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

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

REPLY COMMENTS OF
GARY W. BOX
To Comments of
AMPERION, INC.
Dated 7 July 2003

These are Reply Comments of Gary W. Box to comments filed by Amperion, Inc.

The writer received a BSEE and MSEE from UCLA, 1977 and has been employed as a electrical engineer involved in the power electronics and industrial electronics industries for 29 years, mainly in product development. This experience includes numerous encounters with FCC emission requirements including designing, building and testing equipment for compliance. The writer has also been issued 9 patents and currently holds the call sign N0JCG as a member of the Amateur Radio Service.

These replies take the form of excerpts from the Amperion original comment, noted as "Comment," followed by reply remarks, noted as "Reply". A number annotates each Comment and Reply. Replies commence immediately below.

1. COMMENT
Amperion has used the 1.7 – 30 MHz frequency band in its trial deployments using experimental licenses under 47 C.F.R. 5 granted by the Commission. These same trials were tested and validated to Part 15 emission limitations. Amperion suggests that the possibility of using frequencies up to 50MHz and the associated rules should be explored during this proceeding.

REPLY
Of the entire electromagnetic spectrum, from DC to light, only the tiny sliver between 1 and 30 MHz is capable of unassisted, worldwide communication using little power and absolutely no infrastructure. The Amateur Radio Service, short-wave broadcasters and other services demonstrate this fact daily. When the FCC was established, it was to bring order to the radio spectrum. It has done so by establishing a licensing structure and making rules to protect those services from interference. Unlicensed operation can never be allowed to have priority or even equal footing with licensed services unless they themselves become licensed, which includes a means to identify the source of the transmission. To do otherwise would be to return to the chaos of the spark transmitter.

2. COMMENT
Amperion has conducted extensive emission testing for all of its underground and overhead equipment at each field deployment site. The detailed data collected confirms that Amperion's equipment is compliant with existing Part 15 emission rules. This data was submitted to the FCC earlier this year for analysis and confirmation of this compliance. Further, there have been no complaints at any of our trial deployments.

REPLY

All BPL proponents, Amperion included, are under the mistaken notion that the Part 15 emission limits are a sort of digital threshold, below which there is no interference and above which there is. Harmful interference is defined as any repeated interruption of a licensed service, regardless of the RF field level from the offending device. Recent tests by the American Radio Relay League (ARRL) using a conventional mobile amateur radio configuration documented substantial harmful interference from several BPL systems.

Compliance with Part 15 rules includes the requirement to not cause harmful interference to a licensed service, regardless of the RF emission level.

3. COMMENT
Due to the fact that Amperion's signals do not pass through the distribution transformer at any significant SNR, we do not believe that there is a need to define frequency bands that must be avoided in order to protect the licensed users on the same frequencies.

REPLY
Amperion is making the implication here that there would be no interference to licensed HF users because they will be located some distance away. Several operators in the Amateur Radio Service have achieved world wide communication using power levels significantly below the Part 15 emission level. The power line, which forms an efficient HF antenna, will react the same to RF energy, regardless of the source.

4. COMMENT
We believe that the existing Part 15 rules are adequate at this time to ensure protection against harmful interference to radio services and to avoid adversely impacting the developing and deployment of this nascent technology.

REPLY
We can assume by this statement that Amperion is willing to accept all limitation of Part 15 to unlicensed unintentional emitters. This includes the provisions that the Part 15 device must not cause harmful interference to a licensed user and must accept any interference it receives from a licensed user. Amperion describes their BPL systems as a wide band system using OFDM modulation to avoid frequencies in the HF bands, as necessary. Let's assume that a spectrum analysis of the BPL signal shows no BPL carriers in the amateur bands. How then did the sensitive narrow bandwidth amateur receiver pick up the out of band BPL signal in the ARRL test? If we examine the characteristics of the received noise, we see that most of the interference is a series of random 'pops', which one party described as sounding like a 'Geiger counter'. They were very short, but very often, impulse noise transients. OFDM modulation creates 256 (or more) discrete RF carriers and imposes a separate bit stream on each. The 256 carriers suddenly appear, transmit their bit streams, which form the packet, and then are extinguished. If the leading and trailing edges of these carriers are fast, the edge of each packet will look like an impulse excitation to the power line. The spectrum of an impulse is spread infinitely across the spectrum. The power line obediently reacts to this excitation as the distributed, unbalanced, resonate wire structure it is and an impulse of energy is radiated all across the HF spectrum. The phenomena would occur at every edge of every packet.

