Federal Communications Commission
Washington, D.C. 20554

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

1. The following comments are those of myself, Roger V. Thompson, an Extra Class amateur radio operator (AD5T), licensed Professional Engineer[1] and retired wireless research manager having over 34 years experience in radio as a profession and a hobby. I am also the owner of a telephone company[2] that provides DSL broadband services in a rural area of Mississippi and operator of an Internet Service Provider[3]. Because of my background in professional wireless research, amateur radio and provision of rural broadband Internet services, I have a unique perspective on the issues considered in this proposal. Thank you for the opportunity to comment on this important matter.

2. The Commission's proposals to hold Access BPL to higher standards than normal Part 15 devices are appropriate. The Commission's proposals in this NPRM, however, fail to properly consider the cumulative effects of multiple emitters that will exist with Access BPL deployments, harmonic and intermodulation distortion interference, skywave propagation and resultant noise floor increases, the unintended consequences of bypassing power system

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transformers, the impacts of high frequency energy on existing ac-powered devices, and the impacts of BPL interference to mobile high frequency stations. Additionally, the proposed rules are inadequate in fully defining what harmful interference is in the Access BPL environment and in defining proper test procedures. My comments on these issues and answers to questions posed in the NPRM follow:

3. NPRM Paragraph 30 In Paragraph 30, the Commission addresses a claimed advantage in that BPL might bring broadband to rural and remote areas and states in the footnote, "In this regard, we observe that, according to the June 30, 2003 data reported to the Commission, there were no subscribers to high-speed connections to the Internet in 9 percent of Zip Codes, where about 1 percent of the U.S. population resides." I'm concerned that the Commission would take the data from Report 477, which clearly does not ask for broadband installations of less than 250 high speed lines and incorrectly assume areas for which they have not asked for data are devoid of broadband services. There are many providers of unreported broadband services in rural areas that have less than 250 high speed lines in service, including my own company. Public policy should not be developed without adequate information.

4. The Commission uses international development of Access BPL as an introduction to a statement supporting development and deployment in the United States. Fairness would suggest an equal weight be given to the rejection of BPL in other international venues due to demonstrated serious high frequency interference.

5. NPRM Paragraph 32 A proposed definition of Access BPL is given in Paragraph 32 as "Access Broadband over power line (Access BPL): A carrier current system that transmits radio frequency energy by conduction over electric power lines owned, operated, or controlled by an

electric service provider. The electric power lines may be aerial (overhead) or underground." The Commission requests comments on this proposed definition. This definition obscures the fact that significant radiation from the power lines will also occur, so I suggest dropping the words "by conduction" from this proposed definition.

6. NPRM Paragraph 36 Comments on proposed measurement guidelines for Access BPL are requested in Paragraph 36 after a listing of the Commission's beliefs about Access BPL. These beliefs seem to be central supports for the Commission's position on BPL, however, some of these beliefs point to misunderstandings about the physics of high frequency radio. The Commission believes that Access BPL is not a traditional point source emitter of RF energy, which is certainly true, and that the BPL devices will be the primary emitters of energy with a lesser radiation from the immediately adjacent power line. This belief, along with statements from BPL proponents, is the basis for disagreement with suggestions that there will be a cumulative effect from BPL. There appears to be a misunderstanding about what cumulative effects are and where they might occur. Let's consider some well known facts.

7. It is a fact that BPL operates by the coupling of high frequency radio energy to long power line wires that are, in most cases, suspended above ground. It is a fact that wires fed with radio frequency energy are antennas. It is a fact that the radiation efficiency or gain of an antenna increases with length. It is a fact that power lines are long in terms of high frequency wavelength, so they will be efficient high frequency antennas. It is a fact that high frequency radio energy emitted from antennas can be propagated over long distances by interactions with the ionosphere. It is a fact that the propagation of high frequency radio waves over long distances is enhanced in periods of high sunspot activity and that we are near the minimum of the 11-year solar sunspot cycle at this time. It is a fact that the intensity of the fields radiated from

an antenna decrease in amplitude with distance from the antenna and that local variations in intensity are related to the size and placement of the antenna, giving rise to the reality of antenna radiation patterns. It is a fact that antenna patterns are well known and predicable in uncluttered environments. It is a fact that the pattern of a practical antenna is impacted by the antenna's physical characteristics and by objects nearby in terms of wavelength, including the earth's surface. It is a fact that the radiation characteristics of antennas and the propagation of radio energy are not functions of the amplitude of radio energy at practical levels of power. It is a fact that multiple radiated sources of radio energy combine to a composite signal at a receiver. So, what do these facts have to do with this NPRM about BPL?

