The Access BPL regulations are set forth in Sections 15.601-15.615 of the Commission's rules, 47 C.F.R. §§15.601-15.615.

[11] Carrier current systems transmit radio frequency energy by conduction over electric power lines, *see* 47 C.F.R. §15.3(f). These systems have been operating successfully as unlicensed campus radio stations in the AM Broadcast band for over fifty years in the United States at many universities.

broadband technology, and bring important benefits to the American public.[12] At the same time, it recognized the need to ensure that BPL operations do not cause harmful interference to licensed radio services.[13] Accordingly, the Commission established technical standards, operating restrictions and measurement guidelines for Access BPL to minimize instances of interference to licensed services and to facilitate resolution of such interference where it might occur.[14] These provisions for managing interference include: 1) application of the existing emission limits for carrier current systems in Section 15.109(e) to Access BPL;[15] 2) requirements that Access BPL devices employ adaptive interference mitigation techniques to promote avoidance and resolution of harmful interference; 3) requirements that Access BPL system operators provide information on the areas where their systems are installed and other technical parameters in a central data base that is accessible by the public; and 4) specific measurement guidelines and certification requirements for both Access BPL and other carrier current systems to ensure accurate and repeatable evaluations of emissions from Access BPL and all other carrier current systems. The rules also include specific provisions (not relevant here) for certain critical Federal Government and other services in the form of coordination requirements, exclusion zones and excluded frequency bands.[16] The Commission did not find that the amateur radio service warrants additional protections particular to that service; rather, it concluded that the general Part 15 rules and the additional specific provisions being adopted for Access BPL operations are sufficient to protect amateur operations.

5. Following the issuance of the *BPL Order*, ARRL filed a Freedom of Information Act (FOIA) request, seeking disclosure of Commission studies of emissions generated by Access BPL systems. In response to that request, the Commission released five staff presentations in redacted form and added them to the record in December 2004. ARRL, among others, sought reconsideration of the *BPL Order* on February 7, 2005.[17] The Commission on reconsideration amended its rules in part but generally denied ARRL's petition, making one clarification.[18] It reiterated the need to ensure that BPL operations do not cause harmful interference to licensed radio services and recognized that the substantial benefits of this technology might not be realized if BPL devices were to cause interference to licensed services and other important radio operations.[19]

6. Subsequently, ARRL challenged the Commission's Access BPL decisions in the United States Court of Appeals for the District of Columbia. In its petition for judicial review, ARRL challenged the Access BPL rules on four grounds, alleging that: 1) the Commission ignored long-standing precedent by authorizing the operation of unlicensed devices that could interfere with licensed services and by no longer requiring that operators cease using the unlicensed devices if they actually cause interference; 2) the Commission did not adequately consider an alternative proposal for

[12] *BPL Order* at 21266 and 21271.

[13] *Id.* at 21266.

[14] *See* 47 C.F.R. §§ 15.601-15.615.

[15] *See* 47 C.F.R. §§ 15.109(e) and 15.209; these limits are codified for Access BPL systems at Section 15.611(b).

[16] *See* 47 C.F.R. §§ 15.615(e)-(f).

[17] *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.

[18] On reconsideration, the Commission clarified rule section 47 C.F.R. § 15.611(c)(1), as requested by ARRL. *BPL Reconsideration Order* at 9320 and 9338.

[19] *BPL Order* at 21266.

reducing harmful interference that would have limited Access BPL systems to the frequency band between 30 MHz and 50 MHz, rather than between 1.7 MHz and 80 MHz; 3) the Commission violated the Administrative Procedure Act (APA) by failing to disclose in unredacted form certain technical studies prepared by the Commission's engineers that were relied upon in adopting the rules;[20] and 4) the empirical evidence does not support the Commission's decision to retain the existing 40 dB per decade (40 dB/decade) extrapolation factor to measure Access BPL radiated emissions at frequencies below 30 MHz, which contain several bands used by amateur licensees.[21]

7. The court denied in part and granted in part ARRL's petition and remanded the rules to the Commission for further action.[22] It found unpersuasive ARRL's arguments with respect to the first two points. However, the court found that the Commission failed to satisfy the notice and comment requirements of the APA by redacting staff studies which it considered in promulgating the rules and by failing to make a reasoned explanation for its choice of the extrapolation factor for measuring Access BPL emissions. The court therefore directed the Commission to make the unredacted staff studies part of the rulemaking record and provide an opportunity for notice and comment.[23] With respect to the extrapolation factor, the court found that the Commission has not adequately explained its decision and directed the Commission to "either 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 [which ARRL submitted in *ex parte* comments supporting its petition for reconsideration from the 2004 Order], or adopt another factor and provide a reasoned explanation for it."[24] The court did not suspend the Commission's Access BPL rules pending further actions by the Commission and the rules have remained in effect.[25]

8. As directed by the court, the Commission placed into the record of the above proceeding unredacted versions of five technical staff presentations[26] that it had previously submitted in redacted

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[20] In pertinent part, the APA requires administrative agencies to publish "notice" of "either the terms or substance of the proposed rule or a description of the subjects and issues involved," in order to "give interested persons an opportunity to participate in the rule making through submission of written data, views, or arguments," and then, "[a]fter consideration of the relevant matter presented, the agency shall incorporate in the rules adopted a concise general statement of their basis and purpose." 5 U.S.C. §§ 553(b), (c). In order to provide sufficient notice, the agency must disclose any technical studies and staff reports on which it relies. *ARRL v. FCC*, 524 F.3d at 236, *citing*, *e.g.*, *NARUC v. FCC*, 737 F.2d 1095, 1121 (D.C.Cir.1984).

[21] *See ARRL v. FCC*, at 233. "Decade," a 10 to 1 range, refers to the ratio of the specified measurement distance to the actual measurement distance. An extrapolation factor of 20 dB per decade treats field strength emissions as if they attenuate at a rate inversely proportional to the distance from the emitter (1/R), whereas an extrapolation factor of 40 dB per decade treats emissions as if they attenuate at a rate inversely proportional to the square of the distance from the emitter ($1/R^2$). If the extrapolation factor is 20 dB per decade instead of 40 dB per decade, the correction factor would be significantly smaller, thus resulting in lower permitted values for the transmitted emission levels at the same distance from the emitter. *See* 47 C.F.R. § 15.31(f)(1) and (2).

[22] *Id.*, at 231.

[23] *Id.*, at 240.

[24] *Id.*, at 241.

[25] *Id.*

[26] We note that the use of the term "study" or "report" used for these informal presentations of scientifically collected data, staff notes and observations may imply a greater degree of completion, finality, consideration and conclusion than is the case here. These presentations of information, impressions, and ideas were just that, – informal presentations by staff engineers to other staff engineers and OET managers. A "study" or "report" prepared as information or for consideration would normally be in a formal written format for publication and (continued....)

form.[27] The staff presentations included information regarding measured emissions from various experimental Access BPL systems at locations in Pennsylvania, Maryland, New York, and North Carolina, that were used to familiarize the Commission and its staff with this new technology.[28] These presentations were considered in the decision-making process along with studies submitted by commenters such as ARRL and the National Telecommunications and Information Administration (NTIA). The first two presentations, included in a single file entitled *BPL Measurements in Allentown, PA*, contain data collected on the Amperion BPL system and on the Main.Net BPL system, both in Allentown, PA.[29] The third presentation, *Emissions Measurements on CURRENT Technologies Medium Voltage BPL System*, contains data collected on the CURRENT Technologies (CURRENT) BPL system in Potomac, MD.[30] The fourth presentation, *BPL Summary After Briarcliff Manor, NY Test*, contains data collected on the Ambient BPL system in Briarcliff, NY, and some staff observations.[31] The fifth presentation, *BPL Emission Test Near Raleigh, NC*, contains data collected on the Amperion/Progress Energy BPL system in Raleigh, NC.[32] The Commission observed that the redacted pages mostly contain information regarding specific test notes and test set-up recommendations with respect to the BPL systems at the various test sites,[33] certain requests from third parties,[34] and preliminary and partial data

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reviewed and vetted by agency staff and management, which was not the case in these instances. No formal peer review was conducted. Thus, while there is much useful scientific information in those presentations that was considered in our BPL decisions, other content therein is more properly viewed as discussion materials and options rather than settled conclusions. Accordingly, we will hereinafter refer to these documents as presentations to differentiate them from the more formal and considered findings of a study or report.

[27] *See* Letter dated April 29, 2009 to ARRL from Julius Knapp, Chief, Office of Engineering and Technology.

[28] Two presentations measured emissions from systems marketed by two specific Access BPL manufacturers (Amperion and Main.Net BPL systems in Allentown, Pennsylvania), and three others measured location-specific emissions in pilot Access BPL areas in Maryland (CURRENT Technologies BPL system in Potomac), New York (Ambient BPL system in Briarcliff Manor) and North Carolina (Amperion/Progress Energy BPL system in Raleigh.) *ARRL v. FCC*, *supra* at 237.

[29] *BPL Measurements in Allentown, PA* at
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215595,
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215596, and
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215597.

[30] *Emissions Measurements on CURRENT Technologies Medium Voltage BPL System,* at
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215597 and
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215598.

[31] *BPL Summary After Briarcliff Manor, NY Test*, at
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215598 and
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215599.

[32] *BPL Emission Test Near Raleigh, NC* , at
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215599 and
http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520215600.

[33] *BPL Measurements in Allentown, PA,* slide 6, labeled "Conclusions Regarding Amperion" and slide 7, labeled "Recommendations for Amperion"; *Emissions Measurements on CURRENT Technologies Medium Voltage BPL System,* slide 36, labeled "Recommended Future FCC Tests (to understand technology)".

[34] *BPL Measurements in Allentown, PA*, slide 48, labeled "Conclusions Regarding Main.Net" and slide 52, labeled "Other Issues".

with respect to the noise floor[35] and attenuation rate of the signal strength downline at the test sites[36] as well as the opinions of one staff member as to whether BPL systems are point-source systems[37] and that staff member's opinion on possible ways to treat these systems.[38] In the *RFC/FNPRM*, the Commission requested comment on the information in those unredacted presentations as it pertains to its BPL decisions.

