To The Commission:

Before I begin my comments, I want to first state my credentials. I have a BSEE degree and I also have a Professional Engineer's License. I have been designing, installing, and trouble shooting high reliability, fault tolerant, and safety related instrument and control systems for over 30 years. I am very familiar with EMI/RFI design requirements because of the nature of my chosen profession and feel that I am qualified to comment upon this matter.

I am also an amateur radio operator with the call sign N3TTE. While I do not presently have privileges below 50 Mhz, the issue of interference caused by BPL concerns me because I plan to upgrade my license class sometime in the future and plan to use the frequencies that BPL is expected to be most prevalent on.

According to the basic laws of electromagnetics, if an unshielded wire is energized with electrical energy, that wire will radiate a portion of that energy into space. And if this energy is to carry information, it must change state, that is, it must oscillate. Finally, to carry sufficient information to provide a useful service, it must oscillate at sufficiently high frequencies, that is, the information must be sent at the same frequencies used for radio communications. My conclusion from this little analysis is that any system used to send useful information over power lines will radiate energy, and this energy will be at radio frequencies (RF). So I find any claims being made by the electrical power industry that Broadband over Power Line (BPL) will not radiate to totally ignore the laws of physics.

I have read the comments made by the BPL proponents in paragraphs 20 thru 26 in the Notice of Proposed Rulemaking and find that these comments totally ignore the well known, proven laws of physics for electromagnetic phenomena. Following are my comments on specific paragraphs of the referenced Notice of Proposed Rulemaking.

Para. 20 – The statement that there "have been no complaints of interference from BPL" is disingenuous. First, the deployment of BPL has, to date, been very limited, under very controlled conditions, and sufficient time has not yet transpired for interference to be readily recognized. In Para. 15, it is noted that the Amateur Radio Relay League (ARRL) has submitted audio recording of BPL interference to the FCC, and this, for all intents constitutes a de facto complaint. Furthermore, the ARRL has disseminated these recordings via a web site in order that BPL can be more easily recognized and identified. Now that this information has been made public, complaints will be more forthcoming. In fact, as I am preparing this comment, I have become aware of significant interference at a BPL test site in Penn Yar, New York. And numerous complaints of interference from BPL is listed on the FCC website.

Para. 22 – The statement that "signals of power lines will tend to cancel each other out" is based on a highly idealized situation. The BPL design being proposed uses a differential current (or voltage) technique to transmit signals down a two phases of a three-phase power line. Under very ideal circumstances, such as in carefully controlled conditions in

a laboratory, these independent signals will be perfectly balanced and emissions will be minimal. However in a real world situation with losses to the environment due to weather conditions and equipment deterioration, the two lines will become unbalanced and significant emissions will result. In industrial situations with which I am familiar, balanced signals at much lower voltage levels are required to use shielded wires due to the high probability of interference and cross-talk. Furthermore, using a differential distribution system on a three phase power distribution system would require the use of three separate frequencies for each section, or cell. This is in direct conflict with statements by BPL proponents that only one or two frequencies will be used for each cell.

Para 22 – Next, by definition, a "waveguide" is a hollow structure used for propagation of energy at microwave frequencies[1]. Except for limited cases at generating stations, power lines are solid conductors, and BPL as it is being proposed uses frequencies far below microwaves. So using the term "waveguide" in relation to a BPL system is incorrect and is a misrepresentation.

Para. 23 – Saying that "BPL emissions will drop off very rapidly" is a very inexact statement. According to engineering textbooks[2], the field near an unshielded conductor varies as 1/r where r is the radial distance normal to the conductor. This relationship is derived for an infinite conductor and applies to the practical case where the distance from the conductor is small in relation to the length of the conductor, as would be the case with a power line. Additionally, in these same textbooks, the field for an infinite sheet of electrical charge is constant irrespective of distance. This case would be the limiting condition for a sufficiently large BPL installation. Consequently, I would expect that the emissions for a practical BPL installation would drop off at a rate less than 1/r, which I do not feel meets the term "very rapidly."

Para. 23 – The statement "a single power line is expected to be a rather inefficient radiator" is contradicted by footnote 3 of the NPRM, which describes campus radio stations and how transmission by power line is more than adequately received by broadcast band radios. I also want to note that random length wire antennas have been in use very effectively for quite some time and are equivalent electrically to a single power line energized with radio frequency energy for BPL.