8. If the coupling devices are the primary emitters of radio energy in comparison to the wires they feed, then the coupling devices would have to be more efficient antennas than the wire. This is very unlikely due to the relatively small physical size of the devices in comparison to the wavelengths of energy used. For an unbiased party to conclude otherwise suggests inadequate measurement techniques, limits in measuring equipment, or extremely poor shielding of the coupling devices.

9. Power line wires used for BPL will radiate and the energy radiated does not disappear. The energy will be radiated in a pattern directly caused by the height of the power line, the frequency used, and surrounding objects, including the earth's surface.

10. The proponents of BPL mentioned in Paragraph 36 assert that their implementations assure no accumulation of interference as their devices do no use the same frequency at the same time in a geographic area. Even if this were true today, the Commission has not chosen to restrict the design of BPL systems to assure this claimed characteristic continues into the future, so it is

meaningless. I also question how this non-use of frequencies can continue in a large deployed system operating at high data rates, particularly those described as using spread spectrum or multiple carrier techniques – descriptions the Commission uses in promoting BPL elsewhere in this NPRM.

11. The idea that low level emissions of high frequency energy somehow do not combine into an aggregate effect is clearly wrong. Sophisticated equipment and measurement campaigns are not needed to prove this. This aggregation is rather easily verified by moving a receiver through areas of varying urbanization and noting the change in noise floor with urbanization. Noise levels drop significantly in rural areas, of course. Presumably, the high frequency radiations from all the radiating devices are in individual compliance with the Commission's Part 15 rules on radiated emission. To the extent these devices deteriorate reception of authorized services, however, they are harmful interference but it is impossible to identify any but a few of the individual contributors to the aggregate interference.

12. Today, almost all of these devices are in homes or businesses and are isolated from the power lines by unbypassed transformers. Adding more radiators connected to large power line antennas and bypassing transformers will increase the level of interference wherever the BPL systems are deployed, and will have a much greater effect than the same number of individual "point source" emissions. In addition, as the number of BPL installations increases, the aggregate emissions of high frequency energy will be propagated by "reflections" from the ionosphere and will combine incoherently at distant receivers. This will have the effect of increasing a distant receiver's noise floor[4]. This effect will become more apparent at times of

[4] As examples of propagation of Part 15 level signals, I chose the frequency for my experiments on mobile interference described later by measuring noise levels in the 13.553 to 13.567 MHz ISM band. The noise floor is about 10 dB higher at the center of this spectrum

higher solar activity[5]. Just as the emissions from one vehicle are small relative to the smog that poisons the air of some cities, so will the emissions from individual BPL radiators join with others to create "radio smog."

13. Comments about the proposed measurement techniques given in Appendix C of the NPRM are solicited also Paragraph 36, but also in Paragraphs 45 and 46. My comments regarding measurements are associated with these later paragraphs.

14. NPRM Paragraph 37 The discussion in Paragraph 37 about hypothetical interference to public safety only impacting low-band VHF channels does not recognize the potential for harmonic and intermodulation distortion products of the BPL fundamental frequencies. Given the proposed wide range of frequencies permitted to BPL and the non-linear nature of the power line environment, generation of these products is almost guaranteed and could impact a far wider range of public safety frequencies than low-band VHF.

15. NPRM Paragraph 38 Comments about possible operation of BPL in the AM broadcast band are solicited in this paragraph. Since there is no prohibition on operation in this band in the proposed rules, the Commission must assume such operation may occur regardless of current plans by proponents of BPL. An alternative is to prohibit use of this band for BPL.

16. NPRM Paragraph 42 The Commission proposes in this paragraph that BPL have the technical capability to cease operation when harmful interference occurs. The rules, as proposed,

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than at the edges, showing the cumulative effect of distant sources, even at this time of poor propagation. My test system, operating at the higher Part 15 levels in this spectrum, has been received on both coasts of the United States.

