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

In the Matter of	**)**	
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INQUIRY REGARDING CARRIER CURRENT SYSTEMS, INCLUDING BROADBAND OVER POWER LINE SYSTEMS	**)**	**ET Docket No. 03-104**

To: The Commission

COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, the National Association for Amateur Radio, also known as the American Radio Relay League, Incorporated (ARRL), by counsel, hereby respectfully submits its comments in response to the *Notice of Inquiry* (the Notice), FCC 03-100, released April 28, 2003, 68 Fed. Reg. 28182; *corrected* 68 Fed. Reg. 32720. The Notice requests information on the current state of Broadband Power Line (BPL) technology. These comments are timely filed. For its comments, ARRL states as follows.

I. Introduction

1. ARRL's interest in this proceeding is related only to the interference potential of BPL to Amateur Radio medium-frequency (MF), high-frequency (HF), and very-high frequency (VHF) communications, and, conversely, the potential for Amateur Radio to interfere with BPL in those same frequency ranges. This matter is of extreme concern to Amateur Radio operators nationally and worldwide, and the extensive record of comments of Amateur Radio operators in this proceeding already reflects that fact. The following comments do not address the utility of BPL as a competitive broadband delivery mechanism. It is presumed for the purposes of these comments that BPL could,

either now, or at some future time, provide a means of broadband delivery that might be somewhat competitive with the plethora of other broadband delivery mechanisms now available. However, ARRL's view, after extensive technical investigation and experience with Part 15 devices generally, with power line interference problems, and with Power Line Carrier (PLC) systems, is that there is severe interference potential from BPL in the bands between 2 and 80 MHz to Amateur Radio stations. This interference potential, as a matter of both law and fact, disqualifies access BPL as a potential future competitive broadband delivery system. ARRL is cognizant of the fact that BPL is permitted under present Part 15 regulations. However, the interference potential from access BPL systems is as yet unrealized, as they are not yet deployed. BPL is a Pandora's Box of unprecedented proportions.[1] The Commission's Part 15 rules should be modified so as to prevent interference to users of the HF and low VHF spectrum *ab initio*, and to prevent consumers' reliance on BPL as an interference-free broadband delivery system.

2. The Amateur Radio Service has small allocations throughout the radio spectrum. By far, the heaviest-used allocations are in the MF band at 1.8 MHz; and in the HF bands at 3.5, 5, 7, 10, 14, 18, 21, 24, and 28 MHz. These bands, though subject to propagation changes due to time of day, time of year, and the time of the eleven-year sunspot cycle, are extremely heavily occupied. The HF amateur bands are used for disaster relief communications and for a series of other public safety communications functions, as well as normal international and domestic avocational and experimental

[1] BPL is qualitatively different as an interference source relative to DSL. BPL is a unique system that uses entire swaths of spectrum; a physical construction that occupies entire communities; a shared wiring system that puts neighbor's BPL system on the same conductors that feed multiple houses from the same power transformers; and the use of widely spaced overhead wiring that by its own geometry forms an effective radiating antenna. Other systems such as DSL may be physically large, but the use of twisted-pair wiring, and the fact that current DSL systems stop at 1.1 MHz creates an entirely different interference potential.

communications. In addition, a very substantial increase in the use of the 50-54 MHz band has occurred in recent years due to the availability of this band to entry-level Technician Class licensees; increases in the number of licensees in that license class; increased availability of commercial transceivers for use on that band; and due to the skywave propagation characteristics at 50-54 MHz, to the point that the band is overcrowded at times. Use of the HF bands is most often from residences, though mobile and portable operation occurs daily as well. Receivers are extremely sensitive, necessitated by the long propagation paths and variable signal strengths due to skywave propagation.

