Before the
Federal Communications Commission
Washington, D.C.

In the Matter of	)	ET Docket 03-104
Inquiry Regarding Carrier Current Systems	)	
Including Broadband over Power Line Systems	)	

Comments By James W. Brown

My Qualifications

I received my First Class Radiotelephone and Amateur Extra Class licenses in 1959, and began working in broadcasting in that year. I am an electrical engineer (BSEE, University of Cincinnati, 1964) and have worked for more than forty years in radio communications, broadcasting, and professional audio. My consulting practice specializes in the design of sound reinforcement systems for public places -- theaters, churches, stadiums, and arenas -- and in the electromagnetic compatibility of audio equipment. I am vice-chair of the Working Group on Electromagnetic Compatibility of the Standards Committee of the Audio Engineering Society (although this filing does not in any way represent the views of the AES, that Committee, or my position as vice-chair).

Introduction

Statements by the Commissioners appended to this Notice Of Inquiry convey their impression of the proposed Broadband Over Power Lines (BPL) technology almost as if Alice had entered an electronic wonderland of high speed communications and data without wires and without a price. As a working engineer designing practical systems, I see that price in the form of significant increases in electromagnetic noise as a result of BPL systems, not only in communities where they are deployed, but, through skywave and ground wave propagation, to areas tens and hundreds of miles away. As both a businessman and an engineer, I learned many years ago that there is no such thing as a free lunch.

I thus see two principal questions that must be addressed. First, can the system be implemented at all without causing very significant levels of interference to licensed users of the high frequency spectrum? In other words, is this system even practical on a large scale (as opposed to a demonstration home or residential sub-division)? And second, if such a system is practical, how can Part 15 be revised to authorize a workable BPL system while preventing harmful interference?

The Big Picture

The principal technical issues limiting practicality are:

1) A BPL device is a low power generator of electromagnetic energy that is coupled to mains power lines. The power lines in many commercial and residential buildings are

unshielded and above ground, so they will radiate, at least to some extent, the radio frequency signals they carry. Likewise, above ground wiring delivering power to homes and businesses will also radiate radio frequency signals. A single low power device conforming to Part 15 Class B may not produce sufficient field strength to interfere with communications. One thousand of them in a relatively small area would, however, produce one thousand times the noise power (30 dB greater); one hundred thousand of them would produce 50 dB greater noise than one alone.

2) Radio frequency energy in the mid frequency spectrum (300 kHz – 3 MHz) travel tens and hundreds of miles via ground wave, and energy in both the mid- and the high-frequency spectrum (3-30 MHz) travels hundreds and thousands of miles via skywave. Large, widely-spaced electrical transmission lines used for the distribution of power to communities will act as relatively efficient antennas for much of the mid- and high-frequency spectrum. Thus the mid and high-frequency energy from half a million users within a given community (e.g., Chicago, IL) will carry throughout metropolitan Chicago via ground wave, and over a multi-state region via skywave.

Those 500,000 users are producing 57 dB more energy than one of them. But that's only part of the story -- not only does a user of the radio spectrum in Iowa hear those 500,000 BPL users from metropolitan Chicago, but also another million or so from Milwaukee, St. Louis, Kansas City, Des Moines, Minneapolis, Omaha, and points in between, so now we're up to 61.7 dB more than the strength of a single user. The same simple math, scaled up by a factor of 4 or so (another 6 dB) produces even more interference when applied to the even greater population densities around the northeast quadrant of the United States and Canada. The American Radio Relay League has shown that the combined radiation from these multiple transmitters could destroy the effectiveness of all but the highest power communications systems.