In the Amateur Radio Service this effect has been known for 80 years as "key click". A CW (Morse code) transmitter operates by turning the carrier on and off as the key is opened and closed. In much the same way that the BPL OFDM signal turns its 256 carriers on and off at the beginning and end of the packet, although at a considerably slower rate. In CW, 'key click' is fixed by controlling the rise and fall times of the RF envelope, effectively passing the RF envelope through a low pass filter.

Unfortunately for BPL, passing the signal through a low pass filter will slow the baud rate substantially. OFDM works great in a band where all users are using the same modulation scheme because OFDM itself has good immunity to this effect. This is why there should be no conflict between access and in-home BPL. However, on the HF band, where the development emphasis over the last 100 years has been on raising signal to noise performance by designing ever-sharper filters and highly bandwidth conserving modulation schemes, a mode that continually generates impulse noise across the entire band is incompatible.

5. COMMENT
We recommend that the Part 15 rules continue to use radiated emission limits for BPL systems because this is sufficient to control interference from both low speed and high speed BPL. Since all carrier current systems inject RF signals into the power line for communication purposes, conducted emission limits will be more appropriate at some point in the future.

REPLY
Again, Amperion is assuming that the Part 15 emission limits are a sort of digital threshold, below which there is no interference and above which there is. This couldn't be further from the truth. All HF receivers are relative narrow band peak detectors. They are narrow band to increase the S/N performance as high as possible and lower the noise floor as low as possible.

Also, with this, and other comments, Amperion makes it clear that they are seeking to have the Commission impose the highest possible RF radiation limits on BPL technology. They are thus admitting that the power line is a poor conductor of RF and they need to increase the radiated energy level as high as possible to get sufficient conductive performance. The conducted limits were set after significant study by the FCC and the power distribution system will react the same to RF energy whether it is from noise or intentional BPL injection. Experience has shown that the power lines and related hardware are capable of resonance, RF gain and mixing, which are some of the reasons the limits were imposed in 1989. None of the physics supporting those decisions has changed. By raising the conducted limits the commission would be throwing out almost 20 years of progress in suppressing unintentional HF RF emissions.

6. COMMENT
Since the technology presently being employed operates at higher frequencies, there is the potential for interference with a larger number of licensed radio services. However due to the low levels of unintentional RF radiation we have noted and the fact that the energy levels roll off quickly as you get further from the MV wire, we do not believe our technology poses a particular risk. In addition, should a complaint manifest itself, Amperion technology can shift away from the offending frequency.

REPLY
As noted in #4 and as evidenced by the ARRL tests, BPL technology does produce enough RF energy in the passband of a narrow band HF receiver to cause harmful interference. In order for BPL to work at all, RF energy must be conducted along the entire path from the transmitting device to the receiving device. All parties to the NOI, including Amperion, admit that the power line is an unbalanced system relative to RF. RF energy fed into an unbalanced system of conductors is precisely the definition of an antenna, thus the entire line will radiate. The intensity of the radiation will fall off as the signal passes from line segment to line segment because a good deal of the energy is radiated. The sky wave from this, and all other BPL devices will radiate efficiently and would be received some distance away. Analysis by the ARRL at Part 15 emission levels, indicate 30dB or higher levels within 100 feet of a BPL injected power line. A large part of American population lives less than 100 feet from a power line, so Amateur Radio, short-wave broadcasting, National Bureau of Standards Time Signals, and any other HF service would all be effectively "jammed" for anyone within the BPL service area.

7. COMMENT
Access BPL could also be used to extend traditional utility SCADA throughout the utility power grid. Such a deployment would improve customer service and system reliability and minimize utilities reliance on customers for outage notification. These capabilities are not available with existing low speed power line carrier technologies.

REPLY
In order to operate, the BPL receivers must have an operating bandwidth extending from 1.7MHz to over 30MHz. Such a receiver will be highly sensitive to local transmitters anywhere within the passband. To a first order, a strong signal will cause the receiver AGC to reduce the RF gain, driving the BPL carriers into the noise floor. With a stronger RF signal, the receiver front end will act as diodes and clamp the input to

the receiver altogether, forcing a delay as the receiver recovers when the carrier is removed. With a still stronger RF signal, the receiver front end will act as a fuse and simply fail. None of the BPL proponents address the immunity of BPL equipment in the presence of a strong RF field from a local transmitter.

8. COMMENT
BPL is the only technology that is available which enhances utility distribution facilities and provides enormous potential for economical customer connectivity.

REPLY
Injecting high levels of high frequency RF energy onto the power lines is not the only way the utilities can achieve these goals. In fact it is not the most economical, easiest deployed, or reliable of the choices available to the utility. I would like to remind the Commission of their recent work on establishing the Unlicensed National Information Infrastructure band at 5Ghz. The very function of Access BPL is to be part of this infrastructure. It seems only logical that the utilities also use the U-NII band for this purpose. By mounting U-NII nodes on power poles at appropriate intervals (between 1 and 10 miles), all the goals of the Commission, the utilities and even the manufacturers can be achieved without causing interference to any HF users. Perhaps more importantly, U-NII implementations such as the Motorola Canopy system can be deployed immediately, without any further Commission action or any further cost to the Federal Government.