3. The Amateur Service has struggled with terrestrial interference in the HF bands for years. Interference at HF and low VHF is received from a variety of sources. However, a principal source of reported interference is above-ground power lines. ARRL has researched interference from power line radiation for some years, has assisted in interference resolution efforts, and keeps careful logs of interference cases. Power line noise is the single most frequently identified source of HF interference to licensed Amateur Radio operators. During 2002 and 2003 to date, there have been 245 interference complaints reported by ARRL members to ARRL. These are cases in which the radio amateur has not been able to obtain cooperation from the utility company involved. ARRL estimates that this is but a small portion of the number of actual cases of power line interference to Amateur Radio. Most cases are addressed by the Amateur licensee and the utility company, or else the radio amateur merely suffers the interference where cooperation from the utility is not forthcoming. Of the 245 serious power line interference cases reported to ARRL, 108 of these have resulted in letters being sent by

ARRL technical staff to the utility companies. These letters are not sent by ARRL without good cause. They are sent only when informal, cooperative efforts at resolving the interference problems fail. A total of 86 different utility companies have been involved in these written complaints during 2002/03. In a total of 40 cases, ARRL finally had to refer the matter to the Commission's Enforcement Bureau for resolution, due to non-responsiveness on the part of the utility over a long period of time. Mr. Hollingsworth of the Commission's Enforcement Bureau (who has been extremely responsive and helpful) has sent out letters to 23 different utilities about power line interference problems during 2002 and 2003, representing the most egregious cases. It is fair to say that power line interference to Amateur Radio has been a substantial regulatory burden to the Commission. It is a very substantial problem now for the Amateur Service, without the addition of BPL to the mix.

4. Most power line noise complaints involve several calls to the utility from the complainant. Several visits from an RF interference investigator are typically required. Some utilities, even those attempting to be responsive, lack the ability to resolve power line interference problems readily, efficiently and economically. Most often, the case remains open. Some in ARRL's experience have continued for almost ten years. It is with this experience as a predicate that the Amateur Service views with concern and alarm the Commission's consideration of the use of power lines, an excellent radiator of HF and low VHF signals, for broadband delivery to homes on HF and low VHF frequencies.

5. ARRL also has some experience with in-building Power Line Carrier (PLC) systems. These systems and devices, which use a building's electrical wiring to network computers within that building, presumably have other applications as well. An industry

consortium, HomePlug, has a specification for in-building PLCs. ARRL has worked with HomePlug, which ultimately called for notching in product specifications, so as to remove Amateur bands from the operating frequencies of such systems. Even given the notching out of Amateur bands, there is still some interference to Amateur Radio from devices using the HomePlug standard, but not throughout entire neighborhoods. The interference tends to be from adjacent or nearby residences using a HomePlug device, so the number of complaints from these systems today is relatively small. Where they occur, however, the sole remedy appears to be for the user to cease using the device causing the interference.

6. The Commission has recently addressed "control PLC", by which electric utility companies use PLC to send signals on power lines for several miles to control utility equipment. This is done at low frequencies (LF), typically between 10 kHz and 490 kHz. Because the Amateur Service presently has no LF allocations (the lowest frequency Amateur allocation currently is 1.8-2.0 MHz in the medium frequency range) there has not been any interaction between PLCs and the Amateur Service to date. However, the Commission has refused to make any Amateur Radio allocation in the LF range, precisely because of concerns about interference to and from unlicensed PLC systems. In the *Report and Order* in ET Docket No. 02-98, released May 14, 2003, at Paragraph 18, the Commission held, in part, as follows:

> We note the significant potential for interference between the proposed amateur operations and the incumbent PLCs. ARRL concedes that amateur operations and power lines with attached PLCs would have to be separated in order to prevent interference. We find that separation distances on the order of 950 meters would be necessary to protect the PLCs from interference. We also find that this distance, coupled with the larger-than-expected number of PLCs potentially impacted by this

> proposed allocation, increases the likelihood that a PLC-equipped powerline will be close enough to an amateur station to receive interference. We will not jeopardize the reliability of electrical service to the public.

Though the Commission was, in ARRL's view, in serious error in making this finding, it has nonetheless been concluded that, to avoid interference to PLC systems from LF Amateur transmissions (of less than 1 watt EIRP, and assuming extremely inefficient antennas), there would have to be 950 meter separation between the Amateur antenna and the power line. That *Report and Order* also found that PLCs would cause significant interference to Amateur stations at LF. Having made these specific factual conclusions, and given the irrefutable fact that power lines are relatively *inefficient* radiators at LF, the Commission must give serious consideration to the interaction between Amateur transmissions at HF and BPL at HF, where power lines are extremely *efficient* radiators[2] (and where radio amateurs use transmitter power levels up to 1500 watts PEP output and high gain antennas, resulting in EIRP levels as high, in some instances, as 30 kilowatts).[3]

