Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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**

To: The Commission

REPLY COMMENTS OF ARRL,
THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, the national association for Amateur Radio, formally known as the American Radio Relay League, Incorporated (ARRL), by counsel and pursuant to the *Request for Further Comment and Further Notice of Proposed Rule Making*, FCC 09-60, 24 FCC Rcd. 9669, 74 Fed. Reg. 42631, released July 17, 2009 (the Further Notice), hereby respectfully submits its reply comments with respect to the Commission's reconsideration of the rules governing unlicensed radio frequency (RF) devices to accommodate Broadband over Power Line (BPL) technology. In response to the few comments received in this remand proceeding, ARRL states as follows:

I. Introduction

1. The few comments received from BPL advocates in this proceeding focus, not unexpectedly, on the application of the 40 dB/decade of distance extrapolation factor for radiated emission signal decay measurements from Access BPL systems that the Commission (a) defends, and (b) then proposes to abandon in the Further Notice in favor of a

30 dB/decade of distance extrapolation factor. Since that was the only change in the Access BPL rules proposed in the Notice, and since it is the only proposal in the Further Notice that would have any effect on BPL systems, the few companies that remain interested in BPL understandably wish to avoid any restriction on operation of these unlicensed devices. Their commercial desire to avoid appropriate regulation of BPL is, however, in conflict with the overarching obligation to avoid harmful interference to licensed radio services such as the Amateur Radio Service.

2. ARRL will address each of these comments separately, but one matter should be raised *ab initio*: Current Technologies, LLC identifies ARRL categorically on page 1 of its comments as a "BPL opponent" which urged the United States Court of Appeals to order the Commission to disclose information that it deliberately withheld from the public in the course of adopting its BPL rules. Current mislabels here, and in so doing, misstates ARRL's intent: ARRL is not now, and has never been an "opponent" of BPL.[1] ARRL is and always has been an opponent of BPL interference. ARRL has repeatedly and consistently urged the adoption and modification of BPL rules to provide for operation of BPL systems in a responsible manner that does not predictably or actually cause harmful interference. ARRL has repeatedly and consistently demonstrated to the Commission how this can be accomplished without substantially limiting the ability of BPL systems to provide the throughput possible for this technology. ARRL, a participant in numerous industry meetings, has explained to BPL advocates repeatedly a means of achieving a workable solution to the BPL interference problem. ARRL is not an opponent of BPL in any configuration that does

[1] Indeed, none of those who filed comments in opposition to the rules that the Commission proposed in the original Notice of Proposed Rule Making in this docket proceeding had any reason to oppose Access BPL generally, but for the fact that it has been repeatedly demonstrated to cause harmful interference to licensed services when operated in full compliance with the rules adopted thus far.

not pollute the renewable and critical natural resource of the radio spectrum, and remains hopeful that the Commission and the BPL industry will finally address the Access BPL interference problem in an honest, straightforward and effective manner.

II. The Comments of International Broadband Electric Communications, Inc.

3. The premise of the comments of International Broadband Electric Communications, Inc. (IBEC) is that it has provided "rural broadband" service via BPL as an "experienced builder," and has resolved interference that has been reported to it "under the framework of the existing BPL rules in the original Report and Order."[2] This is misleading. IBEC did not resolve interference complaints by doing what the existing BPL rules require, other than compliance with the general overall non-interference requirement of Part 15 rules. Instead, they have avoided or resolved the interference (and they do not quantify these interference complaints nor their efforts to resolve them) 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. IBEC staff has reported to ARRL that IBEC adopted these practices in all of their installations, and as the result, cases of interference to Amateur Radio were from portions of installations where the notching of Amateur bands was accidentally omitted. The fact that IBEC and most other BPL manufacturers have now implemented these systems and the results reported by IBEC are effective proof that this configuration can be required in the rules without any substantial reduction

[2] IBEC comments, at page 2 (unnumbered pages).

in BPL performance. It also establishes that those operating parameters are necessary [3] modifications to the Commission's Rules.

4. ARRL concurs that IBEC has maintained good communication with the Amateur Service through ARRL, evidencing that such communication, through a mandatory coordination process, is a reasonable requirement for all BPL companies. ARRL has never been able to understand the Commission's reluctance to impose such a requirement for Access BPL companies,[4] other than the Commission's overall "hands off" approach to BPL that it has inexplicably but staunchly maintained throughout this docket proceeding. The BPL database was apparently intended to be a substitute for an active, meaningful coordination plan, but as discussed in ARRL's comments in response to the Further Notice, the database is a dismal failure, and was never sufficient to address the substantial interference potential of BPL under the present rules.

5. IBEC states at page 2 of its comments that it does not support "signal decay variability" in the test procedures for BPL systems. The reference is not clear, though it does seem to be a reference to the Commission's proposal to include an alternate method of measuring extrapolation. IBEC claims that such "variability" would create unnecessary test complexity and impose additional costs without offsetting value. IBEC's point is not clarified at page 3 of its comments, however, where it claims that it *does* in fact support an alternative test method for extrapolation that will allow IBEC to choose any extrapolation it wants. It is difficult to determine why IBEC asserts that "signal decay variability" is bad for the BPL

[3] IBEC's reported interference avoidance/resolution success due to 35 dB full time notching of Amateur bands is to be contrasted with the severe interference depicted graphically in Briarcliff Manor Video #5 in the materials released by the Commission in July of 2009, which depicted a system that did not utilize Amateur band notching of 35 dB.

[4] A reasonable model for a BPL coordination process is found in the prior coordination notice procedure used in Part 101 licensing of point-to-point microwave systems. See, 47 C.F.R. § 101.103.

industry, but for some reason, *in-situ* measurements ("special procedures to address unique site-related issues" as IBEC puts it) are at the same time *not* bad for the industry.