9. On July 17, 2009, concurrent with its release of the *RFC/FNPRM*, the Commission also placed into the record some additional materials that contain preliminary staff research and educational information (preliminary research materials) and were not previously available therein and invited comment on those materials. These materials consist of several working papers and video files that were used in preparing the staff presentations and for staff education. The Commission stated that these are materials that it would not routinely, and in this case did not previously, place in the record. However, the Commission indicated that it now believes it is important to make available all potentially relevant research and information materials in order to fully and most efficaciously conclude its examination of the BPL issues. A list of these additional materials is provided in Appendix F.

10. The Commission also provided an explanation of its reasons for selecting 40 dB/decade as the measurement distance extrapolation factor for frequencies below 30 MHz. The Commission further explained why it believes the studies and technical proposal submitted earlier by ARRL do not provide convincing information that it should use an extrapolation factor that is different from that which it adopted.[39] The Commission also noted the existence of more recent studies that verify the correctness of its determination, although it did not rely on those studies as *ex post facto* rationale or justification for its decision.

11. Consistent with the opportunity provided by the court's remand and its stated intention in the *BPL Order* to review the decision on the extrapolation factor if new information becomes available, the Commission also indicated in the *RFC/FNPRM* that it would re-examine the current extrapolation factor in light of the recently issued technical studies addressing the attenuation of BPL emissions with distance and the efforts by the Institute of Electrical and Electronics Engineers (IEEE) to develop BPL measurement standards. The Commission stated that as the several studies now available show and as it has observed previously, there can be considerable variability in the attenuation of emissions from BPL systems across individual measurement sites that is not captured in the use of a uniform 40 dB/decade

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[35] *BPL Summary After Briarcliff Manor, NY Test*, slide 9, labeled "Raleigh Received Levels at 23.2 MHz from One Overhead Injector" and slide 13, labeled "NTIA Results"; *BPL Emission Test Near Raleigh, NC*, slide 16, labeled "Test Description for Mobile Radio Measurements" and slide 23, labeled "Notch Depth".

[36] *BPL Measurements in Allentown, PA*, slide 40, labeled "Summary of Relative Average Levels".

[37] *BPL Measurements in Allentown, PA*, slide 3, labeled "Major Conclusions", slide 17, labeled "Under-Line Field Strength vs. Distance Down Line" and slide 50, labeled "Conclusions Regarding Access BPL"; *BPL Summary After Briarcliff Manor, NY Test*, slide 17, labeled "New Information Arguing for Caution on HF BPL"; *Emissions Measurements on CURRENT Technologies Medium Voltage BPL System,* slide 35, labeled "Conclusions".

[38] *BPL Summary After Briarcliff Manor, NY Test*, slide 13, labeled "NTIA Results", slide 16, labeled "Skywave (<30 MHz)", slide 19, labeled "HF Issues and Options", slide 20, labeled "Low VHF Options", and slide 21, labeled "BPL Spectrum Tradeoffs and Proposals".

[39] This explanation of the insufficiencies of the OFCOM studies and of ARRL proposal for a sliding scale extrapolation factor responded to the Court's directive in *ARRL v. FCC* that the Commission 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 . . . [empirical data] ..."; *see RFC/FNPRM* at 9679-9680.

standard. To address this variability, it requested comment on whether it should amend the BPL rules to 1) adjust the extrapolation factor downward to 30 dB or some other fixed value and, 2) as an alternative, also allow use of a special procedure for determining site-specific BPL extrapolation values using *in situ* measurements. The *in situ* procedure it proposed was based on a concept that was under consideration at that time by the IEEE working group on power line communications technology electromagnetic compatibility (EMC) in its draft standard P1775/D2.[40]

12. In addition, the Commission clarified that parties testing BPL equipment and systems for compliance with emissions limits in the rules may measure at the standard 30-meter distance rather than the shorter distances recommended in the BPL measurement guidelines. It requested comments on the unredacted staff presentations, its selection of an extrapolation factor for BPL systems based on the slant-range method and the explanation provided therein, and its proposal to allow use of site-specific extrapolation factors as an alternative to the standard extrapolation factor. The Commission stated that in the interim, as justified therein, it would continue to apply the extrapolation factor as adopted in the *BPL Order*.

13. Thirty parties submitted comments and nine parties submitted replies in response to the *RFC/FNPRM*.[41] ARRL submitted a detailed presentation requesting rule changes to further protect the amateur radio service from harmful interference from Access BPL operations while permitting BPL systems to operate in the 3 MHz to 80 MHz range without significant constraint. It specifically asks that we achieve these objectives by requiring that BPL systems employ 1) full-time notching (frequency avoidance) of all amateur frequency allocations and 2) notch depths of 35 dB below the standard BPL emissions limit.[42] Nine of the commenting parties are parties with interests in the Access BPL industry who oppose ARRL's requested rule changes or provide other responses to its submissions. The remaining parties are individual amateur radio licensees who generally support ARRL's position.

III. DISCUSSION

14. In this proceeding, we have established a regime of rules for Access BPL systems that will provide a robust environment for the development and deployment of this important new technology option for delivery of broadband internet/data services while at the same time minimizing the potential for interference to licensed services caused by leakage from power lines of the RF energy used by BPL transmissions. As we observed in the *BPL Order*, there is some potential for increased harmful interference from BPL operations, particularly in locations within a short distance of the power lines used by this technology.[43] Consistent with our responsibilities for managing the interference potential of devices which can interfere with radio under Section 302 of the Communications Act, we have developed

[40] IEEE incorporated the *in situ* concept for deriving distance extrapolation from its earlier draft into IEEE 1775-2010 *IEEE Standard for Power Line Communication Equipment – Electromagnetic Compatibility (EMC) Requirements, Testing and Measurement Methods*, published on Jan 7, 2011.

[41] A list of the parties submitting comments and/or replies is provided in Appendix A.

[42] On Nov 30, 2011, ARRL also submitted *ex parte* comments (November 2010 *ex parte* comments) reiterating its requests, with information from an ITU-R Report published in 2009 (ITU-R Report SM.2158 *Impact of Power Line Telecommunications Systems on Radiocommunications Systems operating in the LF, MF, HF and VHF bands below 80 MHz*), an ITU-T Recommendation published in 2009 (ITU-T G.9960 *Unified High-speed Wire-line based Home Networking Transceivers – Foundation*), an OFCOM Report on *The Likelihood and Extent of Radio Frequency Interference from In-Home PLT Devices* dated Jun 21, 2010, and an IEEE Standard published in 2010 (IEEE P1901-2010 *Standard for BPL Networks: Medium Access Control and Physical Layer Specifications*) that it contends supports its position.

[43] *BPL Order* at 21276.

a set of rules for BPL devices and systems that attempts to minimize instances of interference while allowing BPL systems to operate in a viable manner to serve the needs of the American public.[44] In this regard, we have stated and continue to hold that, on balance, the benefits of Access BPL for bringing broadband services to the public are sufficiently important and significant so as to outweigh the limited increase in potential for harmful interference that may arise. We also agreed with NTIA that while some cases of harmful interference may be possible from Access BPL emissions at levels at or below the Part 15 limits, the potential benefits of Access BPL service warrant acceptance of a negligible risk of harmful interference that can be managed and corrected as needed on a case-by-case basis.[45]

15. To minimize the potential for harmful interference, facilitate its resolution where it may occur, and address cases where its possible occurrence could impact critical services, we adopted additional regulatory measures beyond the emissions limits in the Part 15 rules. These additional measures generally require Access BPL operators to reduce emissions or avoid operation on certain frequencies or in certain locations in order to protect licensed services, to use equipment that can alter its operation by changing frequencies to eliminate harmful interference, to provide information that will assist the public in identifying locations where Access BPL operations are present and provide notice to radio users before commencing local BPL operations in a publicly accessible database. In this manner, the Access BPL rules provide an effective means for limiting harmful interference and ensuring that any instances of harmful interference that may occur can be quickly identified and resolved. As we emphasized in the *BPL Order,* Access BPL systems will continue to be treated as unlicensed Part 15 devices and as such will be subject to the conditions in Section 15.5(b) of the rules that they not cause harmful interference and that they cease operation if they do cause such interference, as required by our rules.[46] As discussed below, upon examination of the information and comments received in response to the *RFC/FNPRM*, we continue to believe that these measures are adequate and appropriate for managing the potential for harmful interference to all licensed radio services that operate on the bands used internally by BPL systems, including the amateur radio service.

16. The requests for comment, explanation of rationale, and proposals presented in the *RFC/FNPRM* were all raised to address further ARRL's concerns about the potential for BPL operations to cause interference to licensed services, and specifically to amateur radio operations. The record submitted in response to the *RFC/FNPRM* essentially consists of 1) a lengthy presentation by ARRL of the reasons and arguments as to why it believes the information in the unredacted presentations and the preliminary materials released in July 2009 show our rules for protection against BPL interference and the extrapolation factor are based on incorrect or inappropriate analysis, technical explanations supporting its positions, and requests for rule changes that it contends would "adequately protect" the amateur service; 2) statements from amateur licensees supporting ARRL's positions; 3) submissions from representatives of the BPL industry opposing ARRL's positions on interference potential and rule changes and 4) comments on our proposals for modifying the extrapolation factor and establishing a procedure for determining site-specific extrapolation factors. Inasmuch as ARRL is the principal proponent of changes to the BPL rules for interference protection and the extrapolation factor, and the principle respondent with regard to the information in the unredacted studies and preliminary materials released in July 2009, we focus the discussion on those subjects on its submissions and arguments.

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[44] 47 U.S.C. § 302. Section 302 states in relevant part that "[t]he Commission may, consistent with the public interest, convenience, and necessity, make reasonable regulations (1) governing the interference potential of devices which in their operation are capable of emitting radio frequency energy by radiation, conduction, or other means in sufficient degree to cause harmful interference to radio communications ...."