7. The greatest interference potential from BPL to Amateur Radio is with respect to "access BPL" systems, which would provide broadband Internet access to homes and

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[2] Attached hereto as Exhibit A is an ARRL study conducted by its Laboratory entitled "Power Line Antennas from 0.1 to 30 MHz." This study, using a well-known antenna modeling program, EZNEC/4, evaluates the relative efficiencies of power lines as LF and HF radiators. Table 1 of that study shows the calculated gain of a power line antenna at different frequencies. The study concludes that, for a given signal level, the radiated emissions from power lines will increase by tens of dB as the frequency is increased. At HF, power line wiring makes a fair to excellent antenna, similar in gain and pattern to antennas used by licensed radio services. At LF, where the Commission concluded that 950 meter separation between low-power Amateur stations and power lines carrying PLC would be required in order to avoid interaction between the two, the power line model antenna gain is -68dBi. At 10 MHz, for example, that antenna gain increases to +4.6 dB.

[3] The Notice acknowledges the problem, at paragraph 5: "This conducted energy can cause harmful interference to radio communications via two possible paths. First, the RF energy may be carried through the electrical wiring to other devices also connected to the electrical wiring. Second, at frequencies below 30 MHz, where wavelengths exceed 10 meters, long stretches of electrical wiring can act as an antenna, permitting the RF energy to be radiated over the airwaves. Due to the low propagation loss at these frequencies, such radiated energy can cause interference to other services at considerable distances."

businesses, using electrical distribution wiring. Overhead wiring is a far better conductor of HF signals than is the electrical wiring within a building. Entire communities will be affected by radiated BPL emissions, and it can easily be seen that interference to Amateur Radio stations will, as a practical matter, not be resolved where the solution is to cease operation of a BPL system in a community. In situations where an Amateur station creates interference to an access BPL system, the level of tolerance of broadband consumers to that interference will be extremely low indeed. So, irrespective of the Part 15 status of BPL, incidents of interaction between the Amateur Service and BPL systems on HF frequencies can be expected to be resolved (in the unlikely event that they could be resolved at all), to the unilateral detriment of Amateur Radio operators.

II. Interference from BPL Emissions

8. ARRL will take the Commission at its word regarding the premise at Paragraph 18 of the Notice, which states as follows:

> In both Access and In-House high-speed BPL technologies, multiple carriers spread signals over a broad range of frequencies that are used by other services that must be protected from interference. In the spectrum below 30 MHz, incumbent authorized operations include…amateur radio terrestrial and satellite…In the spectrum from 30 to 300 MHz, incumbent authorized operations include… amateur radio terrestrial and satellite…Each of these authorized services in the spectrum must be protected from harmful interference.

It is unclear, however, whether the Commission is cognizant of the extreme sensitivity of HF receivers deployed in the Amateur Service, and the extensive disruption of ongoing Amateur Radio communications in the heavily used allocations which would result from deployment of BPL in the HF bands allocated to the Amateur Service. Any such

interference can also be presumed to affect other services, in addition to the Amateur Radio Service, which daily conduct terrestrial emergency and safety of life communications in the HF bands.

9. The Notice, beginning at paragraph 20, asks a series of questions regarding interference potential of BPL. These are addressed these in the order in which they are asked in the Notice. The first series of questions addresses use of high-pass filter circuits, and the effect of those on HF signals inside residences from in-house BPL technologies. The problem with the use of high-pass filters as a means of getting a BPL signal past lossy transformers is that they will not only couple the BPL signal onto the MV lines, they will also couple all other RF noise generating device in every building onto the line as well. This will significantly increase the interference potential of devices that otherwise would have been only a local interference source. The MV lines, which may have been relatively quiet previously, will become the distribution source for in-building RF noise. The interference potential from the use of high-pass filters has not, apparently, been conclusively studied, but it will surely impact both the interference potential from a BPL device, and the potential from other conducting emitters in unknown ways. It would be highly premature to permit the use of these filters without knowing more about the interference potential of them using good science.