6. The real problem with IBEC's comments is that it attempts to "take issue" with the "assumptions"[5] that the Commission's Laboratory staff made in the unredacted studies released by the Commission pursuant to the Court's order. IBEC claims that the Laboratory engineers' finding that the ambient noise floor is lower than it was in earlier studies is in error. IBEC cites the NTIA Phase II study[6] as authority for its assertion that noise levels have in fact increased rather than decreased. To attempt to buttress this argument, IBEC conducted its own "measurements" of RF noise, to compare this against "older ITU curves" that were used by the Commission's laboratory engineers. Unfortunately, however, IBEC's measurements are premised on two quite fundamental errors in its testing. Their measurements of the noise floor of their instrumentation measure included in their study show the *noise floor of their EMC receiver*, but *not* the noise floor of the preamplifier in their test antenna. Exhibit A is a report, "Errors Made in the IBEC Measurements of Ambient Noise Levels," authored by ARRL Laboratory Manager Ed Hare. Figure 1 of that report shows a measurement ARRL made of its Rohde and Schwarz spectrum analyzer, with its input terminated with a 50-ohm resistor. This is similar to what IBEC reports as its measurement of noise floor. However, loop antennas are very inefficient, typically with antenna factors as high as 40 dB/m. Amplified loop antennas can and do increase the strength of the received signal to a usable level (antenna factors of 10 dB/m), but typically, the

[5] The FCC Laboratory staff did not make "assumptions"; they made empirical measurements using scientifically valid methodologies, and drew conclusions reasonable from those observations. That is basic scientific practice. It was the Commission that made "assumptions" which did not in any sense follow from the Laboratory's conclusions. The Commission's assumptions were in spite of them.

[6] NTIA Report 08-450, *Potential Interference from Broadband Over Power Line (BPL) Systems to Federal Government Radiocommuncation Systems at 1.7-80 MHz Phase 2 Study,* NTIA, U.S. Department of Commerce (October, 2007).

inefficient actual loop results in a noise floor set by the preamplifier used in the loop. Figure 2 of Exhibit A shows a result that is very typical and expected for an amplified small loop. This measurement was made in ARRL's screen room, where external signals were virtually non-existent. This measurement of the preamplifier noise of the loop antenna shows a measured noise floor that is only slightly lower than the lowest ambient levels IBEC reportedly measured at three locations. If interpreted in the manner portrayed by IBEC, this “measurement” would show that the noise level in a well-shielded screen room is higher than the median noise levels found by the ITU in the 1970s. Naturally, that interpretation would be wrong. *The majority of the noise measured by IBEC at or near the level shown by Figure 1 was instrumentation noise, not ambient noise*.

7. It is a common occurrence for inexperienced test engineers to make a sweep of spectrum and interpret that measurement as one of "ambient noise." This is incorrect. A sweep, as shown by IBEC, from 3 to 30 MHz, with an antenna connected, is measuring ambient *signals*, not noise. The vast majority of those signals being measured are from intentional emitters, representing the desired signal in most cases. To characterize this as "noise" and report it as such is incorrect. In fact, in a broadband sweep using a measurement bandwidth of 9 kHz, the resolution of the test method, with a bandwidth that is typically broader than the channel bandwidth used by intentional emitters, the measurement bandwidth causes the stronger intentional signals to mask the ambient noise that is between them. Recent work in measuring ambient noise typically uses a narrow bandwidth, to differentiate between signals and noise, and then scales that to the desired reference bandwidth using a $10\log_{10}$(bandwidth ratio) factor.

8. The report provided by IBEC is, additionally, seriously lacking in the types of information commonly included in such reports. As just a few examples, the date and time of day of the testing, the equipment used, and the locations of the testing and the proximity of the location to power lines were not included. The "business" measurement was cited as being located 50 meters from any building, but no indication was made of the proximity of distance from the power lines. The report also indicates that this "business" location was in close proximity to a commercial open-area test site (OATS), a location typically chosen for low noise. Few EMC professionals would characterize a location that is 50 meters from buildings and close to an OATS as a typical business location for measurement of man-made noise. (This could explain the otherwise incongruous determination that noise in this purported business environment was 10 dB lower than the noise in a purported residential area.)

9. IBEC vaguely points to references that ambient noise may have increased over time. The problem is that IBEC cites fourth-hand authorities for this premise. The NTIA Phase II Report, at Section 5.3, states "[f]urthermore, some preliminary studies now indicate that the background noise levels at HF frequencies (sic) may have increased since benchmark noise studies were completed several decades ago." There is a citation for this premise: "See, ITU-R Chairman's report on the meeting of Working Party 1C, Geneva, 11-15 October 2004, Document #54, Annex 2, 'Noise Measurements'." IBEC's fourth-hand recitation of what is shown is that some studies showed that noise levels have increased since 40 years ago. That is not what is included in Annex 2 at all. In fact, Annex 2 simply states that there are some proposals that assume a limited increase of the existing noise floor, without citing them or even indicating any basis for the assumption. How IBEC proceeded from what the document

actually says, that "some studies" *"assumed"* more noise, to an allegation of demonstrated noise floor increases is unclear. It is, however, reminiscent of the old grammar school exercise where a sentence is initiated by a student at one end of the room and whispered among the students one to the next, and at the end, repeated (inevitably radically differently) by the last student. IBEC's citation of a study indicating a noise floor increase over time is based on no authority at all. IBEC has not refuted longstanding and generally accepted ambient noise levels as are described in ITU-R P.372-9.[7] In fairness, the Commission Laboratory staff's finding that it measured noise 10 dB lower than the ITU study levels is not sufficient justification to revise P.372-9 either. Rather, it is simply a confirmation that the levels in P.372-9 appear to be reasonable and typical.

10. IBEC apparently expects the Commission to base its findings concerning ambient noise levels on a single set of measurements made by one stakeholder using equipment with a noise floor that is as much as 15 dB higher than the levels it is trying to discredit. This is untenable. The test technique utilized by IBEC does not discriminate between ambient noise levels, ambient intentional emitter signal levels, and the interaction between those strong signals and the measurement bandwidth used. This makes IBEC's submission of no value whatsoever.