[5] Ignoring solar effects has had disastrous impacts in the past. For example, the Skylab satellite was lost in 1979 due to failure to consider the increase in atmospheric pressure during the solar cycle. Another example was the choice of 27 MHz for local communications in the Citizens Band, a frequency uniquely suited to long distance propagation during solar peaks. "Skip" propagation often makes CB unusable for local communications.

are appropriate in that they state "to avoid site-specific, localized use of the same spectrum by licensed services." This, however, has almost no impact on mobile stations. Existing systems should be brought into compliance with these requirements as soon as equipment from any credible vendor is available and can be installed.

17. NPRM Paragraph 43 A publicly available database is essential to determine the source of BPL interference. Despite the discussion in this paragraph, the proposed rules do not require public access and should be changed to clearly show the public nature of the database. To maximize access and minimize the costs to the public, access should be provided from a single Internet Web site. The coordination of multiple databases and their linking within the BPL industry to form this single effective point of access is an implementation detail. Costs of this database should be paid by the BPL industry. Some means of identifying BPL transmissions from the transmitted signal should also be implemented.

18. NPRM Paragraph 44 The Commission proposes an equipment authorization process based on previous experience with low speed in-building carrier current systems. The Access BPL environment, one where the isolation of power transformers disappears, may cause this previous experience to be invalid.

19. NPRM Paragraph 45 Measurement guidelines are discussed in Paragraph 45 and specified in Appendix C. These guidelines recognize that power lines will act as antennas and propose measurements in terms of midband wavelength of the BPL transmitters, but the techniques proposed will not find BPL's maximum emissions. One major issue with the proposed techniques is that radiation from the power lines will almost always not be at a maximum either at ground level or horizontally from the power line, but will peak at some elevation angle that

depends, in part, on the frequency and the height of the radiator just as does the pattern for any high frequency antenna. Measurement in-situ is appropriate. There will be radiation from buried power lines[6], not just from the transformers, especially as the frequency of operation is in the lower high frequency region, where the depth of the buried line is a small fraction of the operating wavelength. At lower frequencies, there is actually little difference in the effectiveness of a buried antenna and one suspended a few feet above ground. Measurements on buried lines should proceed in the same manner as for aerial ones.

20. Proposed Part 15.109 (e) requires in-building wiring be included in testing of all BPL systems, however the proposed test procedures in Appendix C Section 2 do not clearly include in-building components in the description of the Equipment Under Test (EUT). This omission should be corrected.

21. NPRM Paragraph 46 As in the discussion for Paragraph 45 above, the radiation pattern for BPL power line antennas will almost always not be at a peak at or near ground level. The proposed slant range correction is inadequate as the peak of radiation can be at almost any elevation and azimuth from the antenna and will vary with frequency. As the patterns change dramatically with frequency, the proposal to measure mostly at only the mid-band frequency of operation is clearly inadequate. Measurements should be made across all frequencies of operation in reasonably steps and frequency sensitive correction applied using available software[7] that predicts the actual radiation pattern of the power line antenna. The statement that

[6] A technique used in locating buried power lines is to scan for peaks of noise with a handheld receiver. Tuning to higher frequencies allows for more precise location.
[7] One example is EZNEC pro 3.0, described at www.eznec.com. There are other versions of software that can accurately predict antenna patterns in the presence of actual ground.

field strength will be reduced by ground effects appears to show a lack of understanding about how high frequency antennas interact with the physical environment in which they operate.

22. NPRM Paragraph 47 The proposed measurement guidelines for In-House BPL do not appear to clearly encompass the situation where the In-House system is installed in a home or business that is associated with Access BPL, where the power transformer is bypassed for high frequency radiation. This situation should be tested to assure radiation from the In-House system does not pass through the transformer bypass and cause harmful interference by radiating from the power lines external to the building in which it operates.

23. NPRM Paragraph 48 Comments are invited in this paragraph on the Commission's conclusions and all other aspects of the NPRM's proposals about BPL. I've chosen to add some comments above, following the sequence of the document where possible.