10. As to the various methods of RF signal injection onto "medium-voltage" (MV) lines, and the effect of different methods on access BPL interference potential, a study of alternatives is attached hereto as Exhibit B.[4] This study was conducted by the ARRL Laboratory staff. It notes differences in the way that MV distribution lines conduct

[4] "Methods of Feeding Overhead Medium-Voltage Power Lines with BPL Signals and the Relationship of These Methods to the Radiated Emissions of the Conductors", Exhibit B.

and radiate signals based on the way RF power is fed to the lines. Using an established antenna-modeling program, EZNEC/4 with the NEC-4 calculation engine, ARRL modeled a simple MV power line and two nearby amateur antennas, conservatively located 30 meters from the lines. Three different models reflected three different ways of feeding the antenna, *to-wit:* differential feed between two phases, at one end; one phase to Earth ground, in the center; and one phase fed differentially similar to the way a dipole is fed, offset on the ungrounded phase.

11. Some conclusions drawn from the study are as follows: Feeding the power line as a dipole is the worst choice from an electromagnetic compatibility perspective. It results in a high powerline antenna gain and greater coupling to the simulated Amateur antennas. At 14 MHz, perhaps the most popular and overcrowded Amateur HF allocation, the gain of the powerline antenna fed in this manner is high enough that the power line has more gain than many antennas intentionally deployed by Amateurs for that band. Feeding the line differentially or from one phase to the ground does result in some improvement in the amount of BPL-signal power delivered to the modem load and in somewhat less energy radiated to the simulated amateur antennas. This does not remove the interference potential, which is governed by Section 15.209 of the Commission's Rules.

12. However, it should be noted that the radiation pattern resulting from the model is complex, and much radiated energy is in upward directions on multiple lobes. There is significant coupling between the modeled power line and the modeled amateur antennas, but it is unclear whether the assumed separation distance represents a worst-case analysis for this model. The antennas as modeled are located in the radiating near

field of the large power line radiator. The near-field effects and the assumed height of the antennas (the first being in the same horizontal plane as the power line; the second 20 meters higher) which results in the amateur antennas being outside the maximum field above the power line, result in this case in somewhat less energy at the modeled point than the path loss calculation would dictate.

13. The Notice next asks whether there is a need to define frequency bands that must be avoided in order to protect the licensed users on the same frequencies used by access BPL systems. It also asks what mitigation techniques can be used by access BPL systems to avoid interference to mobile, public safety, or law enforcement users. ***ARRL has, upon diligent and exhaustive research, concluded that all Amateur medium-frequency (MF, i.e. 1.8-2.0 MHz), all HF, and all VHF allocations must be avoided by any access or in-building BPL system, without exception***. As justification for this position, ARRL has conducted a study, attached hereto as Exhibit C,[5] which calculates (using several different methods) the interference potential of any emitter operating at the Part 15 radiated emissions limits that apply to carrier current devices. Those levels are then used to determine the level of degradation in the ambient noise level at the receiver of several typical HF and VHF amateur station installations. Using the current Section 15.209 radiated emission limits for intentional radiators as the applicable standard, and the permitted levels of 30 μV/m measured at 30 meters for frequencies between 1.705-30 MHz, and 100 μV/m at 3 meters for frequencies between 30 and 88 MHz, the radiated emissions are high enough that signals from BPL emitters will be received by nearby antennas. The study takes into account various factors, including the noise figure

[5] "Calculated Levels from Broadband Over Power Line Systems and their Impact on Amateur Radio Communications Circuits", Exhibit C.

(sensitivity) of the receiver, the gain of the receive antenna, typical natural and man-made ambient noise levels in residential environments, receiver bandwidth, and other factors. It also acknowledges that the Commission's rules do not define specifically how BPL signals must be generated, so encoding and modulation methods may vary significantly. Conservatively, the study assumes that all BPL systems have a peak-to-average power ratio of the emission of 10 dB, close to the ratio of Gaussian noise.

14. The ARRL study utilizes several typical Amateur station configurations taken from standard receiver reference circuits previously provided to the Commission, and which are attached as an appendix to the study. The BPL system assumption is based on maximum or near-maximum permitted radiated field strengths. Since BPL signals appear to Amateur receivers as noise, the increase in noise level is calculated, on a worst-case basis. Also factored in are typical residential ambient noise levels taken from an applicable CCIR Report.[6] However, quieter ambient conditions than those assumed typically exist during winter months in rural areas, by amounts varying from 10 to 20 dB.