[45] NTIA comments filed June 4, 2004 in ET Docket Nos. 03-104 and 04-37, 19 FCC Rcd 3335 (2004), at http://webapp01.fcc.gov/ecfs/document/view?id=6516212885, summary at iv.

[46] 47 C.F.R. § 15.5(b).

17. In its comments, ARRL argues in technical detail that BPL emissions propagate much farther than our assessment indicates and that BPL operations therefore pose a much greater threat of interference than that estimated by our analysis. It also asserts that the redacted portions of the staff presentations reveal information that BPL operations cause absolutely preclusive interference and that the Commission knew this information and ignored it.[47] ARRL essentially contends that the amateur service should be afforded protection against any possibility of interference occurring from BPL operations and demands that BPL operations not be allowed on frequencies allocated to the amateur service.[48] The commenting parties representing BPL interests oppose ARRL's demands and support maintaining our current rules. For example, CURRENT submits that "the record as a whole could plausibly have justified a range of regulatory responses...and that the Commission's approach in the *BPL Order* – enabling BPL to go forward subject to unprecedented notching and shut-down requirements, as well as the 40 dB/decade extrapolation factor – all come well within that range." It argues that nothing in the new materials calls those positions into question.[49]

18. We are not persuaded by ARRL's newest technical submissions, including the reports/standards referenced in its November 2010 and June 2011 *ex parte* comments, or its assertions regarding the information in the unredacted presentations and in the additional information we recently introduced into the record in July 2009 that our assessment of the interference potential from BPL operations was incorrect or inappropriate, or that modifications to the BPL emissions limits and other technical rules to provide additional protection for the amateur service are warranted. While there is much valuable and valid information and analysis in ARRL's technical presentations, there are additional considerations that previously led us to draw different conclusions and still lead us to maintain those conclusions now.

19. With regard to the redacted portions of the staff presentations and the preliminary information from early staff work that was released in July 2009, we were, of course, aware of that content and we were also aware of other considerations and facts that bear on the various BPL technical issues. Notwithstanding ARRL's apparent belief that the full content of the staff presentations should have led us to the conclusion it prefers, we found, and continue to find, differently with respect to the regulatory measures that are needed to protect the amateur service from interference from BPL operations. The presentations in those informally conducted experiments were part of our initial internal investigation of BPL and, while there is value in them, they are not the sole source of our information on BPL performance. In this regard, we considered all of the available information on BPL systems and their performance, submissions in the comments and other publicly available information. We also observe that some of the staff presentations on which ARRL focuses were of experimental systems that used early implementations of BPL equipment, developed before the *BPL Order*, that do not appear to have complied with the new rules; additionally, information on other system implementations, particularly our work with the Manassas, VA system, showed different performance characteristics than the systems ARRL criticized. In some cases, ARRL simply (and incorrectly) draws different conclusions from those presentations than we do. Also, the assessments and recommendations in the redacted portions of the presentations merely reflect the views of the Laboratory engineers who performed the testing and analysis; they do not necessarily reflect the consensus view of other engineers, the management of the Laboratory or of OET. Indeed, individual views are often conflicting, but are encouraged in the interest of producing vigorous debate to lead to a thoroughly considered recommendation and decision.

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[47] ARRL comments, summary at 1.

[48] *Id.* at 1.

[49] CURRENT comments at 3.

20. In the two sections of the discussion that follows, we address the potential for interference and the measurement distance extrapolation factor, examining ARRL's arguments on each of the issues it raises on those subjects and the responses of others in the comments. These issues concern: 1) the potential for interference from Access BPL emissions to amateur communications, including the rate at which the level of BPL emissions decline with distance from a power line as informed by the unredacted technical presentations and preliminary materials released in July 2009; 2) the level of notching necessary to protect amateur radio operations and whether to make notching mandatory on all amateur frequencies; 3) the technical considerations underlying the proper, *i.e.*, "correct", value of the extrapolation factor used to adjust emissions measurements made at distances less than 30 meters and other aspects of the BPL measurement procedure and our request for comment on whether to reduce the extrapolation factor; and 4) establishing a procedure for determining site-specific extrapolation factors.

A. The Potential for Harmful Interference

21. *Overview.* In the *BPL Order*, the Commission, with concurrence from NTIA,[50] concluded that the current emission limits will restrict Access BPL systems to low emitted field strength levels in comparison to the signals of licensed radio operations. It found that the effect of these limits will be to constrain the harmful interference potential of these systems to relatively short distances from the power lines that carry the BPL signals. The Commission also recognized that some radio operations in the bands being used for Access BPL, such as those of amateur radio licensees, may occur at distances sufficiently close to power lines as to make harmful interference a possibility. The Commission stated that it believed those situations can be addressed through interference avoidance techniques by the Access BPL provider such as frequency band selection, notching, or judicious device placement, and it adopted rules to facilitate such solutions.[51]

22. The Commission agreed with ARRL that Access BPL on overhead lines is not a traditional point-source emitter, but not with its argument that Access BPL devices would cause power lines to act as miles of transmission lines all radiating RF energy along their full length. In this regard, the Commission observed that the Part 15 emission limits for carrier current systems have proven very effective at controlling interference from such systems. Also, it indicated that the design and configuration of Access BPL systems would be inconsistent with the development of cumulative emission effects for nearby receivers. The Commission further concluded that because the BPL emissions level decreases significantly with distance perpendicular from the line, the potential for interference also decays rapidly with distance from the line.[52]

23. Notwithstanding the above considerations, the Commission recognized that Access BPL systems present concerns for licensed users in the high frequency (HF) and lower portions of the very high frequency (VHF) bands, given the propagation characteristics of RF signals in the range of frequencies being used for these systems, the diversity of users of these frequencies, and the fact that Access BPL devices could be installed at many locations in an area.[53] While it concluded that there is

[50] NTIA undertook a significant effort to both study Access BPL technology, including its operating characteristics and interference potential, and to make specific recommendations to the Commission for policies to encourage its implementation and to manage its interference potential in this proceeding. The Commission staff worked closely with NTIA on this matter and the policy decisions and rules adopted for Access BPL reflect this cooperation and embody many of NTIA's recommendations. *BPL Order supra* at 21266.

[51] *BPL Order* at 21282.

[52] *Id.*, at 21282-21283.

[53] The HF band covers frequencies from 3 to 30 MHz. The VHF band covers frequencies from 30 MHz to 300 MHz.

little likelihood that harmful interference would occur from Access BPL operations at the signal levels allowed under the current Part 15 emission limits, it acknowledged that such interference could occur in limited situations despite the intentions of BPL operators. To address this interference potential, the Commission required BPL operators to comply with additional interference mitigation techniques. It stated that such steps should be taken particularly in those cases where the occurrence of interference would affect critical services[54] or where interference could be anticipated to occur. The interference mitigation measures for critical services include exclusion from operating on certain frequency bands and exclusion from operation in certain areas.[55] For all services, the interference mitigation provisions require that BPL system operators have the ability to remotely cease operation or apply frequency avoidance (notching) on bands where licensed services are receiving interference. BPL operators were required to be able to notch their operations on affected bands to a level 20 dB below the Part 15 emissions limit for frequencies below 30 MHz (*i.e.*, 1/100th of the emissions limits for other unlicensed unintentional radiators).[56]

24. In the *BPL Reconsideration Order*, the Commission affirmed its selection of 20 dB below the Part 15 emissions limit as the minimum notching capability for frequencies below 30 MHz.[57] It also revised the rules to specify that where an Access BPL operator implements such notching, the operator need not provide further protection to mobile operations, nor will the operator be required to resolve complaints of harmful interference to mobile operations by taking steps over and above implementing the "notch." The Commission found that, while this level may be above the noise floor, reception of signals in mobile operating conditions is generally not reliable at levels at or below that level and thus does not warrant protection.

25. *Comments/Discussion*. In its comments, ARRL argues that recently released documents and materials graphically and aurally reveal that Access BPL causes preclusive interference over very large areas when such systems operate under current rules.[58] It contends that, without substantial technical limits that are not in the current BPL rules, Access BPL is incompatible with normal licensed amateur radio communications. It asserts that all of the Commission's 2003 and 2004 presentations, including both the unredacted presentations and the preliminary research materials released in July 2009, directly controvert the conclusions that the Commission reached in the *BPL Order* and in the *BPL Reconsideration Order* and show that Access BPL has a significant harmful interference potential to normal residential amateur radio operation.[59] In this regard, it states that the presentations show that the

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[54] Some of these critical services include national defense, maritime distress and safety, aeronautical navigation and communications, emergency response, and radioastronomy that provide important safety of life and research services. *See BPL Order* at 21287.

[55] For these services, *ex post facto* interference mitigation would not avoid potentially catastrophic results.

[56] 47 C.F.R. § 15.611(c)(1)(i).

[57] *BPL Reconsideration Order* at 9319-9320. The Commission observed that when extrapolated to values for the typical distance of a mobile antenna from roadside power lines (approximately 6 meters horizontal distance and 8.5 meters vertical distance, for a slant range of 10.4 meters) and adjusted for the typical quasi-peak-to-average ratio of 4 dB for Access BPL devices operating at high duty factor, the Part 15 limit corresponds to a root-mean squared (RMS) field strength of 44 dBμV/m for frequencies at or below 30 MHz. A 20 dB reduction would limit emissions to 24 dBμV/m. *BPL Reconsideration Order* at 9318. *See* 47 C.F.R. § 15.209(a).

[58] ARRL comments, summary at 1.

