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

In the Matter of

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

COMMENTS OF GARY PEARCE, KN4AQ

I have been a licensed Amateur Radio operator since 1965, and currently hold an Amateur Extra class license. I am the editor of the SouthEastern Repeater Association magazine, the *Repeater Journal,* and a contributing editor to *CQ VHF* magazine. I am not an engineer, but I do have extensive practical experience with voice, cw and digital modes on HF and VHF/UHF. I operate multiple modes on HF, VHF and UHF both from home and mobile.

In addition, **I have direct experience observing the Progress Energy Phase I and Phase II BPL trial areas.** I am part of a team of local Amateur Radio operators that was invited by Progress Energy to observe their Phase II trial system.

In my comments, I will describe the observations we made, and the concerns I have about BPL operation as a result of those observations. I will make some recommendations for changes in Part 15 that will help alleviate those concerns.

I appreciate the advantages of a broadband Internet connection. I have been a DSL subscriber since the service was offered in my neighborhood about four years ago, and I feel the "pinch" of dial-up service speeds when I'm on the road, or on vacation. But in the rush to promote BPL as the technology that will bring broadband to the unserved population, the detrimental effects to the radio spectrum of the radio frequency energy unleashed are being either understated or ignored.

Briefly, it appears to me that putting RF energy on power lines across large swaths of HF spectrum is a *sea change* in the way we treat that spectrum. While it appears the effects will be local – somewhere between a few blocks and a mile – since power lines are literally everywhere, every high-frequency radio user has a strong potential of being adversely affected, and of having to take some action to have the effect reduced, and perhaps still *not* eliminated. BPL goes far, far beyond anything that was ever envisioned as an unlicensed use of devices under Part 15. This NPRM adds some restrictions and accountability to the rules, but it does not go far enough in either direction, and it provides no penalties.

The burden should be on the BPL operator to attempt to not create interference in the first place, and to quickly and certainly eliminate (not just "mitigate") interference that is caused if they fail in their attempt to avoid it.

Also, I'll discuss and make a recommendation on the definition of the term "harmful interference." The level of mitigation required — the usability of the HF radio spectrum — turns on that phrase.

Tom Brown N4TAB, Frank Lynch W4FAL and I comprised the team of hams from the Raleigh area who were invited to observe the Progress Energy Phase II trial system. No one will mistake our effort for that of the NTIA, but we were able to gain a significant appreciation for the real effects of BPL in a "live" system. Keep in mind that this was a small trial area. The trick will be extrapolating these results to approximate a full system implementation in a dense suburban or urban environment.

OBSERVING BPL in North Carolina

Progress Energy Phase I trial — an "undisclosed" demonstration

I first became aware of the concept of BPL in late 2002, while reading the October *QST* magazine editorial titled "Radio Smog." Data carried by RF on power lines wasn't called BPL in that editorial. I was not alarmed. It seemed to be an absurd proposal.

I first became *alarmed* in the summer of 2003, when I learned that the ARRL's Ed Hare had been observing BPL trials in the US. The video he placed on the ARRL web site showed interference unlike any I'd seen before, in sound, in spectrum coverage, and in strength. Ed demonstrated a variety of noises from several different systems , most with strong signals, covering many MHz of spectrum. The text that accompanied the video said that this noise covered a large geographic area—up to several kilometers from the power line, as observed from his mobile installation with a "compromise" antenna that was far less efficient than even a simple dipole used at home stations.

In October, 2002, my local power company, Progress Energy, announced that it had been testing BPL in the Raleigh area. The announcement, carried in the Raleigh *News & Observer* and on several television news broadcasts, was made only after this "Phase I" test had concluded, and indicated a larger Phase II test would begin around the new year.

Area ham radio operators complained to Progress Energy about the company's plans, once the hams learned of those plans and understood the implication for possible interference. (There had been no complaints from hams of actual interference from the Phase I trial – there were no Amateurs living in the small test community, the trial had received no publicity, and the BPL signals carried no identification, so any ham who had received interference would not know who to complain to.) After the announcement, enough hams contacted Progress Energy that the company decided they needed a limited point of contact with the Amateur Radio community.