The advantages of using the U-NII band over BPL are numerous:

1. No interference to any users in HF.
2. No need for frequency notches.
3. No direct connection to power line, other than for power.
4. Independent of powerline noise.
5. Independent of powerline impedance characteristics.
6. Independent of power grid switching
7. Independent of powerline reliability, with battery backup.
8. Independent of powerline routing. Only pole location is important.
9. Freedom to configure the network as desired; either with directional antennas or omnis.
10. No safety concerns.
11. No interference liability for the utility.
12. Cheaper hardware (5Ghz transverter should be cheaper than powerline inductive components).
13. Lower radiated RF power
14. Lower power consumption overall. Could be solar powered
15. System robustness
16. FCC gets its “third wire”.
17. Providing rural service is trivial.
18. Strap-on installation means neighborhoods could be “wired” in hours, not months.
19. Cheaper installation
20. Little or no rule changes needed.
21. Bandwidth is almost four times wider than BPL, leading to higher performance.

9. COMMENT
It is important that the monitoring and control functions are protected as much as possible from the general users of Access BPL.

REPLY
With the vulnerability of the nations electrical distribution recently demonstrated by the power failure in the Northeast, I can’t imagine the utilities trusting critical command and control functions to a system that is even more vulnerable. BPL is a wide open door for an ILLEGAL, local transmitter to lock up the whole BPL system and thus affect an electrical grid running SCADA through it. It would be far more secure for the utility to invest in fiber or microwave links.

10. COMMENT
The ubiquity of the electric utility infrastructure allows BPL to provide broadband to areas in the US that do not presently have it. A large percentage of the United States still does not have access to high-speed broadband and the services that it enables.

REPLY
The ubiquity of the electric utility infrastructure is one reason BPL should not be deployed. Studies by the ARRL, IEEE and others both in the US and oversees, have shown that BPL will turn every powerline it is injected onto into a high frequency RF emitter. At the very least, this will render HF communication impossible within hundreds of feet of the power line.

11. COMMENT
We would also like to recognize the fact that FCC Order 97, Section 157 essentially places the burden on BPL opponents to justify why a new entrant or technology that may provide more affordable telecommunications to a broader base of customers, should not be approved. Comments filed thus far have not come close to meeting this burden, and remain unsubstantiated and speculative without direct evidence that BPL equipment causes interference in excess of approved limitations established by FCC guidelines.

REPLY
There are three reasons why BPL should not be allowed to inject high frequency RF energy onto the power lines.

1. All BPL manufacturers and proponents, Amperion included, admit that to achieve adequate performance they must increase conducted RF energy levels well above the Class A limit imposed by the FCC. These limits were established and harmonized worldwide to prevent spurious RF emissions from power lines taking into account variations in lines, contact rectification and other power line anomalies. The physics has not changed since then. The power line doesn't distinguish between RF energy from noise and RF energy intentionally injected from a BPL system and will respond the same to both. Allowing BPL to inject HF RF energy into the power line will negate almost 20 years of progress in preventing RF emissions from power lines. Furthermore, BPL spread spectrum and OFDM modulation schemes have been shown to inject impulse like noise onto the power lines and are thus incompatible with narrow band, licensed HF users. Simply put; these systems will interfere with HF users.
2. All BPL equipment must have a RF receiving section, and a fairly broad one at that. The equipment will receive and respond to any RF energy in its passband including that from nearby legal HF services. Even the near field from a 5-watt amateur transmitter will saturate the front end of a BPL receiver. A perfectly legal 10-meter CW beacon at 28.25MHz running 100 watts in the typical residential backyard would render a local BPL system worthless and may even damage it. Simply put; legal HF users will interfere with BPL systems.
3. The entire concept of injecting high frequency RF into the power line is not necessary, and in fact has been made obsolete by the availability of the frequency allocation for the Unlicensed National Information Infrastructure at 5GHz. By the proponents' insistence that this system is intended to bring broadband Internet to the masses, BPL is part of the Unlicensed National Information Infrastructure and should use the frequency allocation set aside for that purpose. This is not a bad thing. In fact, by so declaring, the FCC will harmonize the U-NII picture and deployment can begin tomorrow with existing equipment and no additional rulemaking and no additional testing.

BPL should not proceed because the opportunity cost of injecting RF onto the power line is too high and it is not necessary.

Respectfully Submitted;

Gary W. Box