[59] ARRL also submits that the unredacted versions of the Commission's presentations contain numerous anomalies and that it is not clear that the Commission has released the entirety of any of the presentations, because there are gaps in the slide numbers. In his April 28, 2009 response to ARRL's FOIA request, OET Chief Julius Knapp addressed this situation as follows: "Note that certain slide numbers and dates appear to be out of sequence, due to (continued....)

rules currently permit operation of BPL systems whose interference potential to amateur high-frequency operation from Access BPL is essentially 100 percent at substantial distances from the power lines.[60] In support of its argument that there is significant potential for interference, ARRL submits technical analyses describing why it believes the appropriate extrapolation factor for Access BPL emissions, which is a function of the rate at which emissions attenuate with distance, should be 20 dB/decade rather than the 40 dB/decade that has traditionally been used to extrapolate measurements of carrier current systems for frequencies below 30 MHz to determine compliance with the Commission's emissions limits. To avoid this interference, ARRL requests that the rules be amended to require mandatory notching of all amateur frequency bands at notch depths of at least 35 dB below the level permitted under the Part 15 emissions limits (*i.e.*, 1/5000th of the emissions limits for other unlicensed unintentional radiators).[61] On the other hand, the Utilities Telecom Council (UTC) contends that "the portions of the staff presentations that were previously redacted are largely opinions that make observations, explain 'caveats' in the data, and provide options for the Commission to take."[62] CURRENT states that "on the whole, the preliminary data released in July 2009 have no significant effect on the Commission's earlier conclusions."[63]

26. In its November 2010 *ex parte* comments, ARRL reiterates its request for a requirement for full-time mandatory notching of all amateur bands at a 35-dB notch depth, contending that this provision can be implemented as part of the rules without any adverse impact on the BPL industry. In this regard, it claims that the 35-dB notching capability is already a standard that is voluntarily in effect in most existing BPL system architectures and deployments.[64] ARRL cites a variety of recently published domestic and international standards/reports that specify a 35-dB notching capability.[65] However, in a May 2011 *ex parte* submission responding to this filing by the ARRL, UTC argues that contrary to ARRL's claims, 35-dB notching is not required by industry standards and requests that the Commission not impose such a requirement because it would adversely impact BPL performance.[66] It further states that one of the standards referenced by ARRL, the IEEE P1901-2010, only refers to 35-dB notching with respect to one type of BPL technology, wavelet OFDM.[67] UTC asserts that wavelet OFDM technology's capability to achieve notch depths of 35 dB is not representative of the performance of BPL systems in general. It therefore argues that it would be misleading to suggest that 35-dB notching is required at all, much less for BPL technologies in general. UTC further submits that a deeper notch depth generally requires wider notch width, which means less bandwidth and lower speeds in terms of performance.[68] UTC states that

(Continued from previous page)
repeat printing of files to generate unredacted versions of pages previously redacted." We would also point out that these are not presentations that were intended for release and they underwent various revisions and modifications. The versions provided in the record are the last drafts of those presentations and thus can be considered as the "final" versions.

[60] ARRL comments at 9, footnote 7.

[61] *Id.* at 10.

[62] UPLC comments at 2.

[63] CURRENT comments at 2.

[64] ARRL November 2010 *ex parte* comments at para. 3. As part of its comments, ARRL includes an Exhibit A titled *Rationale for Fixed 35-dB Notches for the Amateur Bands in Access and In-Premise Broadband over Power Line (BPL) Regulations*, in which it outlines the electromagnetic compatibility (EMC) practices and standards that the BPL industry has generally implemented to mitigate interference problems to the amateur radio service.

[65] *See* footnote 42, *supra.*

[66] *See* UTC *ex parte* comments (filed May 4, 2011) at 1.

[67] IEEE P1901-2010, *Standard for BPL Networks: Medium Access Control and Physical Layer Specifications.*

[68] *Id.* at 2.

for these reasons the Commission should continue the current rules, rather than impose 35-dB notching.

27. In a June 2011 *ex parte* rebuttal to UTC's May 2011 submission, ARRL argues that UTC's claims are in error because they are based on a selective interpretation and misstatement of the content of the standards discussed and of the content of other sources that ARRL described.[69] With respect to industry standards, ARRL states that it reported on the notching required in a number of industry standards, not just IEEE Standard 1901, and also reported on information published by or provided to ARRL by BPL manufacturers, and on numerous measurements of BPL systems made by ARRL, members of the BPL industry, regulators and other parties. It submits that in these sources, notch depth was described or measured at depths ranging from 30 to over 40 dB. It agrees that some of those standards and other sources cited in its November 2010 filing do not specifically mandate 35-dB notching, and that in some of the sources it cited the stated notch is instead informative, and demonstrative of the capability of the state of the art.[70] ARRL submits that whether 35 dB is chosen for the Commission's regulations, or 30 dB or 40 dB, is a secondary issue. It contends that the critical point is that the state of the art of BPL system notching is far better than the 10- or 20-dB notching mandated in the current BPL rules and that higher numbers – on the order of 35 dB – are achievable and can be implemented without adverse impact on the technology, and that full time, mandatory notching with substantially higher notch depths than are currently required by the Commission's rules are critical to interference avoidance.

28. In response to UTC's statement that the 35-db notching described in IEEE Standard 1901-2010 applies only to wavelet OFDM BPL technology, ARRL states that UTC fails to note that this standard applies to two BPL technologies, wavelet OFDM and FFT OFDM (HomePlug) and argues that UTC hides the fact that the standard's requirements for FFT OFDM (HomePlug) BPL are very specific, and normative, mandating a 30 dB spectral mask depth and normatively describing a "North America" mask that includes the frequencies for the US Amateur bands.[71] ARRL also disagrees with UTC that a deeper notch depth affects the performance of BPL systems. In this regard, the ARRL submits the findings of a study of In-House (in-building) BPL equipment by the European Telecommunications Standards Institute (ETSI) that indicates that with notching, the overall trend is for a slight reduction in data rate that is not harmful.[72] ARRL further argues that the Republic of Korea has developed rules requiring that the Amateur and aeronautical and marine safety bands be permanently notched and that BPL systems are being successfully deployed in that country.[73]

29. We disagree with ARRL that the recently released materials show interference potential from Access BPL systems to be significantly greater than that which we anticipated in the *BPL Order,* that such interference will be preclusive of amateur operations over large areas, or that the current rules

[69] ARRL *ex parte* comments filed Jun 24, 2011 (June 2011 *ex parte* comments).

[70] *See* the list of sources cited by ARRL in footnote 42, *supra.*

[71] ARRL June 2011 *ex parte* comments at p. 3-4. HomePlug is an industry standard for In-House BPL devices. *See* http://www.homeplug.org/home/.

[72] ARRL June 2011 *ex parte* comments at p. 9. ARRL cites ETSI technical report, ETSI TR102-616, *PLT Report from PlugTests 2007 on Coexistence between PLT and Short-wave Radio Broadcast; Test Cases and Results,* in which test results on in-building BPL devices show 1) the loss of data was not substantial; 2) in some cases, notching spectrum that is being affected by strong interference improved the data rate; 3) there is no consistency to the degree to which notching affects the data rate (in either direction) relative to other factors such as conductor losses and the physical architecture of the premise carrying the BPL signal; and 4) the data rate available to the end user is affected by other factors (primarily the physical architecture of the local wiring carrying the BPL signal).

[73] ARRL June 2011 *ex parte* comments at p. 10-11.

are not adequate to resolve any interference that might occur. Rather, ARRL's in-depth focus on that material is in some aspects consistent with our own assessments, in other aspects incorrect, and, importantly, in many aspects does not account for the real world conditions affecting the propagation of RF emissions at HF frequencies. While ARRL provides significant information on the standard engineering principles concerning the attenuation rate of emissions from line emitters, it is mistaken as to how the attenuation rate should be viewed for purposes of measuring BPL emissions. In this regard, we again conclude that 40 dB/decade is a best estimate of the expected attenuation rate/extrapolation factor in the conditions in which measurements are made under the Access BPL measurement guidelines. We find no information in the comments or the newly submitted information in ARRL's November 2010 and June 2011 *ex parte* submissions that would warrant modification of the Access BPL rules to require notching of all amateur bands at notch depths of at least 35 dB, or otherwise provide additional protection for the amateur service. However, in reviewing the requirement that Access BPL systems be capable of reducing their emissions by 20 dB in a given frequency band and current developments in BPL equipment, we now find that it would be appropriate to increase this required "notching" capability by 5 dB, to 25 dB for BPL systems operating below 30 MHz. We respond to the comments with respect to each of these sets of materials sequentially below.

1. Unredacted Staff Presentations and Newly Submitted Materials

30. In its comments, ARRL argues that the unredacted staff presentations show that:

1) Access BPL is not a point-source emitter; it is a distributive system that has significant interference potential over a wide area at significant distances from (and along) the power line carrying BPL signals. It contends that the Commission's measurements show that there is virtually no signal decay along the power line 230 meters from the coupler.

2) The proper distance extrapolation factor for assumed signal decay with distance from the power line is much closer to 20 dB/decade of distance (20 log R) than to the 40 dB/decade of distance (40 log R) adopted by the Commission for frequencies below 30 MHz.

3) Access BPL has a considerably higher interference potential to licensed radio services than the Commission concluded in the *BPL Order* if operated at the maximum radiated emission levels permitted by the Commission's Part 15 rules (and the BPL rules adopted in the *BPL Order*). Specifically, interference to licensed mobile radio receivers is very likely for very long distances along a power line. The presentations also show that systems operating at the Part 15 emission limits will be at least 25-35 dB stronger than the median values of man-made noise at 30-meters distance. Extrapolating this to a mobile antenna closer to the lines results in an even higher noise level.

4) The Commission erred in concluding that mobile Amateur stations would be protected from interference if, in response to an interference complaint, the BPL operator reduced the BPL radiated emission level from the offending portion(s) of the BPL system by 20 dB below the maximum radiated emission level permitted for Part 15 devices generally. That remedy falls far short of reducing BPL noise to the level of ambient noise in residential environments found by Commission's technical staff, and falls far short of reducing BPL wideband noise levels to the point that mobile communications can be conducted in areas substantial distances from the power line.

5) Measurement of BPL radiated emissions should be done at heights not lower than in the same horizontal plane as the overhead power line.