3) The Power Systems Relaying Committee of the IEEE (Institute of Electical and Electronic Engineers) has noted that transformers used in existing power distribution systems provide significant reduction in mid- and high-frequency power line noise by virtue of their limited bandwidth. BPL requires a good path for mid- and high-frequency energy across such transformers in the form of bridges or couplers. There are two forms of couplers and bridges -- active and passive. The IEEE committee correctly observes that passive couplers will subvert the filtering (that is, make the noise worse). The design of active couplers/bridges represents a significant challenge, especially if they are not to couple power line noise across the transformer. It should also be noted that some of this "noise" that is being filtered by these transformers are the strong transients popularly known as "surges" that can cause major and minor equipment failures.

4) I am particularly puzzled by the hope expressed in the NOI that BPL could be used to "bring Internet and broadband access to rural and underserved areas." Since homes in rural areas are many miles apart, the inherent high frequency attenuation of power lines is almost certain to demand even higher signal levels to overcome the loss. Again, the result is likely to be interference to licensed communications.

Part 15

Part 15 is nearly two decades behind technology. It should be revised to address the above issues in a manner that effectively prevents interference to licensed communications. At a minimum, I propose the following:

5) The field strength limitations must reflect the potential for the entire BPL system (and combinations of BPL systems and other systems) to cause interference to radio communications. While it must continue to apply to individual devices, it must also address any effects reasonably to be expected from the combination of that device with other devices.

6) The NOI requests guidance as to whether medium voltage power transmission systems should be treated as Class A or Class B devices. The answer is simple conceptually -- the limits should be made sufficient to prevent interference to licensed communications, including, but not limited to, reception of broadcasting in automobiles, residences, and businesses, and to the operation of commercial, public safety, and amateur radio communications. When these power lines are in close proximity to highways and residences, a Class B limit is clearly in order.

7) More to the point, Part 15 should require testing of the incidental radiator connected to its "incidental antenna" for compliance with a receiver at a sufficient distance from incidental radiators that the scale and efficiency of the incidental antenna system are accurately reflected in the measurement. It is well known that a simple measurement made in the near field of a radiator does not accurately reflect field strength in the far field. For example, if the incidental radiator is a long power line, measurements made very close to the line might show compliance with current Rules, while measurements made at a greater distance would show the device to far exceed the limits and likely cause harmful interference. The American Radio Relay League (ARRL) has correctly noted this deficiency in a White Paper published on their website.

8) Part 15 should be revised to require Type Acceptance of systems like the proposed BPL system on the basis of showings in field trials with computations demonstrating that large scale deployment will not cause harmful interference. Field trials should measure field strengths over a wide area that result from the deployment of thousands of systems over small geographic area and connection to other geographic areas by medium power lines, and those measurements should extend to the far field of those systems. (For example, the far field of a network of 100 radiators spread over a one square mile area can begin no closer than a mile from that system). The results should then be plugged into well understood propagation models to predict the effects of scaling the system to its intended large scale deployment.

9) ARRL reports that the “spectral mask” approach to system design adopted by the Home Plug system can effectively prevent interference to licensed amateur radio communications. The obvious questions are, "are the amateur radio bands the only spectrum that should be protected? What about short wave broadcasting, radio astronomy, aircraft, marine, public safety, and other communications services using the spectrum between 2 MHz and 30 MHz?"

10) The IEEE filing correctly observes that any non-linearities in equipment that makes up the large scale distribution system for a system such as BPL will cause intermodulation distortion, and that such distortion would likely generate distortion products in the spectrum protected by the spectral mask, thus defeating the mask and causing harmful interference. Such failures are more likely to occur in large scale BPL systems than in relatively small scale Home Plug systems.

Conclusions

If BPL could be made to work effectively without causing harmful interference it could be a reasonable solution for the last mile. The Dutch and Japanese communications agencies have both concluded after field tests that it cannot, at least in currently proposed implementations. The technical challenges are considerable, and most are rooted in basic physics and simple math. Revisions to Part 15 like those proposed herein should allow realistic evaluation of systems with respect to meeting that goal if limits on radiation are set with that goal in mind. My engineering background causes me to seriously doubt that BPL can be implemented on a large scale without trashing the high frequency spectrum. My social sensitivity tells me that such a price is far too high.

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