11. Finally with respect to IBEC, its conclusion at the end of its comments that "at the discretion of the manufacturer, unique procedures may be used to measure power levels" is also untenable. The Commission is obligated to ascertain objective methods of measurement of power levels so as to prevent interference, rather than to allow a manufacturer to arrive at whatever measurement method suits its own interests at the time. If a BPL site is so atypical that it has unique factors, it is honest to subject the site to a measurement technique that

[7] ITU-R P372-8 was superseded by P372.9.

assumes what most sites will show. Otherwise, the results will be based on unique characteristics of sites chosen for testing, and not typical performance of typical equipment found at typical sites. The potential for falsifying results is increased dramatically if site-specific extrapolation is offered to the manufacturers seeking equipment certification.

III. The Comments of Current Technologies, LLC

12. It is difficult to know where to start in addressing Current Technologies, LLC's (Current) comment that the unredacted studies and the July, 2009 documents and materials released by the Commission "continue to support" the BPL rules as adopted. They most certainly do not.[8] It could be argued reasonably that the Commission's Laboratory staff did not focus its studies on the proper extrapolation factor, but any suggestion that those studies "support" a 40 dB/decade extrapolation factor, or the sufficiency of other aspects of the adopted BPL rules is pure sophistry. Current argues, untenably, that BPL radiated emissions are akin to point sources, and so 40 dB/decade applies below 30 MHz (but not, apparently,

[8] As but a few examples: (1) In the Field Measurement Study report dated September 8, 2004 concerning the BPL system at Briarcliff Manor, New York, at Slide # 17, captioned "New Information Arguing for Caution on HF BPL," the Technical Research Branch reiterated its 2003 empirical finding that "Strong fields follow the power line for 0.5 mile. Not a point source." (2) At Slide # 21 of the Briarcliff Manor study (captioned "BPL Spectrum Tradeoffs and Proposal"), the FCC Laboratory engineers listed the interference potential of BPL to Mobile Radio (expressed as [I+N]/N, where I indicates Interference and N indicates ambient noise) in the 2-8 MHz range as "high" and at 8-30 MHz as "Very High." For fixed stations, based on actual measurements, the Laboratory found that the interference distance to fixed stations at 2-8 MHz was 62 meters, and at 8-30 MHz it was 400 meters for a single BPL device operating in an area with noise levels classified by ITU as "residential." It specifically concluded that Amateur Radio operators were potential victims of interference in the entirety of the band 2-50 MHz. (3) The Laboratory, as the result of these findings, essentially recommended strict limits on emissions from Access BPL systems in the 2-30 MHz range, in order to protect Amateur, Federal HF Mobile, Public Safety HF mobile, and other mobile and international broadcast stations. (4) Slide #13 of the Briarcliff Manor study, captioned "NTIA Results" reveals that both NTIA and the Commission's field tests showed that in ITU residential areas, BPL increases the noise floor for land mobile stations at ranges up to 15 meters horizontal distance from the power line by *30 dB* in the mid-and upper ranges of the HF band. The chart attached to that slide shows that at almost 100 percent of the points measured along a 340-meter BPL power line by the NTIA, the 20 dB (I+N)/N interference level was exceeded. Almost 60 percent of those points in the mid to upper HF range exceeded the 30 dB (I+N)/N interference level in a typical land mobile receiver. This is consistent, says the slide, with FCC Laboratory measurements.

above 30 MHz, for reasons never explained by anyone at any time). The FCC Laboratory studies conclude precisely the opposite.

13. Current argues that the Commission need not adopt the only justifiable extrapolation value, only one that is reasonable in light of the record. That is not entirely correct either, and certainly not a test that is permissible in this case in light of the Court of Appeals' explicit remand order.[9] The D.C. Circuit does not allow an agency to ignore ostensibly reasonable alternatives where it admits that the choice embraced suffers from noteworthy flaws.[10] Furthermore, "unless the Commission answers objections that on their face seem legitimate, its decision can hardly be classified as reasoned." [11] ARRL's comments earlier in the rulemaking proceeding, and in its recently filed comments on the Further Notice proposal pointed out noteworthy, and in ARRL's view determinative, flaws in the use of a 40 dB/decade extrapolation factor. A 40 dB/decade factor is not derived from valid science, and ARRL has demonstrated that, at the measurement distances typically used for BPL measurements, the proper extrapolation factor is much closer to 20 dB/decade than 40 dB or 30 dB. There is nothing in the Further Notice that allows the Commission to merely rubber-stamp its 40 dB/decade extrapolation assumption, or just pick randomly that extrapolation factor as one of several argued alternatives, as Current suggests.

14. In fact, an assumption is precisely what 40 dB/decade is -- nothing more -- and it always has been since it was included in the Commission's rules initially. The Commission determined in 1989 -- 20 years ago -- that the 40 dB/decade extrapolation factor *for point*

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[9] The Court ordered that on remand, the Commission "shall either provide a reasoned justification for retaining an extrapolation factor of 40 dB per decade for access BPL systems sufficient to indicate that it has grappled with the 2005 studies, or adopt another factor and provide a reasoned explanation for it."
[10] *City of Brookings Mun Tel. Co. v. FCC*, 822 F.2d 1153, 1169 (D.C.Cir. 1987); *Farmer's Union Cent. Exch.Inc. v FERC*, 734 F.2d 1486, 1511 (D.C. Cir. 1984).
[11] *Canadian Association of Petroleum Producers v. FERC*, 254 F.3d 289, 299 (D.C.Cir. 2001).

source radiators would be used "*[p]ending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified*." 47 C.F.R. § 15.31(f)(2). Thus, for 20 years, the 40 dB/decade extrapolation factor was explicitly understood to be, and stated in the rules as, a temporary placeholder until a more accurate extrapolation factor was determined. No one ever established that that number was correct, even for point-source radiators operating below 30 MHz, much less line-source radiators. It is submitted that ARRL has provided the Commission to date with ample justification for adopting an extrapolation factor considerably closer to 20 dB/decade of distance than 30 dB, and the Commission is not at liberty in light of that to rubber-stamp the assumed and temporary placeholder 40 dB/decade extrapolation factor, which never had any technical basis to start with, and has not for the intervening 20 years it has been applied.[12]