31. First, we agree with ARRL that a BPL system does not behave as a point-source emitter. Neither, however, can it be analyzed as a line emitter. Analysis and prediction of RF propagation in the HF frequency region is extremely complex and difficult, and particularly at locations close to the ground,

as the Commission, ARRL and many other commenters have acknowledged throughout this proceeding.[74] Our intent in the *BPL Order* was not to say that power lines are point-source radiators, but rather simply that the interference potential lessens with distance down the line from the coupler — though this occurs at rates that can vary significantly with power line topology.

32. ARRL points out that one of the video files in the staff materials released by the Commission in July 2009 shows interference to mobile reception of signals in the amateur 20-meter band (14.0-14.35 MHz). Specifically, it states that the video of the Briarcliff Manor system recorded on August 17, 2004 (Briarcliff Video #5) shows in a graphic, compelling manner the severe and constant interference caused by the BPL system to amateur reception over huge geographic areas which obviously precluded essentially all Amateur HF communications in the area. It submits that no objective observer of this video could possibly conclude that the level of BPL radiated emissions permitted by the Commission's Part 15 rules is acceptable. ARRL is correct that the interference that is apparent on Briarcliff Video #5 is not acceptable and would not be permissible under either our Part 15 rules or the system operator's experimental license.[75] However, while interference can occur from BPL operations along a stretch of power lines as shown in that and other videos in the preliminary materials released in July 2009, we did not and do not find this example to substantiate a need for more restrictive rules on BPL systems. First, it does not appear that any of the mitigating features that are required in the rules had

[74] Access BPL systems operating on overhead power lines do not act as point sources. The operation of these systems depends on injecting BPL-modulated radio-frequency (RF) energy that travels down the power lines for detection by subsequent BPL devices. The BPL RF current and voltage carried by the power lines cause RF emissions from the power lines — not just from the BPL couplers. The ARRL correctly notes that in some cases BPL emissions may exhibit relatively little decay 0.5 mile downline from the coupler, though in other cases the decay can be much more rapid, e.g., as shown on slide 8 of *BPL Summary After Briarcliff Manor, NY Test*. In general, one would expect those RF emissions to gradually diminish with distance downline from the coupler as energy is lost to resistance in the power line conductors and correspondingly to emissions from the power lines. In addition to this gradual decay with distance downline, a more abrupt drop in RF energy on the power line is expected to occur when the power line splits between two branches, e.g., continuing down the same street in addition to branching down a side street. Such a branch splits the RF energy between the two branches and also causes an impedance mismatch that reflects some of the energy back toward the BPL coupler. Both the splitting of energy between the branches and the reflection of some of the energy back toward the coupler cause an abrupt reduction in the RF current that continues down the power line away from the coupler. This reduction in current is accompanied by a reduction in emissions from the portions of the power line beyond the split. In addition, the energy directed back toward the coupler by reflection causes standing waves, which can cause the emissions from the power line to alternately increase and decrease at various points along the line. (Connection from an overhead line to feed an underground cable results in an even larger impedance mismatch and a larger reflection of the incident RF energy.) Consequently, one can expect that the RF emissions from the power line may alternately increase and decrease in moving down the power line, but with a gradual overall decline with distance downline from the coupler and with occasional step-change reductions in emissions caused by impedance mismatches and branches. These various effects contribute to a net — but erratic — reduction in RF signal level on the power line with distance downline from the coupler. These effects are the cause of both the need for repeaters to boost the level of BPL signals in order to enable the systems to function properly and the decay in interference potential of BPL emissions with distance downline.

[75] The Briarcliff Manor Access BPL system was operated under an experimental license and therefore not subject to the Section 15.209 emissions limit. It was, however, subject to a non-interference requirement. *See* 47 C.F.R. § 15.209. We also note that in its reply comments, CURRENT observes that ARRL, on the one hand, in a December 28, 2005 report of its measurements on the Briarcliff test, (http://www.arrl.org/tis/info/HTML/plc/filings/Briarcliff-Compliant-Engineering-0106.pdf) complains that the system was out-of-compliance with the rules. It submits that ARRL cannot both complain that a system is out-of-compliance and yet also use interference from that system as evidence that the rules are inadequate. CURRENT reply comments at 7. We agree and our assessment of the interference potential of a compliant system and the effectiveness of the Part 15 emissions limit in controlling interference is not based on the performance of the Briarcliff Manor system.

been applied to this system.[76] In addition, our staff did contact the licensee about interference from that system several times over the course of its operation and the operator took steps first to cease operation on the amateur frequencies and then to install new equipment that had notching capability.[77] Subsequent examination of that system by field agents of our Enforcement Bureau found no interference, which substantiates the effectiveness of our rules when properly observed.[78] Also, as indicated by the primary and secondary title screens of Briarcliff Video #5, the system was notched only in the 20-meter amateur band, and not in the 15-meter amateur band, for which that video was recorded.[79] Thus, we did not and do not consider the interference that appears in Briarcliff Video #5 to be representative of the performance of a system operating in accordance with the set of rules we set forth for Access BPL systems.

33. We also see no merit in ARRL's argument that statements on the same presentation slide concerning an interference problem from the Phonex carrier current system to ARINC aeronautical communications and opining that compliant Access BPL "may be worse" should have served as a factor in our decision on protection for the amateur service. In the *BPL Order*, we recognized the critical nature of aeronautical communications and, given the free space propagation path from a power line to an aircraft, excluded Access BPL systems from operating on frequencies used by that service.[80] With respect to the Phonex case, we also observe that the Phonex system at issue might not have been the source of the interference with ARINC's communications and its performance therefore cannot be used as an empirical basis for establishing any benchmarks with respect to the interference potential of BPL systems.[81]

34. ARRL next observes that another presentation slide in the Briarcliff Manor presentation recommends that the Commission "impose [a] 5 dB height correction [factor]" on measurements and a "20 log R extrapolation factor" if it is going to allow BPL on medium voltage (MV) overhead power lines and should use a 20 dB/decade extrapolation factor for signal decay with distance from the power line.[82] It observes that the presentation states that this "reduces interference [from BPL] to fixed stations." Basing the BPL emissions limits and measurement procedures on an attenuation rate of 1/R, *i.e.*, 20 dB/decade would, of course, reduce signal levels and thereby provide additional protection to licensed services against interference. We note that the slide in question does not provide a "recommendation" as claimed by ARRL, rather, it only presented several options for other staff and management to consider in its deliberations. Further, as we concluded previously, we do not believe that such additional protection is needed or warranted, but rather hold that the Part 15 "no interference requirement", the Part 15 emissions limit for carrier current systems, and the interference mitigation measures we adopted in the *BPL Order*

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[76] Note that at the time of all of the testing recorded in the recently released documents, the Commission had not yet adopted any of the interference mitigation requirements on Access BPL systems, such as dynamic notching and remote shut-down.

[77] *See* Letter dated February 10, 2005 from Bruce Franca, Deputy Chief, Office of Engineering and Technology, to Christopher Imlay, ARRL.

[78] *Id.*

[79] *See also* the "Briarcliff Manor BPL Video Files" description in the preliminary materials released in ET Docket No. 04-37 on July 17, 2009.

[80] *See BPL Order* at 21287.

[81] *See* Memorandum from Joseph Casey, Chief, Spectrum Enforcement Division, Enforcement Bureau, to Bruce Franca, Deputy Chief, Office of Engineering and Technology, dated January 27, 2004, in ET Docket Nos. 03-104 and 04-37, at http://fjallfoss.fcc.gov/ecfs2/document/view?id=6516083908; *see also,* comments of Phonex Broadband Corporation on this subject at http://fjallfoss.fcc.gov/ecfs2/document/view?id=6515683343.

[82] ARRL comments at 28; Briarcliff Manor presentation summary at slide 19.

collectively provide sufficient protection to licensed services from the potential for harmful interference from Access BPL operations. As discussed below, we also continue to find that the attenuation rate of emissions from power lines is typically higher than 20 dB/decade and varies with location. At distances within 30 meters of the power line and when using the slant-range measurement procedure prescribed in our measurement guidelines, $1/R^2$, *i.e.*, 40 dB/decade, properly describes the expected attenuation rate at frequencies below 30 MHz, and variability around that rate is also expected.

35. It is also important to understand, as we discussed in the *RFC/FNPRM* and ARRL largely ignores, that RF propagation in the lower frequencies ranges, and particularly at frequencies below 30 MHz, is greatly affected by environmental factors, so that there is significant variability in propagation from place to place. These include ground absorption and conductivity, terrain, vegetation, and the presence of structures and other man-made objects, including additional power lines arrayed on pole/towers in the near-field of emissions from a power line carrying Access BPL transmissions. In some cases, emissions from BPL systems that are expected to be compliant with the rules will attenuate with distance at relatively high rates and be well below the Part 15 limits while emissions from other systems, or even from the same system but at a different location, will attenuate at a relatively lower rate and exceed the Part 15 limits. We are aware of these variabilities in this complex operating environment and to account for it, we adopted the additional provisions for mitigating harmful interference that are set forth in the rules. In addition, recognizing this variability, we did not base our assessment of interference potential on any standard performance factor, such as an attenuation rate by itself, but rather on the successful past performance of our existing standards and the availability of suitable approaches for managing the potential for harmful interference and correcting any harmful interference that may occur.

36. We have also fully considered the issue of how to measure Access BPL emissions, including whether a 5 dB correction factor was needed for Access BPL measurements below 30 MHz. In the *BPL Order*, we concluded that the existing measurement procedure that provides for measurement of the magnetic field at 1-meter height with no correction factor was appropriate for measurements in that frequency region.[83] There is no additional information in the presentation summaries that leads us to find that this decision should be changed.