15. The conclusions to be drawn from the ARRL Study at Exhibit C, are as follows. As can be seen from Table 3, received signal levels of BPL noise at typical amateur stations are, in worst cases, between 33.7 and 65.4 dB higher than typical ambient noise levels. BPL cannot be deployed using Amateur allocations in the MF, HF and VHF bands without severely high interference potential. To prevent widespread harmful interference from BPL systems, all MF, HF and VHF amateur spectrum must be avoided. The maximum emission limits in Part 15 will result in strong BPL signals being received by nearby Amateur receiver systems, at levels typically as much as 65 dB higher than the otherwise ambient noise floor. Amateur stations in some especially quiet

[6] CCIR Report 322, June, 1995, http://www.nosc.mil/sti/publications/pubs/td/2813/.

locations, and stations with antennas that must be located close to electrical wiring will be degraded even more. Even if Amateur spectrum is avoided, the spurious and out-of-band emissions from BPL systems operating on adjacent spectrum must be deeply suppressed. Amateurs whose antennas must be located closer than 30 meters from the radiating power lines will need up to 100 dB of suppression of spurious BPL emissions to operate free of harmful interference. This level of suppression is difficult to obtain.

16. The Notice concludes that the Commission's Part 15 rules have been successful in permitting flexible development of new devices and systems. That is to a large extent correct. However, it would be incorrect to assume that the present Part 15 regulations are sufficient to avoid interference to licensed services, especially at HF. The Part 15 radiated emission limits presume the deployment of point-source radiators with localized interference potential. They were not, in general, designed to deal with multiple-transmitter or radiating distribution systems operating at or near maximum permitted levels over large geographic areas. The rules also assume likely separation between a given Part 15 device and the victim receiver in a licensed service. Those assumptions are each inapplicable in the case of BPL. In many cases, the separation between amateur HF stations and community-wide medium-voltage power lines will be far less than 30 meters, and the systems will be ubiquitous throughout communities. Some access BPL systems now in development use repeaters on the MV lines, repeating the interference potential from one area to many others along the line. Any past "success" with Part 15 type regulation of unlicensed devices or systems is inapplicable to HF or low-VHF deployment of BPL. Most Part 15 devices are not deployed in residences adjacent to, and on the same frequencies as, high-power, high-receiver sensitivity

Amateur stations used daily. In this case, there is incompatibility between HF BPL and HF Amateur Radio operation, and the former (and spurious emissions from the former) simply cannot be permitted on the same frequencies.

17. The Notice next asks whether access BPL equipment should be considered to be operating in a residential (Class B) rather than commercial (Class A) environment, since it would be installed on medium-voltage lines that supply electricity to a residential neighborhood. The answer to this is patently obvious. Access BPL would operate throughout residential communities, if permitted at all, and would provide a service to residential consumers. It would not and could not be restricted to commercial or industrial environments by its nature, and it therefore cannot be reasonably classified as a Class A system. ARRL has established that BPL is incompatible with HF and VHF Amateur Radio operation from residential areas (and as well in certain mobile environments) and should not be permitted to utilize any spectrum in or proximate to Amateur allocations. In any case, however, BPL must be considered to be, and classified as, a Part 15 system deployed in a residential environment, and subject to stringent radiation standards.

18. The Commission asks what mitigation techniques are used by in-house BPL systems to avoid possible interference with licensed radio services such as Amateur Radio, and whether there is a need to define frequency bands that must be avoided in order to protect the licensed services that use the same frequencies as in-house BPL systems. ARRL has worked with the HomePlug alliance in this respect, and that cooperative effort has resulted in HomePlug's decision to exclude Amateur bands from its standard. ARRL contends that no in-house BPL system should utilize any Amateur

band whatsoever. Amateur receivers are subject to severe interference from in-house BPL operating on Amateur allocations, and in-house BPL systems would be susceptible to interference from the relatively high transmitter and effective radiated power levels from residential Amateur HF station operation. A case study illustrates the problem.[7] There was deployed a model PX-421 wireless modem jack. This was a carrier-current device that operated on 3.53 MHz, in the midst of the Amateur 3.5-4.0 MHz band. It was Verified per the Parts 2 and 15 rules, but when widely deployed, there were widespread reports of harmful interference to Amateur Radio stations. Many units sold were ultimately recalled, but many were found one at a time in the field by radio amateurs and service technicians using directional antennas and spectrum analyzers. The cost of finding larger numbers of such devices would be prohibitive and logistically impossible. Incompatibility between residential deployment of in-house carrier current devices operating on Amateur frequency bands has therefore already been experienced and documented, and has proven extremely difficult to resolve. Clearly, with in-house BPL as with access BPL, the use of Amateur bands must be precluded.[8]