15. Like IBEC, Current is correct that its BPL deployment configuration represents a reasonably successful model for interference avoidance, at least relative to Amateur Radio. However, Current does so by *avoiding the use of HF frequencies on medium-voltage distribution lines altogether*, and by using in-premise modems that have 35 dB of filtering in the United States Amateur allocations at all times. Current, rather than arguing untenably that 40 dB/decade is the right extrapolation factor, or (incredibly) that BPL radiates as a point source, should be touting its system as a model for revised regulations, so that the rules require all BPL systems to do what its systems actually do – operate only above 30 MHz on

[12] Lest anyone assume that the 20-year tenure of the extrapolation factor is evidence that 40 dB/decade is sufficient. This would be incorrect. The factor applies only to radiated measurements below 30 MHz, which under FCC rules, apply only to intentional emitters and carrier-current devices. One need look no farther than the reports from the redacted and July 2009 FCC studies to see the effect of the present extrapolation factor. These reports show that a carrier-current device, presumably Verified under the equipment authorization rules using a 40 dB/decade factor, was involved in an interference case to the ARINC facility in California. This report found that this "legal" device was capable of interference for a distance greater than a mile from the ARINC facility.

medium-voltage power lines, and to notch all Amateur allocations full-time throughout the system, to notch depths of 35 dB. The low interference potential of Current's BPL system is not, in any sense of the term, related to the appropriateness of a 40 dB/decade extrapolation factor. That argument is a *non sequitur*.

16. Current argues that the Commission's "notching and shut-down requirements" are in some manner "unprecedented". Those two requirements are, as ARRL has shown in comments and in its earlier Petition for Reconsideration in this docket proceeding, illusory. There never has been a BPL notching requirement for Amateur Radio. There *should* have been one. The requirement that BPL devices have the *capacity* to notch is and has been[13] meaningless where there is no requirement to implement it. As to the "shut-down requirement," as Current puts it, there is not one case – not one – in which a BPL system was ever required by the Commission to shut down in response to documented complaints of harmful interference to Amateur Radio. Even BPL systems authorized by Part 5 experimental licenses, which have a more stringent "shut-down" requirement than do Part 15 devices generally, never were required to stop interfering with Amateur stations, and the interference cases went on for years at a time. What is "unprecedented" (aside from the complete inapplicability, much less effectiveness, of what the Commission loosely calls "interference mitigation techniques" in the BPL rules to date) is the authorization of a Part 15 system that uses many megahertz-wide swaths of high-frequency spectrum, 24 hours per day, on unshielded overhead power lines throughout entire municipalities, if not entire utility distribution areas, without any necessary and applicable restrictions.[14]

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[13] As shown by the large number of BPL interference complaints where effective notching was not implemented by the BPL companies.

[14] The December 3, 2003 report of the FCC Laboratory entitled "Broadband Over Power Line (BPL) Test Results and Considerations" Slide #3 of that study concluded, *inter alia*, that "BPL interferes with nearby

17. Current, in an effort to minimize the effect of the unredacted studies of the FCC Laboratory engineering staff and the materials prepared in 2003 and 2004 which were released to the public in July of 2009, [15] claims that one might "cherry pick" those materials for "bits of data" that might be read "in isolation" to suggest harmful interference from BPL. This is simply *not* a good faith assessment of those documents and materials. As ARRL stated in its comments in this proceeding, no reasonable person could view the Briarcliff Manor Video #5 and conclude that BPL systems are being properly regulated by the Commission. There is an overwhelming amount of data, including video, that shows that BPL interference isn't just "possible" as Current puts it. The interference is *certain* if BPL systems are using spectrum that is in use locally, assuming compliance with present regulations, and the NTIA Phase I study validated that conclusion. The only fair conclusion from the unredacted studies conducted by the Commission's Laboratory staff and the July, 2009 released materials (which derived from the same source) is that BPL is an interference generator of unprecedented magnitude, if operated at the permitted radiated emission limits on frequencies that are in use locally.

18. The major flaw in Current's argument appears at pages 4 and 5 of its comments. Current claims, in an effort to support the Commission's retention of the 40 dB/decade

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shortwave & amateur reception (including MARS);" that "resolving interference complaints will be difficult/impractical;" and that Part 15 radiated limits were "[a]dequate for most devices, but not for BPL." The difference, noted the Laboratory, is that BPL has a broad bandwidth; it has high emissions over that wide bandwidth; it is exempt from conducted limits except in the AM broadcast band; it is in close proximity to neighboring residential antennas; there are no intervening walls to attenuate interference; and the radiators have a large spatial extent. These factors make BPL authorization by the Commission "unprecedented."

[15] An attempt by Current to minimize the video materials released in July of 2009 includes its gross mischaracterization of the video files as "simulated interference" and "deliberately induced interference." The files represent the results of empirical tests of interference potential of BPL, which is shown to be overwhelmingly high, and the Commission knew this well before it adopted its insufficient and ineffective BPL rules in 2004, and before they were affirmed in 2006. The videos are compelling empirical illustrations of the severe interference potential to Amateur Radio of Access BPL operating in compliance with the present, inadequate rules.

extrapolation factor, that BPL signals radiate in the manner of a point source. To illustrate this, they utilize the following graph. The graph, however, does not illustrate what Current asserts.