37. ARRL points out that slide 20 of the Briarcliff Manor presentation listed options of notching or mandatory advance coordination for protection of low-VHF public safety channels and that the

[83] *See BPL Order* at 21303-21310. In its May 2004 comments in this proceeding addressing the Commission's proposed measurement guidelines later adopted, ARRL supported a measurement height of 1 meter with the use of a loop antenna to measure magnetic fields, stating that "ARRL has done antenna modeling that shows that the magnetic field will typically vary approximately 3 dB with height..." *See* ARRL comments filed May 3, 2004, Exhibit D at page 28, at http://webapp01.fcc.gov/ecfs2/document/view?id=6516182983. According to this submission, the maximum value is found at power line heights of 18 meters above ground, a height much higher than typical power line heights of 10-12 meters. For example, Figure 5 of Exhibit D shows only a 1.4 dB difference in the H-field intensity between a measurement at 1 meter and a measurement at a power line height of 11 meters, for 14 MHz. Further, ARRL agrees that measurements at such height, or even at typical power line heights of 10-12 meters, are neither practical nor safe. However, in its subsequent reply comments in the same time frame (filed June 2004), ARRL then agreed with NTIA's suggestion for a 5-dB height correction for measurements below 30 MHz (which NTIA itself later dropped based on subsequent studies, *see* NTIA supplemental comments filed Sep 24, 2004 at 3). Nonetheless, ARRL did not submit any data to the contrary to rebut its own previous submissions that the magnetic field does not vary much with height, especially at typical power line heights of 10-12 meters, obviating any need for a height correction factor for frequencies below 30 MHz. In its *ex parte* comments filed on January 11, 2010, ARRL again reiterated its demand for a height correction factor, stating that most standards require the use of a height-scanning antenna mast, but neglected to address that emission measurements below 30 MHz are made with a loop antenna and that its earlier modeling data and conclusions support the findings from NTIA and from the Commission that no height correction factor is necessary for frequencies below 30 MHz.

Commission did not adopt either of those options but instead put in place a notification requirement.[84] It also observes that the same slide listed the 50-54 MHz amateur band that is typically used for both mobile and fixed operations and the Commission did not acknowledge the interference potential to amateur operations in that band and offered no remedy for it. In the *BPL Order*, we determined that public safety systems, because of the often critical and/or safety-of-life nature of the communications they provide, merit the additional protection of advanced notice of BPL operations. We stated that an advance notification would provide a public safety operator with an opportunity to assess whether there are portions of its geographic area of responsibility about which it should make special arrangements with the Access BPL operator in order to avoid interference.[85] We did not address the frequencies used by the amateur service on an individual basis, but rather concluded that amateur radio frequencies generally do not warrant the special protection of frequency exclusion that was afforded frequencies reserved for international aeronautical and maritime safety operations.[86]

38. ARRL observes that slide 21 of the Briarcliff Manor presentation predicts the potential for BPL to cause interference to mobile operations to be "high" to "very high." It further observes that the same slide has a table indicating that the interference distance to fixed stations would be 62 meters at 2-8 MHz and 400 meters at 8-30 MHz in areas where the noise levels were at the International Telecommunication Union (ITU) "residential" level.[87] It contrasts these statements with our findings in the *BPL Order* that the potential of Access BPL systems was "low" and observes that in the case of mobile communications where a vehicle is close to the power lines, the potential for interference will indeed be higher. While we again recognize that at some locations (including where nearby antennas are located above the height of the power line) the attenuation rate of Access BPL emissions will be lower and at other locations it will be higher, these levels are consistent with our interpretations that the interference potential is low such that it can be managed adequately with the additional interference mitigation measures and the "no harmful interference provisions" of Part 15 that are also in our rules.[88] In this regard, the distances from a power line to an amateur fixed receiver will be sufficiently short that if harmful interference were to occur, the recipient could readily identify its source and request that it be resolved. We observe that International Broadband Electric Communications, Inc. (IBEC), a major operator of Access BPL systems, reports (with confirmation by ARRL in its comments) that it has been communicating with the local amateurs and emergency services in the areas it covers to implement a successful interference resolution process.[89] It states that it has been able to resolve interference complaints, as they arise, under the framework of the existing Access BPL rules. This information provides confirmation that the processes and requirements we established, when used in practice, are adequate to prevent most cases of harmful interference to licensed services, and to resolve quickly any instances of harmful interference that do occur.

39. *Spectrum Notching.* The rules provide for mitigation of BPL interference where it may occur by notching. In the *BPL Order* and the *BPL Reconsideration Order,* the Commission found that, for frequencies below 30 MHz, a 20-dB notch would appropriately address any harmful interference that

[84] ARRL comments at 29-30.

[85] *BPL Order* at 21288-21289. Section 15.615(e) requires that notifications of Access BPL operations be provided to local public safety agencies at least 30 days prior to a system's initial operation.

[86] ARRL had requested that the Commission include the amateur HF and VHF allocations with other bands that NTIA determines require protection from BPL interference. *BPL Order* at 21289.

[87] *See* Briarcliff Manor presentation summary at slide 21.

[88] 47 C.F.R. § 15.5.

[89] IBEC comments at 2; *see also* ARRL reply comments at 3-4.

might occur to mobile operations, given both the low signal levels allowed under the Part 15 emission limits and the fact that a mobile transceiver is generally only in one place for a limited period and can readily be re-positioned to provide some separation from the Access BPL operation.[90]

40. In its comments, ARRL argues that slide 13 of the Briarcliff Manor presentation summary references predictions from the *NTIA Phase 1 Study* that show that the noise floor would rise by more than 20 dB at nearly all points, and by 30 dB at most points, along a 340-meter modeled power line. It also notes that the slide states that in NTIA's measurement activities, NTIA took occasional samples of noise power along the line with the Access BPL system turned off and found noise levels lower than predicted by the ITU for residential areas.[91] ARRL therefore contends that the 20-dB standard for the notching requirement is insufficient.[92] We initially note that NTIA's sampling of noise power was only at a very limited number of locations and not sufficient to serve as the basis for a conclusion that the noise floor is lower than the levels recognized by the ITU.[93] Further, as discussed below, there is not sufficient information in any of the submissions regarding changes in the noise floor to justify a change from our use of the well-established ITU-recommended levels for the noise floor in different environments.

41. In its November 2010 *ex parte* submission, ARRL provides additional comments[94] that reference several recent domestic and international industry and governmental reports/standards to support its request for a 35-dB notch of all the amateur frequency bands. These documents include: 1) ITU-R Report SM.2158;[95] 2) ITU-T G.9960;[96] 3) IEEE P1901-2010;[97] and 4) OFCOM Report on In-

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[90] *BPL Order* at 21294 and *BPL Reconsideration Order* at 9318.

[91] The ITU's expected noise power levels are set forth in ITU-R Recommendation P.372-10 *Radio Noise*.

[92] ARRL comments at 36.

[93] We also note that in the same report, NTIA concludes that "the results for the vehicular mobile receiver predict that the received BPL signal power near the Earth surface falls off rapidly with distance from the lines. The distances within which these thresholds were exceeded at fifty percent of locations were modestly smaller at a third frequency (4 MHz) and much smaller at the fourth frequency (40 MHz). In all land vehicular cases considered, reductions in S/N were less than 3 dB and 10 dB beyond one-hundred-and-twenty-five meters and fifty-five meters, respectively." NTIA Report 04-413, "*Potential Interference From Broadband Over Power Line (BPL) Systems To Federal Government Radiocommunications at 1.7 - 80 MHz*," Phase 1 Study, Volume 1, April 2004 (*NTIA Phase 1 Study*), at 23.

[94] ARRL November 2010 *ex parte* comments at Exhibit A.

[95] *See Impact of Power Line Telecommunications Systems on Radiocommunications Systems operating in the LF, MF, HF and VHF bands below 80 MHz*, International Telecommunications Union (ITU) Report SM.2158, 2009. This report covers the use of the radio spectrum and associated interference protection requirements of radiocommunication services operating below 80 MHz with respect to the impact of BPL systems as part of the International Telecommunications Union studies on the compatibility between radiocommunication systems and high data rate telecommunication systems using electricity power supply or telephone distribution wiring. *See* http://www.itu.int/pub/R-REP-SM.2158/en.

[96] *See Unified High-speed Wire-line based Home Networking Transceivers – Foundation*, ITU-T G.9960, 2010. This ITU Recommendation specifies the system architecture and physical (PHY) layer for wireline-based home networking transceivers capable of operating over premises wiring including inside telephone wiring, coaxial cable, and power-line wiring. Transceivers defined by this Recommendation use OFDM-type modulation and are designed to provide EMC and spectral compatibility with other devices sharing the in-premises wiring. *See* http://www.itu.int/rec/T-REC-G.9960-201006-P.

[97] *See Standard for BPL Networks: Medium Access Control and Physical Layer Specifications*, IEEE P1901-2010. This standard provides specifications for several of the BPL existing OFDM protocols, essentially a multi-carrier (continued....)

Home PLT devices.[98] All of these documents mandate or recommend notching of the amateur frequencies.[99] ITU-R Report SM.2158 states that the maximum allowable increase in the noise floor[100] due to BPL emissions should not exceed 0.5 dB, based on the assumption that the fade margin[101] of the amateur service in long distance communications is less than 1 dB.[102] Based on this assumption, ARRL argues that a notch depth of 34 dB would be required if a 20-dB/decade extrapolation of the FCC emission limits is used and a notch depth of 43 dB would be needed if the existing extrapolation factor of 40-dB/decade is used.[103]

42. In re-examining all of the information pertaining to the depth of the notching requirement, we now find that it would be appropriate to increase the required notching capability to be 5 dB greater than the 20 dB specification we initially adopted. Previously, we observed that when operating with a 20-dB notch below 30 MHz, the maximum allowed emissions from an Access BPL system is 10 dBμV/m at the Part 15 measurement distance of 30 meters, a level which is at or only modestly above the noise

(Continued from previous page)
technique that spreads data among multiple carriers to allow a more robust operation in a noisy environment. *See* http://grouper.ieee.org/groups/1901/.

[98] *See The Likelihood and Extent of Radio Frequency Interference from In-Home PLT Devices*, OFCOM Report, June 21, 2010. This report focuses on In-House BPL devices in the United Kingdom, concluding that the notching of international amateur frequencies combined with interference mitigation features such as power control and smart notching would be sufficient to reduce interference to negligible levels. *See* ARRL November 2010 *ex parte* comments at Exhibit G.