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[7] See, http://www.arrl.org/tis/info/rfieljx.html

[8] The difficulty with exclusion of Amateur bands when authorizing BPL is that Amateur allocations are not static, but dynamic. Recently, in ET Docket 02-the Commission allocated five channels, each 2.8 kHz wide, near 5 MHz for Amateur use. Amateur HF allocations are now under consideration at WRC-03. Any new BPL systems in the HF and VHF bands should not preclude any allocations decisions regarding the Amateur Radio Service. Yet, that is ***exactly*** the position taken by the Commission. The Commission stated in the *Report and Order*, FCC 03-105, released May 14, 2003, at paragraph 17, that:

> "We disagree with the ARRL's and Amateur operators' assertions concerning the consideration we should accord incumbent Part 15 use in these bands in deciding whether to provide an allocation for amateur services. Our decision must be based upon the facts at hand and our evaluation of any potential changes to the spectral environment due to our decision. In evaluating whether new operations should be added to a band, licensed or not, we must consider the potential for interference conflicts between the operations. While unlicensed PLC operations have no protection status, they provide a vital public service. Therefore, we disagree with amateur comments that we should not consider the impact on unlicensed operations when making spectrum allocation decisions."

19. The Notice asks what probable interference environments and propagation patterns of access BPL and in-house BPL systems exist, and whether specific interference issues, such as increases in the noise floor, should be addressed. It also asks what models are available for predicting radiated emissions from access BPL systems. In addition to the studies heretofore referenced, ARRL has conducted a study of electric and magnetic fields near physically large radiators,[9] which reveals the extremely complex radiated patterns from a simplified powerline model developed under the EZNEC 4.0 program with the NEC-4.1 calculation engine. One conclusion that can be drawn from this study is that it is not practical to try to model a complex installation that consists of overhead power lines, all the other lines that are present nearby such as guy wires, telephone and cable television wiring, and all the wiring in nearby buildings, the configuration of which cannot be determined. Added to that confusion are the unknown losses in the transformers, street lamps, and constantly changing electrical loads in the buildings drawing power from the system. The only reasonable conclusion is that it is not possible to determine the interference potential of BPL wiring with a computer model. Carrier-current devices cannot be measured under controlled laboratory conditions because the power line wiring used to conduct signals is an integral part of the operation; therefore, such systems must be measured *in-situ*. A "typical" installation does not exist, given the wide range of wiring configurations typically found in an electric utility system. The

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From this, it is plain that, should BPL be permitted in the HF or VHF bands, and should any change in the Amateur allocations in that spectrum be permitted at any later date, the Commission might very well conclude, in accordance with this policy, that BPL which provides a competitive broadband access medium for consumers is a vital public service. Therefore, no changes in HF allocations are possible thereafter. This is completely unacceptable to the Amateur Service, and is, *a priori*, bad spectrum policy. The Commission's willingness to predicate allocations decisionmaking on unprotected, at-sufferance unlicensed devices and systems occupying a band, makes it necessary to preclude the introduction of such unlicensed users into the band at all, lest any future Amateur allocation changes be precluded forever after.

[9] See, Exhibit D, attached: "Electric and Magnetic Fields near Physically Large Radiators".

physical configuration of this wiring makes it difficult to determine the point of maximum field strength to demonstrate compliance with any Part 15 rules. This is especially complex where a BPL system might use both medium-voltage lines and in-building wiring to conduct signals between BPL modems and access points. ARRL's study reveals that the Section 15.35(f) test provision, which assumes a 40 dB/decade (square of inverse linear distance extrapolation factor) does not work in the radiating-near-field region of large radiators. When one makes a measurement close to a large radiator, the measurement is close to only a part of the radiating structure, so the field at that point is not affected equally by all parts of the radiator. As one moves to a more distant point, the effect of the more distant parts of the radiator become more significant. The only reliable means to measure a field strength 30 meters from a large radiator is to make multiple measurements along its length in short increments at the specified distance to determine the maximum field, above, below and to the side of the line (These measurement points may not be possible due to access to land where the maximum field occurs). Otherwise, systems may be permitted to exceed the maximum permitted field strength levels that would not be permitted if measurements were made accurately at the specified distances. Additionally, for the same reasons, and because of the differences in the near-field/far-field effect, the Section 15.31 measurement procedure for radiated emissions of carrier current systems at three "typical" or "representative" installations is insufficient and inapplicable to both access and in-building BPL systems

