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

In the Matter of	)	
	)	
Inquiry Regarding Carrier Current Systems,	)	ET Docket No. 03-104
including Broadband over Power Line Systems	)	
	)	
	)	

Comments of James P. Lux, P.E.

1. I am a registered Professional Engineer in the State of California, and am the principal of Innovation Consulting and Design, a consulting firm. Over the past 25 years, I have worked with a variety of radio frequency signaling systems, including broadband radio frequency (RF) spread spectrum systems, and with manufacturers wishing to incorporate radio frequency capabilities in their systems. I have also designed and been involved in the manufacture of high-speed digital systems, most of which are subject to regulation as unintended emitters under Part 15 of the commission's rules. As a result I am quite familiar with the existing regulatory system as it pertains to unlicensed radiators.

2. The Commission seeks comments on whether the existing Part 15 type regulation is appropriate for application to Broadband over Power Line (BPL) systems and components, and if so, what modifications may be necessary. Further, the Commission seeks input on whether additional limitations or requirements may be appropriate for BPL applications, particularly in view of their potentially wide distribution.

3. My comments are primarily directed to Access BPL, that is, broadband data services carried by the electrical power distribution network. The in-home BPL is likely to be of very low power and presents fewer potential problems from interference, and does not present some of the more complex problems I outline below.

4. The Commission asks whether Access BPL, particularly that carried over medium voltage lines, should be considered as Class A (commercial) or Class B (residential) environments for the purposes of Part 15. The Commission asks about probable interference environments and propagation patterns of Access BPL, including any specific issues of interference that should be addressed. The Commission also asks for comments regarding models for predicting radiated emissions.

5. These questions, expressed by the Commission, all point to a general concern of insuring that interference from BPL systems will not adversely affect existing users of the radio spectrum. The Commission must weigh the value of added competition from a new means of providing broadband digital access with the value provided by existing users of the spectrum. It is unclear whether Access BPL can actually provide a credible competition to such other means as Digital Subscriber Line, Wireless services, and Cable

Modems. The comments of W.Lee McVey (24 June 2003) address this issue at some length, particularly with the concerns about the ever increasing trend to underground power distribution lines, which are not suitable for Access BPL.

6. With respect to interference from unintended radiators, the current rules, including Part 15, apply a two-pronged approach for reducing or eliminating interference. The first prong is the manufacturer compliance with the radiated and conducted interference and susceptibility requirements. The second prong is that the user of the equipment is responsible for terminating use if it is found to interfere with another licensed service. Merely complying with the Part 15 emission requirements is not, in itself, sufficient to prevent interference. Many have commented in previous rulemakings and inquiries that if the Part 15 limits were set low enough to guarantee no interference under all conditions, no electronic equipment could be manufactured that would meet them, hence the second prong.

7. My comments fall in the following areas:

I Appropriateness of existing Part 15 requirements for Access BPL
II Modeling approaches cannot provide a useful tool
III Difficulty in identifying the responsible party to identify and correct interference
IV Difficulty in identifying the source, or even the existence of interference
V Unintended side effects of widespread Access BPL deployment.
VI Concluding remarks

I - Appropriateness of Part 15 style testing and regulation

8. The Part 15 regulations essentially embody an approach of requiring practical tests in the context of a simple Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) model. The fundamental model is that of a "box" connected with one or more cables to the outside world. The measurements are made at a sufficient distance that the "box" can be considered a point source and simple inverse square law scaling applied. The thrust on the conducted emissions is to insure that sufficient filtering be provided so that emissions remain "inside the box", and testing is done in a standardized environment (i.e. using Line Impedance Stabilization Networks (LISN)) to ensure that interference is unlikely.

9. In the case of intentional radiators under Part 15, they are generally very low power devices (cordless telephones, garage door openers, etc), where the emissions would be undetectable a short distance (i.e. the size of a home) away. There are explicit restrictions on physical antenna size and regulations designed to make it difficult for an end user to connect a larger antenna, thereby limiting the effective radiated power. Further, the devices are of small size, with short wavelengths, so the "point source" approximation is reasonably valid.

10. Part 15 style regulation is probably appropriate for in-home BPL, particularly if a spectral mask is applied to protect sensitive bands, as for radio astronomy. The commission is faced with a weighing of relative value of the various existing users when constructing the spectral mask, however, the generally low power of in-home BPL provides the saving grace of distance attenuating the signals below the existing background.

11. However, for Access BPL, where power is likely to be much higher, and more important, the signals are carried over unshielded wires suspended high over the ground. This is quite different from the usual Part 15 device where the connecting cables are actually filtered to eliminate any conducted RF. The long length and large physical size of the cables, relative to the possible victim receiver, make the "point source" or "box" model inappropriate.

II - Modeling approaches cannot provide a useful tool

12. The Commission has recognized that the simple model is inappropriate for Access BPL, and solicits comments on the state of the art for modeling of such systems. The state of the art for numerical modeling of electromagnetic phenomena is very advanced, assuming that sufficient computational resources are available to calculate the model. However, all models require an accurate representation or description of the system being modeled for the model results to be valid.

13. An Access BPL device will put significant power into an amazing variety of physical configurations, ranging from short low voltage feeders from pole to house to transmission lines spanning hundreds of kilometers. The components used and installation configuration of the existing overhead distribution plant is very diverse. The existing power distribution network is not documented sufficiently well with respect to the Radio Frequency characteristics. Electrical description and system configuration record keeping that is perfectly adequate for the distribution of 60Hz power is not sufficient for an accurate numerical model.