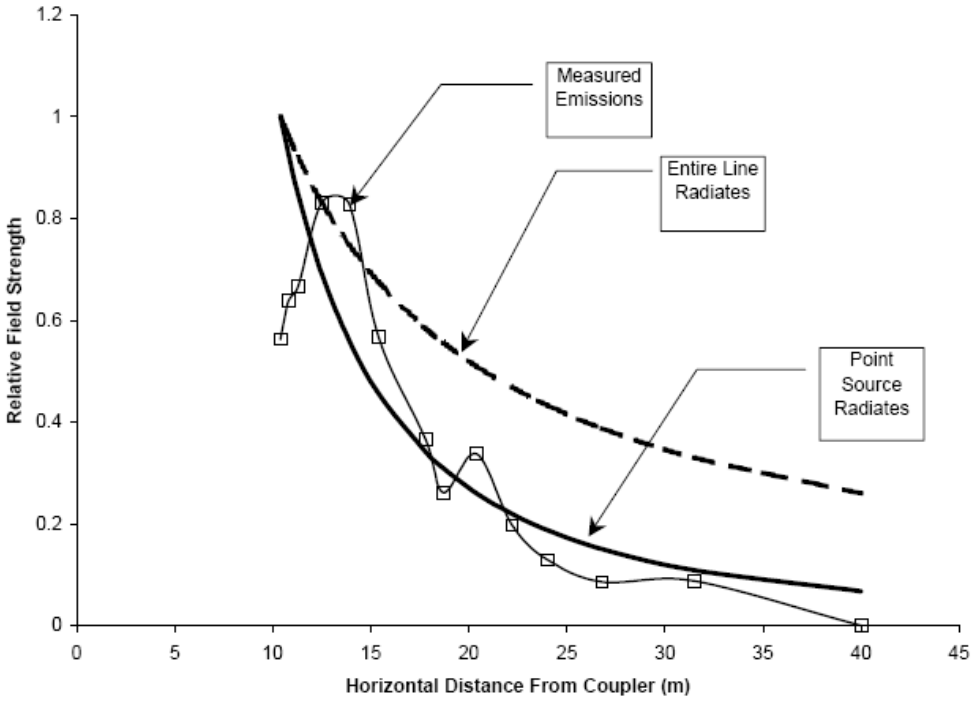

Figure 1: This graph, provided by Current in its filings, purports to show that the emissions from BPL are a point source. Instead, the data show that power lines develop the standing wave of emissions typical of a line emitter. The data also show that any four points along the line purported to be measurements will calculate to a different extrapolation value.

19. It is correct, as Current argues, that 40 dB/decade is the emissions decay from a point source, but that is true <u>*only*</u> within the distance bounded by wavelength/2pi. *Beyond that distance, the emitter will decay at a 20 dB/decade rate*. <u>*At a distance of 10 meters from the radiating source, all frequencies above 4.77 MHz will be measured at greater distance than wavelength/2pi, where the decay versus distance is at a rate of 20 dB/decade*</u>. ARRL agrees with Current that *within* the boundary of wavelength/2pi, a 40 dB/decade

extrapolation is appropriate.

20. The Current graph depicted above is the same graph that Current provided in its comments earlier in this proceeding in 2004. It is unexplained in Current's comments now, just as it was then. The graph, originally presented as measurements of an overhead power line, offers no explanation as to the frequency of the purported measurement.[16] It does not describe the height of the line; the measurement height; or whether E- or H-fields were measured. The vertical scale is also unexplained, indicating only "relative field strength," without indicating whether it is a linear scale in microvolts per meter, or a log scale in dBuV/m.

21. Those rather glaring deficiencies notwithstanding, one can draw a few reasonable conclusions nonetheless. The field strength depicted shows a standing wave, typical of what is seen from a line emitter.[17] In all of its modeling, ARRL has never seen field strength *decrease* by several dB under the overhead power line as shown in the graph, if calculated at the point of peak emissions, which is the only point at which any extrapolation determination could be presumed to be valid. However, in the standing wave developed near line emitters, the peaks in field strength are separated by approximately 1/2 wavelength. From the peaks shown in the graph, the frequency appears to have a wavelength of approximately 19 meters. It can also reasonably be assumed that the measurement height is 1 meter and that the lines are approximately 10 meters in height. Reporting of measured results must contain this very basic information in order to be of any value. Lacking such, Current's attempted illustration must be discounted completely.

22. Assuming *arguendo* that ARRL's assumptions about the graph are correct,

[16] Current's equipment operates above 30 MHz on overhead power lines, so this is either not a measurement below 30 MHz, or it is a measurement made in some other completely undescribed way.
[17] There is ***no*** standing wave developed from a point source radiator.

Current's graph still suffers from inexplicable data. The lines superimposed on the purported test results are described as being from an "entire line radiating" source, which Current has described as having 20 dB/decade decay; and a "point source radiating" source, described as having 40 dB/decade decay. They are graphed, however, against what is characterized as a "horizontal distance from coupler" distance. The two superimposed lines show 20dB/decade decay and 40 dB/decade decay respectively for linear distance, *despite* the fact that they are graphed against horizontal distance, rather than slant-range distance. Slant-range distance is presumably the linear distance that the data purport to represent. If these data were corrected for slant range, they would show that radiation from a line source decays at approximately 26 dB/decade and a point source radiates at 55 dB/decade, so it is not at all certain which of the lines in the graph have been corrected for slant range and which have not. It appears that the two lines that show 20log and 40log decay rates are linear, not horizontal distance. If the measured data are also linear distance, they show a decay rate of 29.2 dB/decade. The inconsistencies in this graph are not helpful. The derivation of these graphical data is not explained by Current, nor are they in Current's original filing, where they first appeared. From the context, and given the glaring errors and inconsistencies, it appears as though they might have been fabricated in an attempt to illustrate the points that Current is trying unsuccessfully to make.

23. Even if the data in Figure 1 are actual ascertained values, the line showing the standing wave is still inexplicable. The mixing of slant-range distance (inferred from the test data, which are valid at 40 dB/decade *only* for slant-range distances) with linear extrapolation for straight-line distances overlaid on a graph represented as horizontal distances, completely voids any value the graph might have had in illustrating any specific value of distance

extrapolation. The graph is not without its merits, however. The line showing the standing wave of measured data clearly shows that one would obtain a *different* value of extrapolated result from different sets of four points, using any extrapolation factor, starting with measurements made at varying distances from the power line.

24. Current parrots the FCC position that to determine extrapolation, it would be necessary to have a very large number of observations from different BPL installations. Current, presumably in agreement, adds that these data must be taken at a large number of frequencies over a wide range of distances from the line. It then adds that radio noise makes it very difficult to obtain consistent results. On page 8 of its comments, however, Current inexplicably changes its argument, supporting a case-by-case determination of extrapolation that is intended to be used to obtain equipment authorization of systems that will be used in thousands of installations. It is completely illogical to state on the one hand, as Current does at page 5 of its comments, that determination of an extrapolation value will require "a large number of observations from different BPL installations" and then to state three pages later that it supports a methodology that will determine that extrapolation based on only four measurements. As its own graph shows, any four measurements will yield radically different conclusions.