20. The Notice asks whether there are test results from field trials of access BPL that may assist in the analysis of harmful interference, or reports of interference from in-house BPL that may assist in analysis of harmful interference. The simple answer is that

there are field tests which reveal substantial interference potential to the Amateur Service. There have been several field trials outside of the United States.[10] These studies include interference tests in field trial areas, measuring tens of dB of increase in ambient noise levels, across much of the HF spectrum. In Austria, video recordings were made of some of the field trials.[11] This video is compelling, demonstrating that widespread noise from BPL systems is probable. In the United States, there has been relatively little in-field testing. ARRL has not received significant encouragement from the utilities sponsoring the field tests in the United States, despite efforts to conduct cooperative studies. With respect to one test site in Maryland, after ARRL staff announced to the sponsoring entity their intention to visit the site to conduct some interference measurements at the test site, the site was, without notice, shut down "for maintenance" at the announced date and time of the tests. In any case, it is unclear that the United States test sites represent configurations of access BPL systems that could or would be deployed in the United States, and therefore it is unclear whether any interference testing at those sites would be relevant, much less conclusive. ARRL nevertheless hopes to conduct further interference tests at those sites in the near future, if any cooperation from the sponsoring utilities can be obtained.

21. The Notice asks whether existing Part 15 rules for low speed carrier current systems are adequate to protect authorized users of the spectrum who may be affected by the new high speed BPL technology, and what changes in those rules are necessary to protect authorized radio services. The attached technical studies and the foregoing argument demonstrate that (1) BPL at HF and low VHF is incompatible with incumbent

[10] See, http://www.arrl.org/tis/info/HTML/plc/#Amateur_Interference_Studies.

[11] See, , http://www.arrl.org/tis/info/HTML/plc/#Video.

Amateur operation, and (2) that the existing radiated emission levels permitted by Part 15 are too high, and would permit widespread interference to Amateur HF and VHF stations. BPL should not be permitted in or adjacent to any amateur allocation, and the rules should clarify that any changes in the Table of Allocations domestically which change the Amateur HF or VHF allocations will necessitate retroactive modification of both access and in-building BPL systems to exclude any amateur HF or VHF bands. ARRL does not believe that there are rules which would permit BPL systems to operate in or near Amateur allocations which both adequately protect Amateur Radio stations from interference at HF and VHF, and at the same time "avoid adversely impacting the development and deployment" of BPL. The two systems are fundamentally incompatible.

III. Immunity

22. As far as ARRL has been able to determine, none of the field trials of BPL systems has studied immunity of BPL systems from RF signals of authorized services. The Commission has concluded that LF PLC systems would suffer harmful interference from Amateur stations located 950 meters from a power line carrying PLC, on frequencies where coupling is not particularly efficient. The utility industry argued with respect to PLC interference from Amateur stations that PLCs below 490 kHz would suffer harmful interference from 1 watt EIRP amateur stations. The Commission used that as a premise in refraining from making an allocation for the Amateur Service near 136 kHz. Yet, the same industry, together with BPL manufacturers, is apparently contending now that at HF and VHF, where the power lines are better antennas than they are at LF, that BPL can co-exist with Amateur stations using more than 10,000 watts EIRP. Both arguments cannot be valid.

23. Typically, if an Amateur station is using 1500 watts and a 3-element parasitic Yagi antenna, the peak field strength 100 feet away in the main antenna lobe will be approximately 30 V/m on HF frequencies. Most industry standards for immunity of consumer grade electronics require that the equipment be immune to fields of approximately 3 V/m. It is unreasonable to expect that BPL equipment will be considerably in excess of that immunity level, given the efficiency of the power line as a receive antenna for signals in the same frequency range. The Amateur Service is most concerned about the BPL immunity issue, because, regardless of the regulatory considerations, consumers of unlicensed RF devices and services have no idea what the relative privileges and immunities of licensed, authorized radio operation are, and a licensed radio amateur will be vilified (or worse) for "causing" interference to internet access provided by BPL. The same utilities that are either unable or unwilling to rectify normal powerline interference problems suffered by radio amateurs cannot be relied on to properly address interference problems to BPL consumers triggered by interference susceptibility of BPL systems, and of which Amateur Radio transmissions are merely the catalyst.