Tom Brown N4TAB, the ARRL Wake County Amateur Radio Emergency Coordinator, Frank Lynch W4FAL, an ARRL Technical Specialist, and I, an ARRL Public Information Officer, became that contact team, and had individual discussions with Bill Godwin, one of the engineers in the Progress

Energy BPL group. Godwin promised that we would be invited to observe the Phase II site as soon as it was in operation.

We also learned from him, and from another company engineer, that the Phase I hardware was still in place, and some of it was still in operation, in the Wakefield community in north Raleigh. We went to listen with mobile Amateur Radio equipment.

My car is equipped with an Icom 706 MKIIG transceiver, capable of continuous reception from below the AM broadcast band to 200 MHz, and an Outbacker Perth Plus antenna. This is a reasonably efficient and sensitive system, capable of worldwide communication with other Amateur Radio stations, but still falls far below the performance of a home station using a simple dipole.

When I arrived at the Phase I site, I observed the BPL signals in person for the first time. They appeared to be a continuous series of RF carriers, about 1 kHz apart, mostly unmodulated except for a "tick-tick-tick" sound. This has come to be known as the "signature" of this particular brand of BPL. The carriers occupied the spectrum from near 26 MHz to about 28.7 MHz, covering all 40 CB radio channels and the bottom half of the 10 meter Amateur radio band, which begins at 28.0 MHz.

I could hear a strong signal for almost a mile as I drove along Falls of the Neuse Road, near the entrance to the Wakefield subdivision. When I turned off the road into the subdivision, the signal faded to inaudible in about 500 feet. Since at the time I was unfamiliar with any other details of the BPL system, this was my only observation.

Progress Energy had not solicited cooperation or reports of interference from the Amateur Radio community during this Phase I trial , and since the trial had not been publicly announced, it received none. The company stated in a report to the FCC that no interference complaints were received. Frank Lynch pointed out later, after examining the company's FCC filings, that while this claim was true, it should be considered disingenuous. If any Amateur Radio operators *had* heard the signals, they would not have known what they were, nor who they belonged to, as they were "unidentified," a condition permitted by the license.

It turned out later that in fact one Amateur Radio operator – Andy Stoy K4MTN – *was* receiving daily interference in the fall of 2003 while on a routine commute to work down Falls of the Neuse Road. The interference continued into early 2004, and he in fact did *not* know the source of the interference, nor who to complain to, until March when he came across an article I wrote about our observation of the Phase II BPL systems that was published in several area club newsletters and web sites, and on the ARRL web site (**www.arrl.org/news/features/2004/01/20/1/**). In an e-mail exchange with Andy beginning March 17, 2004, I discounted his report at first, for several reasons. First, we had been told that the Phase I site had been turned off. Second, his initial report was not particularly precise, either in the "signature sound" of this BPL system, or the spectrum involved. He did describe the general location correctly. And finally, I had already received several e-mail inquires, if not outright complaints, about interference received by area hams who were nowhere near any BPL trial sites and were obviously hearing some other type of interference.

Across several e-mail exchanges, Andy provided a clearer picture of the interference he was receiving. He described the "signature sound" and spectrum that I had observed earlier, although he added that he was also hearing what sounded line traditional wide-band "power-line noise" at the same time. Tom Brown visited the area and confirmed that the Phase I system was indeed still in operation, at least along the overhead power line, with a signal in the 26 to 29 MHz area.

We reported this to Bill Godwin, Andy filed a formal complaint with the FCC, and within a few weeks the system was dismantled.

Progress Energy Phase II trial — partially disclosed

On January 15, 2004, Tom, Frank and I were invited to see the new Phase II trial area, or at least part of it, just installed and not yet serving customers, in the Holland Meadows neighborhood, about seven miles south of Raleigh. The neighborhood consisted of a few square blocks of newly built homes, surrounded by farm fields and scattered residences. The area was essentially rural, with a few suburban style developments here and there.