25. ARRL would cite in opposition Figure 1 of Exhibit C from its Comments in response to the Further Notice.[18] That shows that it simply is not possible to determine the "real" extrapolation based on 4 measurement points in this environment. Instead, it is important that the Commission determine an extrapolation value that follows the way that field strength varies around typical representational models illustrated by ARRL's

[18] See ARRL Comments filed September 23, 2009, Exhibit C, *Modeling as an Alternative to Measurements in Determining the Extrapolation of Measurements Below 30 MHz*, at Figure 1.

Exhibit C, Figure 1 of its Comments. That same ARRL Exhibit demonstrates that any attempt to determine extrapolation from four points is simply flawed and unworkable.

26. Current's Figure 1 shows that a measurement made at 10 meters distance shows a relative value of -5.2 dB (relative) at a slant-range distance of 13.5 meters. If the next four points versus distance from this graph are taken at a horizontal distance of 12.5 meters, a slant-range distance of 15.4 meters, the field strength has **increased** to -1.4 dB. This would be an increase per distance decade of 30.8 dB/decade. No manufacturer would, of course, use results that would cause it to have to *add* 30.8 dB/decade to get to 30 meters, so other data points would have to be chosen. In this instance, a test engineer would continue to see an increase in field strength until a horizontal distance of approximately 14.5 meters. From that point, the next three points do show a decrease along a fairly straight line, so that could be presumed to be an accurate measurement of extrapolation. The level at 14.5 meters horizontal (17.1 meters slant range) is -1.4 dB and the level at 18 meters distance (20.1 meters slant range) is -12.0 dB. These four points show that the field strength varies at an incredible (and discreditable) 90.2 dB/decade. Even if it was assumed that this graph was mixing scales and the data scale was based on slant range instead of horizontal distance, the data show that those four points have an extrapolation of 74.4 dB/decade. Any four other points, all of which could be presumed to be "in the range of reasonableness" would yield different results. Clearly, these data provided by Current into the record in this proceedings, show that any method of choosing four points to measure extrapolation, then applying that to 30 meters distance, will yield a result that is wildly inaccurate.

27. Finally with respect to Current, the discussion of the OFCOM studies and the CISPR 18 standard is not well-taken. As to CISPR 18, Current claims that the study is dated 1996, well before the development of BPL, and it addresses noise produced by power distribution systems not relevant to BPL. That is not so. CISPR 18 is very much descriptive of the way that noise of all types is coupled onto and out of power lines. BPL signals, though Current would have it otherwise, do not radiate from lines differently than other RF noise. As to OFCOM, especially OFCOM 1, ARRL maintains that if a single extrapolation number is to be specified in the Commission's rules, the study establishes that extrapolation should be 20 dB/decade in the region from 10 to 30 meters. At lower frequencies, it could be specified at a higher level, if the Commission wishes to use a frequency/distance based formula.

IV. Comments of HomePlug Powerline Alliance, Intellon Corporation and Arkados Group, Inc.

28. The Comments of these three entities, referred to herein collectively as "HomePlug" are similar in content.[19] Their effort is solely to preserve the 40 dB/decade extrapolation factor. They cite as authority the NTIA Phase II study and the Brazil study. ARRL has already rebutted the Brazil study in its Comments filed September 23, 2009.[20] ARRL will separately address the NTIA Phase II study, but briefly, the major flaw in the NTIA Phase II study is that the modeling used does not fully account for the way that field strength decays at angles other than 90 degrees. With respect to height, it errs in its attempted justification of the 5 dB height correction above 30 MHz but not below, and it justifies 40 dB/decade by discarding 20 percent of the points, saying that if 80 percent of the points are at

[19] Arkados, for example, did not bother to change all of the headers of HomePlug's comments that it apparently used when preparing its own.
[20] See Exhibit B, ARRL Comments in response to the Further Notice.

or below the level that is predicted by 40 dB/decade, that is good enough. ARRL asserts that the NTIA Phase II study was prepared in 2007; three years after the decision by FCC to apply the 40 dB/decade factor for BPL. It was configured with the specific intent of supporting the Commission's decision to use 40dB/decade, rather than to accurately determine the proper extrapolation factor. This differentiates the Phase II study from the Phase I study, which was apparently less politically influenced.

29. HomePlug companies have access to literally thousands of measurements related to deployment of in-premise BPL modems *in-situ*. It is noteworthy that none of the HomePlug entities provided even a single measurement in comments in this proceeding. They do, however, cite a paper recently released by the Communications Research Center in Canada.[21] HomePlug's one-line conclusion from this study is that the "path loss coefficient is 36 dB/decade at a measurement frequency of 37.8 MHz with the shadowing standard deviation of 3.28 dB." The applicability of this study to HomePlug's point, however, is virtually nil. As can be determined *a priori* from the title of the study, the information does not extrapolate to frequencies significantly below 30 MHz, as the lowest frequency in the study is 37.8 MHz. The study did not analyze near-field or even line-of-sight propagation. To quote the study: "A total of 223 measurements, <u>almost all of which were line of sight,</u> were taken at locations approximately equally split between on and off the CRC site." The minimum distance at which measurements were reported in the graphical data appears to be approximately 120 meters, non-line-of-sight. Any characterization that this study somehow supports a 40 dB/decade extrapolation across

[21] Pugh, Bultitude, and Vigeron, *Path Loss Measurements with Low Antennas for Segmented Wideband Communication at VHF*, Communications Research Center, Ottawa.

the HF range, at distance of 10 and 30 meters, is inaccurate and a mischaracterization of the study's intended purpose.

30. HomePlug attempts to discredit the OFCOM studies, but does so ineffectively. OFCOM studied overhead power lines, and as such, there is nothing to differentiate them from those in the United States. The Further Notice and other commenters attempt to infer some differentiation, but neither the Commission nor any commenter who argues that there *may* be differences between BPL in the United States and BPL in the United Kingdom has offered any information about what those differences might be, and what impact the differences, if any, may have on the OFCOM measurements. Somehow, however, the Brazil study is evaluated by HomePlug under a different, more liberal standard.[22] HomePlug attempts to discredit the OFCOM studies by arguing that OFCOM used a peak, rather than a quasi-peak detector in the studies. This is a red herring. The relative difference between measurements would be identical for peak or quasi peak. There is no technical reason to assume that the use of either detector would yield a different extrapolation result. HomePlug's attempt at discrediting the OFCOM studies, and that of the Commission in the Further Notice, are baseless. Extrapolation is not different in the United States than in the rest of the world. Overhead lines do not radiate differently here than in Europe. Extrapolation does not vary based on the detector. Nothing cited by the Commission or HomePlug changes the basic laws of electromagnetics physics that dictate how fields decay near radiators.