14. The physical plant is, in many cases, decades old, serving perfectly well at its designed function of power distribution. However, changes that may be insignificant for power distribution, such as insulation aging or degradation, high resistance contacts with metallic members (pole insulators), and so forth, can have very large effects for radio frequency signals.

15. The cost of creating an "RF-accurate" model of the power distribution system is likely to be prohibitive, and maintaining such a model database would also be a Herculean task. Validating a model, assuming it could be built and maintained, is also a non-trivial task.

III - Identification of responsible party for interference remediation

16. An aspect of Access BPL that is not well addressed by the current regulatory structure for unintentional radiators, including Part 15, is the assignment of responsibility for rectifying interference.

17. Certainly, the manufacturer of Access BPL equipment would have no problem complying with some set of radiated and conducted emissions, although, in this case, the whole purpose of the equipment is to conduct some RF signal to the power line. However, regulatory compliance with various regulations and regulating agencies is a standard manufacturing issue, and presents no real difficulty, assuming that the requirements, particularly for testing, are written appropriately.

18. It is unclear who the "responsible user" would be in the case of interference from Access BPL equipment. The consumer broadband services industry has many tiers and interlocking agreements, the arrangement of which is virtually impenetrable to the average consumer with a possible interference problem. Who would be responsible for responding to the inquiry? Who would be responsible for investigating the source of the interference? Finally, if there were an interference problem resulting from the interaction of several disparate pieces of equipment, owned by separate entities, who is responsible for fixing it?

19. A typical scenario for Access BPL may have the following involved:

- The original manufacturer(s) of the equipment
- The power line owner
- The utility that operates the power line
- The internet service provider (ISP) that is using the Access BPL system to provide data services
- The service company that installs and maintains the Access BPL equipment

Some of these entities are highly regulated, some partially regulated, and some totally unregulated. This may provide economic incentives to "point the finger" in ways that will not lead to rapid resolution of interference problems.

20. With existing power line interference cases, it is fairly straightforward to find out who actually owns the equipment that has the problem and to find an appropriate contact. Historically, the owner has been a regulated public utility, and has no real economic incentive to avoid fixing the problem, especially as power line interference is often an early warning sign of incipient equipment failure. The increasing trend to deregulation of electric power utilities is a worrying one, and the recent spate of warning letters from the commission to electric power utilities regarding power line interference is troubling. In the past, such complaints and problems were dealt with quietly and expeditiously, without any need to seek the commission's assistance.

IV - Location of source of interference

21. Existing regulations and rules presume that the source of interference can be located to a single point, so that remedial measures can be taken. Unintended radio frequency emissions from an Access BPL system will present a diffuse source that is difficult to localize.

22. The modulation schemes for Access BPL are likely to be complex and broadband, so as to accommodate the varying and disparate propagation through the power distribution system. Signals using these broadband modulations are difficult to detect and isolate, as they resemble noise, and the investigator is faced with distinguishing one noise-like signal (the potential interference) from many other environmental sources of noise-like signals. Anthony Good, in his comment for this proceeding of 14 May 2003, makes a particularly apt comparison to "Campus Radio" power line AM broadcasts, in that these broadcasts, should they cause interference, are narrow band, and easily distinguished.

23. Access BPL traffic is likely to be uncertain and bursty, and not under the direct control of the operators or users. This will make direction finding and interference resolution more difficult, as the interfering signal will appear intermittently and inconsistently.

24. Wide deployment of Access BPL will essentially create a large diffuse area source for interfering signals. Even if one is able to distinguish an interfering Access BPL signal from others, it may be confused with other Access BPL signals which are not resulting in interference.

25. If an equipment fault or interaction results in interfering signals being placed on the electric power distribution line, the long length of these lines will make it difficult to identify the source of the problem, as the interfering signal will propagate down the wire, radiating essentially continuously. In the past, interference from power lines has been located by using direction finding at higher frequencies to locate a point source.

V - Unintended side effects

Skywave Propagation

26. The frequencies that would be used by Access BPL can propagate via skywave, giving the signals potentially intercontinental reach. The older powerline carrier systems used frequencies below 2 MHz, which do not have much skywave propagation due to absorption by the lower ionosphere layers. A narrow band signal with a radiated powers as small as one watt can be detected essentially world wide, depending on the state of the ionosphere and the frequency being propagated. There may be international treaty aspects to unlicensed radiation, even that which is unintended. The comment already filed by the North American Shortwave Association on 30 June 2003 addresses this issue in quite some detail.

Spurious signal generation

27. In any system where there is significant power at multiple frequencies, there is a risk of additional signals being generated by interactions. Such signals, referred to as intermodulation interference, are encountered where there is a semiconductive junction or other nonlinear component in the circuit. A common unintended non-linear component is a corroded mounting bolt or two dissimilar metals in contact forming a semiconductor junction, as between a current carrying conductor and the bolt attaching the line to a insulating support structure. The physical plant for power distribution is of widely varying age and condition, and there is no doubt that there are many such corroded connections, which have no deleterious effect on the primary function, carrying electrical power.

VI - Concluding remarks

28. The Commission has started the process of examining a new alternative for providing low cost broadband access to a larger user population. Some existing field trials, in very carefully controlled situations, have provided promising results for small numbers of users.

29. However, as we contemplate large scale deployment of such technologies, there may be problems of scale: more diversity of installed equipment base leading to wider variability in performance; more independent and interlocking entities with varying business relationships where short term financial optimization may not provide the "greatest good to the greatest number". There are also great uncertainties in procedural methods to measure and detect interference, and to resolve problems.

30. I think that some of these issues need further research and field testing before a wide scale commercial deployment is appropriate, particularly with respect to methods of measurement and interference resolution.

Sincerely,

/s/

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7 July 2003