[99] Concerning the level of notching needed, the ITU-T 9960 Recommendation specifies 30 dB notching of In-House BPL systems for compatibility with amateur radio services. The OFCOM Report, which focuses exclusively on In-House BPL devices, indicates that although smart notching capabilities (between 30 and 40 dB) are already part of the product roadmaps of the BPL vendors that were consulted as part of the study, it is recommended that where possible the introduction of these features be formalized. The IEEE P1901-2010 Standard provides for 35-dB notching for both In-House and Access BPL devices. The ITU-R Report SM.2158 does not specifically recommend a particular notch depth with respect to compatibility with amateur radio services, but states that "the maximum allowable increase in the total noise floor due to [BPL] emissions should be 0.5 dB." ITU-R Report SM.2158 at p. 35.

[100] ITU-R Report SM.2158 at p.36-37. The noise floor figures are derived from Recommendation ITU-R P.372-10 (2010) *Radio Noise*. *See* http://www.itu.int/rec/R-REC-P.372/en. In its June 2011 *ex parte* comments, ARRL also mentioned ITU Recommendation SM.1879 that refers to the SM.2158 report with respect to the increase in the noise floor.

[101] "Fade margin" refers to the amount by which a received signal level may be reduced without causing system performance to fall below a specified threshold value.

[102] ITU-R SM.2158 at p. 35.

[103] *See* ARRL November 2010 *ex parte* at Exhibit A, p. 29. ARRL also includes in this *ex parte* additional Exhibits B through G that show operation of BPL systems with 35-dB notching and certain other information relating to its position that BPL poses a threat of interference to amateur operations. Exhibit B is a copy of a joint report issued in 2001 by HomePlug and ARRL with respect to the cooperative tests and development of the HomePlug standard for In House BPL which incorporated 30 dB notches in amateur bands. Exhibit C is a copy of a news article released in 2006 discussing a demonstration at ARRL's headquarters of the notching efforts made by Spanish BPL chip manufacturer DS2 to avoid interference to amateur radio services. Exhibit D is a description of errors found in the BPL database maintained by UPLC, which ARRL has also identified in its comments (filed Sep 23, 2009). Exhibit E is a report commissioned by IBEC in 2004 to show that spectrum notches for the Amateur bands were implemented at an IBEC deployment in Cullman, AL. Exhibit F is a test report made by the Albermarle Amateur Radio Club in 2004 on another IBEC BPL system in Nelson County, VA, showing test results on spectrum notches in various amateur bands. Finally, Exhibit G reproduces an OFCOM report dated Jun 21, 2010 that studied the interference potential of In House BPL devices on radio services in the HF and VHF frequencies in the U.K.

floor in the HF bands at most locations.[104] That is, our intention was that Access BPL emissions in a notched bandwidth would not be significantly greater than the background noise at the distances normally used for protection against harmful interference from Part 15 unlicensed devices. We also evaluated the potential for interference at closer distances that can occur when conducting mobile communications while traveling adjacent to roadside power lines. We observed that when extrapolated to values for the typical closest distance of a mobile antenna in motion from roadside power lines (approximately 6 meters horizontal distance and 8.5 meters vertical distance, for a slant range of 10.4 meters) and adjusted for the typical quasi-peak to average ratio of 4 dB for BPL devices operating at high duty factor, the Part 15 limit corresponds to a root-mean-squared (RMS) field strength of 44 dBμV/m for frequencies at or below 30 MHz. A 20 dB reduction would limit emissions to 24 dBμV/m. We concluded that given the high variability of the noise floor at HF frequencies, where increases of as much as 20 dB or more are common, mobile reception of relatively weak signals under 24 dBμV/m is generally intermittent and not reliable because both the received signal and the ambient noise levels vary up and down (the received signal and noise energy levels generally do not rise and fall together) as the vehicle moves.

43. In carefully reviewing the record on this issue, we acknowledge ARRL's point that the modeling in the *NTIA Phase 1 Study* predicts that Access BPL emissions on frequencies below 30 MHz that are at the Part 15 limit would raise the mobile radio noise floor at 15 MHz and 25 MHz by 30 dB in 59% of residential locations.[105] After a 20-dB notch, the BPL remaining emissions would still produce a noise floor increase of about 10 dB for mobile operations in residential locations at those frequencies. As we observed in the *BPL Reconsideration Order*, there is considerable variability around the median noise level, such that increases of as much as 20 dB are common and reduce the reliability of signals at the margin of expected reception.[106] While we continue to believe that the significant variability in background noise levels limits the reliability of HF signals below 30 MHz such that BPL emissions at a level of 24 dBμV/m should not generally be considered harmful interference, we also understand that the 20 dB value for noise increases due to diurnal and seasonal factors is the maximum expected effect and that in many cases the daily variability in the noise floor levels will be somewhat less. We have no specific information on the distribution of the diurnal and seasonal variability of noise floor levels; however, we believe that an increase of 5 dB in the required notching capability, or half the 10-dB current margin of BPL emissions affecting mobile reception above the residential noise floor, according to NTIA's estimates as supported by ARRL, would take a more conservative approach and provide

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[104] *BPL Order on Reconsideration* at 9319-9320. The nominal noise floor in the HF band, as recognized by the International Telecommunications Union, varies with frequency and population/commercial density (values are provided for business, residential, rural, and rural quiet areas). For reception with a short vertical monopole, the ITU median noise levels are 10 dBμV/m, 5 dBμV/m, 0 dBμV/m, and -7dBμV/m in business, residential, rural, and rural quiet areas, respectively, in a 9-kHz bandwidth at 30 MHz (at lower frequencies the ITU median noise levels increase on a sliding scale). The Part 15 radiated emission limit for Access BPL and other carrier current systems is 30 dBμV/m quasi-peak in a 9 kHz bandwidth at 30 meters for frequencies at or below 30 MHz, *see* 47 C.F.R. § 15.611(a).

[105] *NTIA Phase 1 Study*, Volume I, Table 6-3. These predictions assume that mobile operations occur at a distance of 15 meters horizontal distance from the power lines. The increase in the noise floor is different at different frequencies below 30 MHz. For example, the same table in the NTIA *Phase 1 Study* shows that a 30 dB noise floor increase at 4 MHz only occurs in 6% of residential locations.

[106] See *e.g.*, comments of NTIA in response to the *BPL Notice of Proposed Rule Making* (filed Sep 8, 2004), in which it states that "[p]ower line noise resulting from ingress of ambient radio noise can vary by upwards of 20 dB throughout the day and seasonally, especially at frequencies below 12 MHz." NTIA comments at 9. In addition, the ITU-R Rec. P.372-9 information on the values of decile deviations of man-made noise, showing combined variability with location and time of 19.4 dB, 16.4 dB and 16 dB in business, residential and rural environments, respectively. *See* ITU-R Recommendation P.372-9 (2007), *Radio Noise,* Table 2, at p. 15.

protection for amateur mobile operations in more instances, while continuing to recognize the variability in emissions that limit the service to mobile amateur receivers.[107] Given our understanding supported by the assertions in the record that most BPL operators are already using notches of at least 25 dB, we would expect the cost imposed by this requirement to be minimal or nil. We find that the benefits of providing additional protection for licensed services outweigh any potential additional costs to BPL providers. Such benefits include a more integrated environment where BPL devices may share spectrum with licensed users, with lesser concerns for potential harmful interference. BPL devices bring expanded benefits to electric utility companies by allowing them to monitor, and thereby more effectively manage their electric power distribution operations.[108] BPL also brings "last-mile" delivery of broadband services to some rural and underserved areas.[109]

44. With respect to the new information in ARRL's November 2010 *ex parte* submission, we first are not persuaded that a 0.5 dB increase in the noise floor as used in the ITU-R Report SM.2158 is a reasonable assumption for the numerous reasons we stated above with respect to the significant variability in background noise levels at HF frequencies.[110] Further, it appears that the 0.5 dB number was used in the ITU Report without any discussion, analysis or other explicit rationale. We further note that in its June 2011 *ex* parte submission, ARRL mentions that ITU-R Recommendation SM.1879,[111] which refers to the above report, does recommend that stations operating in the Amateur Service be protected to a level such that noise at the protected station is not increased by more than 0.5 dB.[112] Although ARRL provided calculations to relate the 0.5 dB increase in the noise floor with the Part 15 limits to arrive at its requested 35-dB notch number, it again did not provide a rationale for using a 0.5 dB increase in the noise floor as the protection criterion at HF frequencies. With the exception of ITU-R Report SM.2158, the reports/standards submitted by ARRL in its November 2010 *ex parte* comments do not include any analysis that shows that 35 dB or some other figure is the proper level of notching needed to protect amateur operations, but rather simply state as their recommendations/requirements a notching depth that existing BPL equipment can meet. We also recognize the ARRL's observation in its June 2011 *ex parte* submission that in the IEEE P1901-2010 standard there is a normative requirement for a 30-dB notch depth for the FFT OFDM (HomePlug) technology.[113] While this voluntary industry standard is apparently being used by manufacturers of HomePlug In-House BPL equipment, it is more stringent than

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[107] In our previous decisions, we have assumed that mobile operations occur at a distance of 6 meters horizontal distance from the power lines. Following the analysis set forth in the *BPL Reconsideration Order*, at the shorter 6-meters distance, a 5-dB increase in an Access BPL notch will leave a margin of approximately 15 dB above the residential background noise level.

[108] *See* IBEC Smart Grid solutions at http://www.ibec.net/services.php; Amperion Smart Grid solutions at http://www.amperion.com/solutions.php.

[109] *See* IBEC High Speed Internet services to rural Americal at http://www.ibec.net/services.php.