Para. 24 – The statements in this paragraph may describe a laboratory or test installation, but they do not describe a practical installation.

> If a base frequency of 20 MHz is assumed, in order to achieve a reasonable signal to noise (S/N) ratio, the maximum effective bit rate will be $1/10^{th}$ of the carrier, or in this case, 2,000,000 bits / second[3]. If an installation of 100,000 users is assumed, and 10% of the connected users are accessing the system

[1] Pg. 25-1; Reference Data for Radio Engineers; Howard W. Sams & Co; 1975
[2] Pgs. 38 to 45; Engineering Electromagnetics; Hayt; McGraw-Hill; 1967 and Pgs. 698, 699; Physics Part II; Halliday, Resnick;John Wiley & Sons; 1968
[3] Southern expects a bit rate of between 200 and 500kbps. However they do not state the base or fundamental frequency this occurs at, nor do they explain the modulation method.

simultaneously, then the effective bit rate per user per frequency is 200, which about 0.005 or 0.5% of a typical dial up line (28,800 bits/sec or baud). This is not a very effective system.

If we decide to design a BPL system so that the performance is ONLY EQUIVALENT to a dial up line at 28,800 baud, then the maximum simultaneous users per frequency is 6. If there are two frequencies available per area, as described in Para. 24, and still assuming that 10% of the lines are in use at a time, then only 120 users can be considered to be an "area" as defined in Para. 24! So for an installation of 100,000 connections, a MINIMUM of 834 "areas" is required.

In addition, some means must be provided to distribute signals to the "areas" in a practical installation, and unless expensive additional infrastructure is installed, the only foreseeable way is to send signals across "areas" to their destinations using additional frequencies. So the implication in Para. 24 that only 2 frequencies will be in use for an installation is a misleading simplification. For a practical installation, many more frequencies will be required. And because the base frequencies must be modulated to carry information, each frequency in use will be accompanied by a set of harmonic frequencies. My conclusion is that an installation connecting sufficient users to be economically practical will contain far more than two frequencies.

Para. 25 – The statement that radiated emissions from multiple sources cannot combine, while mostly technically correct, is still a misrepresentation. Radiated emissions do not combine except under unusual circumstances, but still are present simultaneously. The most recognizable example of this is the radio broadcast band where all the frequencies from the various broadcast radio stations in an area are always present, but only the one a receiver happens to be tuned to is actually heard unless it is overpowered by a strong signal on an adjacent frequency. In the same way, all the BPL frequencies present in a given vicinity will be present at the same time.

Para. 26 – The operation of an Orthogonal Frequency Division Multiplexing (OFDM) system described in this paragraph does not address interference with receivers and only partially addresses interference with transceivers. First, from the description, it is apparent that a transceiver needs to first transmit for an OFDM system to recognize that it is creating interference and switch frequencies. However a receiver, by its very nature is not capable of transmitting and an OFDM system would continue to create interference for a receiver. As for the transceiver, the description in Para. 26 does not address how long the OFDM would wait before retrying a frequency that it had detected transmissions on. Too short a "wait period" would cause a resumption of interference if the transceiver was in the "receive" mode of operation. Ambient Corporation, however, is to be commended for recognizing that BPL can create interference and for attempting to mitigate it.

In addition, I also have comments on other paragraphs in the NPRM.

Para. 33 – It must be recognized that emission of RF energy by BPL systems will be an unavoidable result of the nature of electromagnetic energy as explained by the laws of physics and as a result, BPL system will not be "unintentional" radiators. In particular any BPL interference with broadcast short-wave frequencies could create a potential First Amendment issue because it could be reasonably argued that a BPL system constitutes a government endorsed jamming system.

Para. 33 – From a practical view, all that can be reasonably expected is that a given BPL system will be adjusted so that frequencies at which interference occurs will have minimum impact on all members of the public, and the interests of the public as a whole could be better served if a block of unused government frequencies be allocated for BPL use rather than allowing BPL use of the entire HF and lower VHF spectrum.

Para. 37 – Due to the potential for BPL to create interference that degrades emergency communications, public service agencies should have the authority to require all non-essential (to public safety) portions of a BPL system to be immediately disabled in a state of emergency.