The following comments concern other important issues not covered in the NPRM.

24. Impact on Mobile Amateur Radio Operations There is no mention in the NPRM specifically concerning protection of mobile amateur radio stations, which will be very close to power lines as the operators drive down streets or roadways where Access BPL has been deployed.

25. To better understand the impacts of Access BPL on mobile operations, I constructed a test system operating at 13.553540 MHz using a slowly keyed CW carrier and assessed the signal strength over distance with my typical amateur radio mobile station. The signal level was set to the Part 15 limit for general high frequency operation, not the much higher level allowed at the frequency I was using. A significant signal level was heard at a level that would have made

communications impossible out to a distance of 363 meters. A detectable signal, which would have interfered with desired signals of the same level or less, was heard at 415 meters. With the mobile station's engine stopped, a signal could still be heard at 491 meters.

26. My conclusions are that Access BPL should completely avoid frequencies available to licensed amateur radio mobile stations as the level of interference will be very high and the transitory nature of mobile operations makes the procedures that might protect fixed stations impossible.

27. Security There will be almost no protection from unauthorized interception of Access BPL signals.

28. Impact of Transformer Bypassing In the Notice of Inquiry for BPL, the Commission questioned the impact of eliminating the low pass filter characteristics of low-voltage distribution transformers[8]. No discussion of this issue was included in the NPRM, so I will repeat my comments:

29. "As transformers are bypassed for high frequencies, the isolation that exists today will disappear, exposing BPL data customers and non-subscribers alike to noise and signals from other homes or businesses, broadcast radio sources, radiating electrical equipment, arc welders, computer radiation, and other noises carried on the power line. Sources of interference that were reduced in amplitude by the transformer isolation at high frequencies will become more apparent. This increase in interference and noise will impact innocent bystanders on the same transformer who have no interest in using broadband power line data services. Exposing the

[8] Paragraph 20 of the NOI, ET Docket No. 03-104

uncontrolled home and business environment to the power distribution grid at high frequencies also increases the possibility of significant non-linear effects that can cause mixing of the desired data signal frequencies and generation of harmonic and non-harmonic products that can cause unexpected effects at frequencies outside the transmitted bandwidth. Systems deployed for years to implement control and alarm purposes in homes that depend on transformer isolation will be exposed to the possibility of false operation and there may be more damage from the higher frequency components of lightning strokes that would have been reduced by the unmodified transformers.

30. Obviously, same-transformer users of the same spectrum as used by Access BPL inside the house will be adversely impacted even if they are not users of BPL services. This impact will also exist for high frequency services like standard time stations (WWV and CHU in North America) and short wave broadcast listeners. Additionally, even if the local transformer is not bypassed, Access BPL signals on the medium voltage side of the transformer will very likely cause similar impacts. The interference footprint of Access BPL will be much larger than the locations of served customers."

31. Defining Harmful Interference It should be clear and established in the Commission's rules that harmful interference definition is not to be redone or modified by the interfering parties who have clear motivation to avoid responsibility and to minimize impacts on their customers. Defining harmful interference is the licensee's right and responsibility and correcting it is the responsibility of the BPL provider.

32. Other Alternatives The Commission does not seem to have considered viable alternatives that do not so negatively impact high frequency reception. One such example is the system proposed by Corridor Systems[9].

33. Impacts on Existing Equipment To a reasonable approximation, all existing equipment that uses alternating current from power companies was developed under the assumption that only low frequencies would appear at the power connection. The impacts of high frequency energy appearing at power supplies are largely unknown, and there may be as yet undiscovered negative impacts as a result of BPL implementation.

34. Mitigation of Interference There should be no place for the concept of mitigation of interference to take hold as a substitute for elimination of interference to licensed stations. In no case should BPL providers be allowed to take the position that they have done the best they can and any residual interference, despite the level of harm, must be tolerated by the licensee. The word "mitigation" should be replaced with "elimination" in the proposed Part 15.109 (f).

35. Conclusion The Commission has proposed added restrictions on Access BPL correctly as it is a significant threat to licensed users of high frequency and low VHF spectrum. The Commission has, however, not properly considered a number of technical issues that are a matter of record in this proceeding.

/s/
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