31. HomePlug argues that in the OFCOM studies, the height of the measurement antenna was not specified, so it must be kept at 1 meter to be valid. Homeplug uses

[22] At least Current admitted that the Brazil study had "weaknesses" and was of use only "to the extent of its reliability." See Current comments, pp 6, 7.

circular, and flawed, logic. It is essentially saying that unless the antenna is located at the distance that the fields decay most rapidly -- low to the ground going away from a horizontally polarized antenna -- then any results that may show that field strength decays less rapidly, at any height, are not valid. HomePlug does note correctly at page 6 of its comments that field strength varies substantially with distance, making any "estimate of path loss coefficient very uncertain." This conclusion clearly indicates that *in situ* determination of extrapolation is inappropriate.[23]

V. Comments of United Power Line Council

32. UPLC, unlike IBEC or Current, offers no technical analysis in its comments. Instead, it argues in summary fashion that the unredacted studies released by the Commission and the July, 2009 Documents are "generally consistent" with the Commission's 2004 Access BPL Order and the 2006 Order on Reconsideration. It claims that the empirical findings of the Commission's Technical Research Branch of the FCC Laboratory, Office of Engineering and Technology, are "largely opinions" and that the Commission's 2004 and 2006 orders "adopted rules that address these opinions." These are ludicrous allegations.

33. ARRL showed extensively in its Comments in response to the Further Notice that the unredacted studies, and the July, 2009 materials, prepared by the FCC Laboratory engineers, were relied on by the Commission in developing its BPL rules, and the Commission readily admitted that. The Commission stated, specifically, at paragraph 47 of the Order on Reconsideration, as follows: "We clarify that in this proceeding, the Commission relied, in the aggregate, on NTIA's BPL Phase 1 Report, on the various interference studies filed in the record, including ARRL's studies, *and on its own internally*

[23] It should be noted that HomePlug did not support the Commission's proposal to permit *in situ* measurements for determination of extrapolation in individual cases.

conducted studies as described in the materials provided in the FOIA response to ARRL."

The technical studies that the Commission withheld from the public were conducted and prepared by competent Commission engineering staff working in their professional capacities at the time. They were the engineers at the Commission most familiar with BPL systems' operation, based on actual field studies. There is nothing that UPLC has shown to be unreliable about any of the materials prepared by the FCC laboratory.

34. As to the consistency of those materials with the conclusions reached in the 2004 and 2006 BPL orders and the rules adopted therein, they are as different as night and day. The unredacted documents revealed the following:

(1) Access BPL is by 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. In fact, the Commission's measurements show that there is virtually no signal decay *along* the power line 230 meters from the coupler. The Technical Research Branch found that *"… BPL operating near the current FCC limits without specific means to reduce emissions in amateur bands will likely have a major impact on some amateurs. A 25-35 dB increase in noise floor 30 m from a residential power line is significant – especially if decay rate down the line is low."*

(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 (20log R) than to the 40 dB/decade of distance adopted by the Commission at frequencies below 30 MHz.

(3) Access BPL has a considerably higher interference potential to licensed radio services than the Commission concluded in the Access 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 Access BPL Order). Specifically, interference to licensed mobile radio receivers is very likely for very long distances along a power line. The studies also show that systems operating at the Part 15 emission limits will be 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 a noise level even higher.

(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) The proper course of action for the Commission at the time was to ban Access BPL on overhead power lines, as a means of protecting licensed services from harmful interference in the High Frequency bands.

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

There is no correlation whatsoever between these findings and the Commission's BPL rules, or the 2004 or 2006 Orders. UPLC's protestations to the contrary are ridiculous.[24]

35. Equally astonishing is UPLC's claim that though there were "parts" of the unredacted studies that the Commission did not implement, it is nevertheless "within the Commission's prerogative to credit only certain parts of the studies." For that premise, UPLC cites the Court of Appeals' remand order in this proceeding. In fact, the Court held *precisely the opposite* of UPLC's contention. It said that "[w]here, as here, an agency's determination 'is based upon a complex mix of controversial and uncommented on data and calculations, there is no APA precedent allowing an agency to cherry-pick a study on which it has chosen to rely in part."[25]

36. UPLC does not even bother to address the FCC Laboratory's finding that the ambient noise levels in residential areas were ascertained to be lower than expected, and therefore the interference levels from Access BPL on overhead lines was higher than expected and results in "underestimation of interference levels." UPLC writes this off as being "merely advisory in nature" and it "doesn't seem essential to the studies or to the

[24] UPLC argues at Page 3 of its comments that the Commission adopted a height correction factor which was suggested in the unredacted studies. That height correction factor was only for frequencies above 30 MHz, so UPLC's claim that this addressed the FCC Laboratory recommendation on "BPL HF Issues" is specious.

[25] *American Radio Relay League, Inc. v. FCC*, 524 F.3d 227 (D.C. Cir. 2008) (*Slip Op.* at 15)

basis of the FCC's technical rules." Actually, it is proof that the Commission's recitations in the 2004 Access BPL Order and the 2006 Order on Reconsideration that the interference potential of BPL is "low" were knowingly incorrect when made, and that the rules adopted did not in numerous respects address the real interference potential.

37. In its criticism of the OFCOM studies, UPLC, citing only the Commission's further Notice, claims that the studies were "anecdotal." There was nothing anecdotal about them. They were measurements made by a competent body, and were far better documented than the Brazil study that UPLC cites with approval.[26]

38. UPLC attempts to make the case that there has been a "lack of interference complaints involving BPL systems, which serves to validate the 40 dB extrapolation factor for BPL…" There is no cause-and-effect relationship there whatsoever. As ARRL has explained repeatedly, the relative absence of BPL interference complaints is due to (1) the dearth of BPL deployments at the present time; and (2) the fact that those Access BPL deployments now in the field typically make no use of Amateur spectrum, and use full-time notch filtering to 35 dB, which is precisely what ARRL urges as regulatory requirements for all BPL systems, now and in the future. The relative lull in interference complaints has nothing whatsoever to do with the appropriateness of a 40 dB/decade extrapolation factor.