[110] We note that ITU-R Recommendations are not binding on the Commission. *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co- Frequency with GSO and Terrestrial Systems in the Ku- Band Frequency Range, Memorandum Opinion and Order and Second Report and Order*, ET Docket No. 98-206, 17 FCC Rcd 9614, 9631 (para. 41) (2002) ("[R]ecommendations resulting from ITU-R deliberations are not necessarily binding for purely domestic allocation decisions . . . ."). *See also Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, Third Memorandum Opinion and Order*, ET Docket No. 98-153, 25 FCC Rcd 11390, 11393 n.16 (2010).

[111] *See* ITU-R Recommendation SM.1879, *The impact of Power Line High Data Rate Telecommunication Systems on Radiocommunication Systems below 30 MHz.*

[112] ARRL June 2011 *ex parte* comments at p. 4.

[113] *Id.*, at p. 3-4.

is necessary for our regulatory purposes as discussed above and in any case does not apply to the Access BPL applications at issue herein. We also do not find persuasive ARRL's argument that deeper notching can be implemented without adverse impact on the data rates of BPL technology. In this regard, the testing on which ARRL bases this claim was on In-House rather than Access BPL equipment and in any case our principal concern is with imposing regulation that is more restrictive than necessary rather than simply minimizing the impact that such regulation might have on some aspect of BPL equipment or its operation. While we duly note the Republic of Korea's decision to require permanent notching of the amateur bands, the relevance of that determination by that country's regulatory body at that time to our present consideration is not readily apparent, and ARRL provides no information regarding either the radio environment or the regulatory objectives and standards that informed that decision by which we might consider how those considerations might affect our own decision making.

45. We recognize that one of the documents referenced by ARRL, IEEE P1901-2010, is an industry standard for both Access and In-House BPL equipment authored by nearly a hundred entities that include BPL service and equipment providers and that this standard describes a 35-dB spectrum notching for compatibility with amateur radio services that can be supported by a type of BPL technology known as wavelet OFDM, as elucidated by UTC.[114] Further, as ARRL submits, its scrutiny of systems listed in the BPL database indicates that existing BPL systems in the U.S. are generally notching the entirety of the HF amateur allocations, using equipment capable of notch depths of at least 35 dB.[115] Thus, it appears that many BPL systems now in operation may be voluntarily observing the notch depth and band avoidances that ARRL is requesting. While those industry practices are consistent with the ARRL's goals in this matter, we nonetheless find they are more stringent than are justified from a regulatory standpoint.[116] In this regard, we do not find that an increase in the required notching capability to a level above 25 dB is needed to protect against interference to amateur or any other licensed services. To require that all systems adhere to a *de facto* industry 35-dB notching standard would unnecessarily constrain BPL operators, as stated by UTC, and equipment manufacturers who might choose to design for a different level of operation that would comply with the notching level we have determined will provide adequate protection.[117] Further, to require that all of the amateur bands be notched would unnecessarily restrict BPL operations in areas/locations where no amateur operations are present that could receive interference.

46. As indicated above, we see no statistically-valid support for ARRL's position that the ambient noise levels have become so low as to contradict our conclusion here that a 25-dB notch is generally sufficient to protect licensed services.[118] Further, for fixed stations, if a 25-dB notch is not sufficient to resolve observed harmful interference or other steps to resolve the interference are not successful, under Section 15.5(c) of the rules, the operator is then, upon notification by a representative of

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[114] ARRL November 2010 *ex parte* comments at Exhibit A at 14 and UTC *ex parte* comments (filed May 4, 2011) at 2.

[115] ARRL November 2010 *ex parte* comments at para. 8 and Exhibit A.

[116] *See* discussion in para.42, *supra*.

[117] UTC *ex parte* comments (filed May 4, 2011) at 2.

[118] We disagree with ARRL that the single measurement by our staff of a noise level below 0 dBμV/m shows that noise levels are typically below the ITU residential noise floor. One observation is not a sufficient sample to statistically support any conclusion(s). *See also,* ARRL reply comments in which it 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.

the Commission, required to cease operation until the interference is corrected. In such cases, the interference might perhaps be resolved by using new equipment that includes a filter with a notch capability greater than 25 dB. We believe, however, that the new 25-dB notching requirement will be sufficient to resolve the great majority of cases of harmful interference that might occur and therefore do not see a need to require that Access BPL systems routinely use equipment with greater notching capability.

47. In changing the notching level to 25 dB, we are aware that Access BPL operators have already installed equipment with 20-dB notching capability in compliance with the rules and that there is some inventory of equipment built to that standard which has not yet been installed. While we believe that the greater level of protection provided by our rule change is prudent in the long term, we have not observed any cases to date where the notching afforded by existing equipment has not been adequate to resolve interference. Accordingly, given the limited number of devices already deployed and manufactured, we will not require their replacement or prohibit their installation for replacement or in new constructions. In order to afford manufacturers time to redesign their equipment to comply with the new, more conservative 25-dB notching requirement, we will allow an 18-month period from the date this action is published in the Federal Register before the requirement becomes effective.

48. In its reply comments, ARRL submits that IBEC did not resolve interference complaints to amateur fixed stations by doing what the existing BPL rules require, other than compliance with the general Part 15 requirement to correct any harmful interference.[119] It states that instead, IBEC has avoided or resolved the interference by doing two of the things that ARRL has requested as modifications to the existing BPL rules: 1) IBEC avoided the use of Amateur bands in its installations, and 2) it has used state-of-the-art notch depths of 35 dB. We observe that avoiding a frequency band where interference could occur is certainly an option that is contemplated under the rules. Using a notching capability with attenuation of greater than that required in the rules where needed is also consistent with the general requirement in Part 15 rules that a device not cause harmful interference. We do not, however, find the fact that equipment which can provide 35-dB notching capability is now available and IBEC's choice to use such equipment to be indicative that we should require that level of notching capability in all instances. Rather, while the rules will now require a notching capability of at least 25 dB, that level of attenuation will only be deemed sufficient for resolving harmful interference in the case of mobile operations; the system operator is still responsible for resolving harmful interference to fixed operations if the 25-dB notch capability is used and the interference remains. Under the notching rules we are adopting, a BPL system operator has the flexibility to install a notching capability greater than 25 dB or to implement other measures for resolving harmful interference in cases where the 25-dB notch is not sufficient. In this regard, IBEC did, in fact, take the steps required under Section 15.611(c) of the rules – it configured its systems to be capable of remotely reducing power by 35 dB and adjusting operating frequencies to avoid site-specific, local use of the same frequencies by licensed radio operations.[120] A different operator might have chosen an alternative approach for complying with this rule.

2. Preliminary Documents released in July 2009

49. In its comments, ARRL addresses the three additional staff PowerPoint® presentations that were placed into the record on July 22, 2009 (three additional presentations).[121] It contends that these

[119] Reply comments of ARRL at 3.

[120] 47 C.F.R. § 15.611(c).

[121] These presentations, as listed in Appendix F, are "Field Strength Measurements Relative to ARRL Concerns Regarding BPL," October 16, 2003; "Broadband Over Power Line (BPL) Test Results and Considerations," December 3, 2003; and "BPL Emission Tests in Briarcliff Manor, NY," August 17-19, 2004.

presentations are "most relevant" to the determination of the actual interference potential of BPL to licensed radio services, the proper radiated emission level for BPL systems at HF, the proper distance extrapolation factor for signal decay, and the necessity of full-time notching of all Amateur Radio allocations by BPL systems in order to avoid interference.[122] ARRL argues that, in the aggregate, these presentations show that the Commission's assumptions in the *BPL Order* with respect to the interference potential of BPL to the amateur service, both fixed and mobile stations, were wrong.[123]

50. ARRL first states that the three additional presentations collectively show that radiated noise from overhead power lines carrying Access BPL signals increases significantly above the ambient noise level when measured at ground level.[124] It alleges that the *BPL Order* improperly focused on mitigating interference to licensed services after the fact, rather than on preventing interference from BPL to licensed services *ex ante*.[125] ARRL contends that the Amateur Service is uniquely adversely affected by BPL interference and that the probability of harmful interference to amateur communications is virtually 100 percent in residential areas where there are overhead MV power lines. ARRL asserts that practical experience with BPL interference indicates that the information in the three staff presentations was absolutely correct: interference is not practically resolved *post hoc*, and BPL has a far higher likelihood of interference to the amateur service than other Part 15 devices, which are qualitatively different. It demands that the rules be revised in view of these facts just now coming to light.[126]

51. Notwithstanding ARRL's contentions, we did consider the information in these presentations in the *BPL Order* and in the formulation of our rules for regulating interference from Access BPL emissions. There are no new facts, information, or interpretations in these presentations or in ARRL's comments that are inconsistent with our previously stated understandings and findings. These presentations, as well as other information in this proceeding, show that Access BPL operations can raise the RF noise level to levels above the noise floor such that they can cause interference to amateur operations in the close vicinity of power lines on which the BPL signals are carried. As the presentations show, the area of interference is essentially limited to distances close to and along the power lines.[127] While some interference is possible at locations close to the power line, we believe that in the great majority of locations, interference will not occur to radio services because either propagation conditions limit the range of the Access BPL emissions or there is no licensed amateur station present and operating on the frequencies on which such emissions appear. We see no need to require an Access BPL operator to reduce emissions below the Part 15 limits where there is no potential for interference. In addition, we have required that a database of Access BPL systems be established to allow amateur operators to identify BPL operations in their area before the systems commence operation so that they have an opportunity to alert the BPL operator of their presence before the system is activated.[128] We address specific points in ARRL's arguments in the following paragraphs.

52. ARRL argues that the three additional presentations released in July 2009 show that in

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[122] ARRL comments at 39.

[123] *Id.* at 45.

[124] *Id.* at 46.

[125] *Id.* at 45.

[126] ARRL comments at p. 45-46.

[127] *See* for example, "BPL Emission Tests in Briarcliff Manor, NY," slide 23 – "distance away from the power line, which exhibits a rapid drop-off with distance."

[128] The requirements for the Access BPL database are set forth in Section 15.615(a) of the rules, 47 C.F.R. § 15.615(a).