Para. 45 – The requirement that BPL emissions be measured in parallel with the power line is a very realistic and good requirement. However, I believe that it is imperative that the FCC recognize that because a BPL system could create a highly distributed emitter of RF emissions instead of distinct point emitters, that any distance corrections be verified by actual testing before they are permitted to be applied to equipment qualification tests. I have performed a small sensitivity study on my PC in order to understand the impact of various parameters on the emissions from a power line using MathCad[4] software to create a "first principles[5]" simulation[6] of a power line segment being used for BPL transmission. This study made me aware that:

- The relationship of the overall length of the power line segment to the wavelength of the signal imposed upon it is critical to the emissions from the power line segment. Not only is the total length of the power line segment vs. the wavelength significant, but also whether it is an integral multiple of the wavelength is also significant.
- There can be a substantial "near-field" effect in which the field drops off very rapidly before it recovers and drops off at a far less rapid rate. In the near field, the power line segment can act as a rather inefficient antenna, but beyond near field phenomena it can act as a quite efficient antenna.

While this study was limited in scope, it served to demonstrate to me that using a power line for signal transmission is a special situation and that further, in-depth studies and experiments with actual large-scale installations, carried out by independent bodies are advisable before testing methods are established for equipment and system qualification. I would recommend that the FCC proceed slowly and cautiously in developing

[4] Mathsoft Corp. www.mathsoft.com
[5] Using relationships in Engineering Electromagnetics; Hayt; McGraw-Hill; 1967
[6] The study was of a variable length line segment in free space containing a standing wave of charge at a wavelength within the HF and lower VHF band with the field calculated radially from the center of the segment.

measurement guidelines and that large scale field measurement programs be conducted at the BPL test installations.

In summary, after reading the NPRM, researching the available information on BPL, and reviewing the basic principles of electromagnetics, I believe that there is a great potential for harmful emissions (e.g. RF pollution) from BPL systems. Based on the overall poor performance of electrical utilities in keeping their transmission and distribution system in good repair, I do not believe that electrical utilities will be able to adequately undertake the added responsibility for BPL systems. I therefore recommend that BPL systems be required to expeditiously address and rectify all complaints about harmful emissions and that they be required to file periodic reports with the FCC concerning each and every complaint, if it was resolved, and if resolved, how long resolution took. I further recommend that BPL systems be periodically inspected by an independent entity for conformance to regulatory requirements, including auditing and verifying their complaint logs. And I also recommend that there be substantial regulatory penalties for BPL system that do not meet regulatory requirements, including requiring a consistently non-conforming BPL system to be completely shut down and taken off line.

If BPL systems are as interference free and problem free as their proponents advocate, then these proponents should not have any difficulty accepting conditions such as these for installing their systems.

In closing I wish to divert from the technical issues surrounding BPL and speak about amateur radio. The amateur radio frequencies and the amateur radio operators in this country are a national resource. In reading the comments and replies by the BPL proponents, noticeably Current Technologies, there is a very noticeable belittling of the skills and the intentions of the amateur radio operators who provided comments on this issue. While these "hams" were not as polished in their writing as the highly paid wordsmiths who work on behalf of the BPL proponents, every one of them was writing from a sense of support for and love of this country.

In an emergency, such as hurricanes, wild fires, and tornados, amateur radio operators selflessly volunteer their equipment and expertise to support our citizens and our governments at all levels. They coordinate efforts of the primary providers, such as firemen and EMT's, they assist with searching for and requesting aid for the injured, they bring family members back together. Their efforts save lives and protect people and property. In fact, the term "amateur" is a misnomer as we actively prepare for and train for emergencies. Amateur radio operators are "am ateurs" only in the sense that we are unpaid volunteers, not that we are unskilled or unprepared.

I live in Pittsburgh, near where Flight 93 crashed. On the afternoon of Sept. 11, 2001, I checked into an emergency net as I was driving home from work. At home I ensured my radio equipment was charged and ready, then I packed some clothes as I monitored the local emergency frequency awaiting a call for volunteers. Fortunately there were no further tragedies on that date. However numerous amateur radio operators traveled from across the country and volunteered their time to assist in locating the bodies of the

victims of Sept 11th at the former World Trade Center site. Since Sept 11th, I have purchased additional equipment and supplies, and greatly expanded my emergency kit to increase my personal level of preparedness.

The threat to our lives and our country from terrorists is very real. If and when a repeat of Sept. 11th comes, every citizen and every resource will be needed. As a country we cannot and should not squander the resource of amateur radio; a resource which has consistently come through in emergencies to save lives and protect our people.

Respectfully submitted,

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