IV. Conclusions

24. The concept of expanded PLC systems at HF and low-band VHF is flawed. There is currently a multitude, and probably sufficient array, of competitive broadband delivery mechanisms. But for the severe interference potential from, especially, access BPL to licensed Amateur Radio operation, it would be reasonable to add BPL as a competitive means of providing internet access through existing infrastructure. As it is, adding BPL as a broadband delivery system would be akin to reverting to soft coal as a

residential heating source. It would work, but at what cost? The Commission has stated as a fundamental principle that incumbent, licensed radio services, including the Amateur Service, must be protected from interference from any deployment of BPL. However, premised on the calculations and technical investigation of the interference potential from these devices, and based on the rather poor track record of utilities generally in dealing with large numbers of interference complaints to date, there is no reason to believe that (1) BPL can coexist with Amateur operation at HF or VHF, or (2) that when the inevitable interference is experienced, the interference problems could or would be rectified.

25. The Commission asks in this Notice of Inquiry, in essence, whether BPL systems should be regulated differently than other Part 15 devices which may operate in the HF bands. The answer is that yes, they must, in order to avoid interference to the sensitive incumbent licensed services in these bands. The present Part 15 regulations were designed to protect against interference from devices that would radiate or conduct signals on a localized basis. The devices for which the Rules were designed typically emit signals only on specific frequencies or bands. BPL systems will occupy all of the HF, low VHF and some MF bands. The relatively high emission limits that work for individual point-source radiators are inapplicable to BPL systems. BPL system radiated levels are complex and difficult to measure due to the length of the powerline acting as an antenna. The increase in noise levels in residential areas over current ambient levels is reasonably calculated to be as much as 65 dB, due to the efficiency of the powerlines as radiators. There is a fundamental incompatibility between BPL systems in residential areas and Amateur Radio stations. The Commission has found as a matter of fact that

separation of 950 meters between Amateur stations operating at 1 Watt EIRP using inefficient antennas would be required at LF, where power lines are relatively inefficient. At HF, where the lines are extremely efficient radiators, and where Amateur stations utilize extremely sensitive receivers, efficient, high-gain antennas, and EIRP levels approaching 10,000 watts, the Commission cannot find that the interaction between Amateur Radio and BPL would be *less* than at LF, where it refused to make an Amateur allocation.

26. The Commission has created a policy whereby it is willing to permit unlicensed devices and systems to occupy bands allocated to licensed radio services. However, it is unwilling, once those unlicensed and unprotected services become deployed on a widespread basis, to create allocations for new or additional licensed services, because interference may result to the unlicensed devices and systems. This is the case with PLC operation at LF. Yet, the HF allocations are dynamic, and change from time to time, either because of international allocations changes or because of domestic changes. At the present time, according to the Commission, the HF spectrum needs of government agencies are undefined. Allowing BPL to occupy the HF spectrum will, if the current Commission policy is applied consistently, preclude any later changes in the HF spectrum which are incompatible with BPL. This is an intolerable situation. ARRL is unwilling to have the Amateur Service gored with the double-edged sword of an incompatible service that will at once (1) cause widespread interference, and (2) preclude any future changes in the Amateur HF allocations.

27. BPL is, as mentioned above, a Pandora' Box of unprecedented proportions. Once deployed, the consumer's expectations will be such as to preclude termination of

the service, and interference problems, both to and from BPL, will inevitably be both widespread and impossible as a practical matter to rectify. The Amateur Service cannot be protected from interference from BPL, and BPL cannot be protected from interference from HF and VHF Amateur stations. The rules must insure that BPL is not permitted to operate in or near any Amateur Radio allocation, and if BPL is permitted at all, any changes in Amateur Radio allocations must immediately trigger retroactive modifications to BPL facilities to delete any use of Amateur frequencies. In addition, spurious emissions from BPL facilities must be substantially attenuated below current Part 15 spurious emission levels.

Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio, respectfully requests that the Commission take no steps to permit access or in-building BPL at HF or VHF at this time.

Respectfully submitted,

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