[26] UPLC and the other commenters should be careful in citing the Brazil study, because the sole conclusion of that study is as follows: "Although it was demonstrated through the trials outlined herein that PLT systems cause harmful interference to other communication systems, the implementation of mitigation techniques such as notch filters and output power control offer the effective protection to enable the coexistence of systems sharing the same frequency spectrum." Furthermore, Brazil, on September 21, 2009 introduced into CITEL's XV Permanent Consultative Committee I (Telecommunications) a Resolution entitled *Broadband Power Line Communications Resolution* (OEA/Ser.L/XVII.4.1, CCP.I-TEL/doc. 1790/09), which lists, among other requirements to prevent BPL interference to authorized radio services, the necessity of notching Amateur Radio frequencies and specific coordination with the Amateur Service. It places on an "excluded bands" list for BPL most Amateur High Frequency allocations.

39. At page 6 of its comments, UPLC argues that a 30 dB/decade extrapolation factor would "impose a significant compliance burden on BPL operators.[27] Cost of compliance is not an issue with respect to the determination of a scientifically valid extrapolation factor, (though it seems to be the underlying cause of the concern of all of the commenters in response to the Further Notice). The Commission should resist the temptation to continue to allow the politics of broadband rollout to trump scientific fact. The Commission's obligation is to determine the way that a measurement made at a horizontal distance of 10 meters from power lines will relate to the field strength at a distance of 30 meters at locations where antennas will be located, in order for the extrapolation factor to have any meaning at all. Whether or not BPL systems respond commercially to the reality of signal decay is not a function of cost, or convenience, or the Commission's overarching desire to facilitate broadband rollout. The Commission's regulations must have scientific integrity.

40. Finally with respect to UPLC, at page 7 of its comments, UPLC argues inconsistently with respect to *in situ* extrapolation factors. In the first paragraph on that page, UPLC claims that there would be "little relief" if the Commission allowed BPL system operators to use an *in situ* extrapolation factor. It would be time consuming and costly, according to UPLC. In the very next paragraph, however, UPLC urges that the Commission permit BPL system operators to develop their own *in situ* BPL extrapolation factors, because it would provide "flexibility to demonstrate compliance with the Commission's rules. So, it says, it supports BPL system operators being permitted to use their own *in situ* extrapolation factors. This inconsistency from one paragraph to the next is impossible to reconcile. The "flexibility" that UPLC urges is nothing more than a request that the industry be able to make

[27] This same argument constituted the entire premise of the comments of SPiDCOM Technologies, S.A. for retaining the inapplicable 40 dB/decade extrapolation factor for frequencies below 30 MHz.

measurements that show compliance for any circumstances that are encountered. As ARRL noted with respect to Current, the "flexibility" in the single example Current cited in an effort to show the way field strength varies with a standing wave could be used to demonstrate almost any extrapolation that a test engineer wanted to find. As shown in ARRL's Comments in response to the Further Notice, in Exhibit C, Figure 1, there is variation in any complex RF environment that precludes any authorization for subjective *in situ* extrapolation determinations.

VI. Conclusions

41. Neither the comments analyzed herein nor anything in the Commission's Further Notice in this proceeding harmonize the unredacted documents, and the July 2009 Documents with the Commission's present BPL rules. Those rules are completely inadequate (to the extent that they apply at all to the substantial interference potential of Access BPL to Amateur Radio stations) and must be modified. The comments herein discussed are *badly* flawed technically; some glaringly so; and none offer valid justification for the retention of a 40 dB/decade extrapolation factor. The 40 dB/decade factor is not, and never has been scientifically valid for frequencies below 30 MHz, and it was placed in the rules as a temporary placeholder 20 years ago, with the intention that it apply to point source radiators only. It is beyond reasonable dispute that Access BPL is not in any sense a point source radiator. The Commission has no valid authority whatsoever to justify the 40 dB/decade extrapolation factor to Access BPL. The NTIA Phase II report and the Brazil study are not valid justifications; the Canadian study cited by HomePlug is not applicable at all to HF bands. As ARRL has previously shown, if the Commission is unwilling to adopt a sliding

scale extrapolation factor by frequency, it must adopt a factor that is far closer to 20 dB/decade than 30, or 40 dB.

42. Since a reasoned justification for a 40 dB/decade extrapolation factor cannot be sustained in the face of the existing contrary evidence, the Commission should adopt another extrapolation factor that is consistent with the evidence. Its proposal of a 30 dB/decade extrapolation factor in lieu of the 40 dB/decade factor is admittedly arbitrary. A 20 dB/decade factor is scientifically justifiable for frequencies below 30 MHz generally. While there is some increase in attenuation as the frequency decreases toward 3 MHz, the Commission's measurement techniques, and the variability in radiation from the power lines necessitate the use of a 20 dB/decade extrapolation factor for the band 3-30 MHz for a physically large, line source radiator such as Access BPL.

43. The content of the heretofore withheld documents necessitates a complete review of the BPL rules. Such a review, fairly conducted, would trigger a reduction in the permitted radiated emission levels for Access BPL, among other changes. However, if the Commission adopts the full time notching of Amateur allocations to a depth of 35 dB, and as well a scientifically valid extrapolation factor for signal decay with distance from the power lines, the Commission will have reduced the harmful interference potential of Access BPL to at least the Amateur Service, and it will have at the same time accommodated Access BPL so that whatever potential it might have in the future can be realized without unnecessary regulatory constraint.

Therefore, for all of the above reasons, ARRL, the national association for Amateur Radio, again respectfully requests that the Commission amend the rules governing Access

Broadband over Power Line systems in accordance with ARRL's comments filed September 23, 2009 in response to the Further Notice in this proceeding.

Respectfully submitted,

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