This was the first time we learned details of the BPL system operation, which used equipment provided by Amperion. An Amperion engineer, Gerrett Durling, flew down to provide the demonstration. We saw the hardware involved: injectors, repeaters and extractors, both pole-mounted for overhead power lines, and pedestal mounted for underground power lines. We were told that these devices created or utilized the RF signals that carried the data down the line, using a total of 6 MHz of radio spectrum in two "blocks" to carry the data. One RF block, 2.5 MHz wide, was used for uplink data from customers to the service provider. The other RF block, 3.5 MHz wide, carried downlink data from the provider to the customer. These two RF blocks could be located anywhere in the HF radio spectrum, from about 2 to 50 MHz. They could be at opposite ends of the spectrum, or as close together as 100 kHz. And as in the Phase I trial, they consisted of a "wall to wall" series of carriers, 1.1 kHz apart.

We were told that a pair of spectrum blocks was usable for about 2000 feet, where they would be received and regenerated by a repeater onto two new blocks, using another 6 MHz of spectrum. The spectrum used on one leg of power line could not be reused for several legs to avoid self-interference.

We observed the radiated RF on our mobile receivers. On the overhead power line, the initial spectrum used was 23.44 - 26.08 MHz, and 27.9 - 31.7 MHz. The lower block covered the 12 Meter Amateur Radio band (25.89-25.99 MHz) and adjacent spectrum, while the upper block covered the entire 10 Meter band (28.0-29.7 MHz) and adjacent spectrum. As was the case in our Phase I observation, the signal was very strong –"S-9"– as we drove along the highway adjacent to the overhead power line for about a mile. When we turned off the road and moved perpendicular to the line, the BPL signal faded to "just audible" in about 500 feet.

However, we added an element we didn't have in looking at Phase I. By coincidence, Amateur Radio operator and ARRL Technical Coordinator for North Carolina Danny Hampton K4ITL lived about eight-tenths of a mile from the BPL extractor. We called him on a cell phone, and he reported that he

was able to hear the 28 MHz BPL signals clearly at his home, using an 80 meter dipole antenna. This reception was far beyond the distance our mobiles were ever able to receive the signal.

This trial used the overhead line to demonstrate bringing the BPL data to a neighborhood from a distant source. The trial neighborhood itself had all underground power wiring, and we also observed signals from some of the legs of this part of the system. We found RF energy across the spectrum, from 3 to 30 MHz, again in split 6 MHz blocks used by each 2000 feet or less of power line. Most of these spectrum blocks covered one or more Amateur Radio bands.

The signal strength from the underground lines was weaker than that of the overhead lines. Our mobiles could hear it for 100 to 200 feet from the above-ground pedestals that contained injectors and repeaters. The lower frequency signals seemed to propagate a bit farther than the higher frequency signals. K4ITL could not hear any of the underground signals, which came only as close as a half-mile to his antenna. There are no Amateur Radio operators living in the trial neighborhood, so we could not make any observations with antennas more efficient than the mobile antennas.

Amperion's Gerrett Durling told us that his company had the technology to move the spectrum used by each injector and repeater by remote control from their Network Operations Center (NOC). I asked him to demonstrate that by moving the signal off the 10 meter band, and he said they couldn't do it at the moment because the NOC technician was busy provisioning another trial area. This concluded our initial observation of the Phase II trial. That overhead line remained on the 10 meter band for another two months.

More Phase II sites identified

On February 19, 2004, the Raleigh *News & Observer* ran a story of Progress Energy announcing the Phase II trials to the public. Only at that time did we learn that there was not just one trial area, but three. The trial we had witnessed was known as Holland Meadows, and the two new ones, about 5 miles away, were called "Whitehurst" and "Woodchase," all named for the subdivisions used in the trial. The Woodchase trial also used an overhead feeder delivering BPL data to a neighborhood that used all underground wiring. The Whitehurst neighborhood trial used only underground wiring.

Our next step was to use the FCC Amateur Radio license database and the Street Atlas mapping program to identify the location of every Amateur Radio operator in the zip code areas of the three trials (*Figure 1*). We located three hams within one mile and four more within two miles of the Holland Meadows trial. We found seven hams within one mile and four more within two miles of the Woodchase trial. Since the Whitehurst trial has no overhead lines, so we did not attempt to locate hams to monitor that trial, other than to confirm that there were no hams living in or immediately adjacent to the trial area.

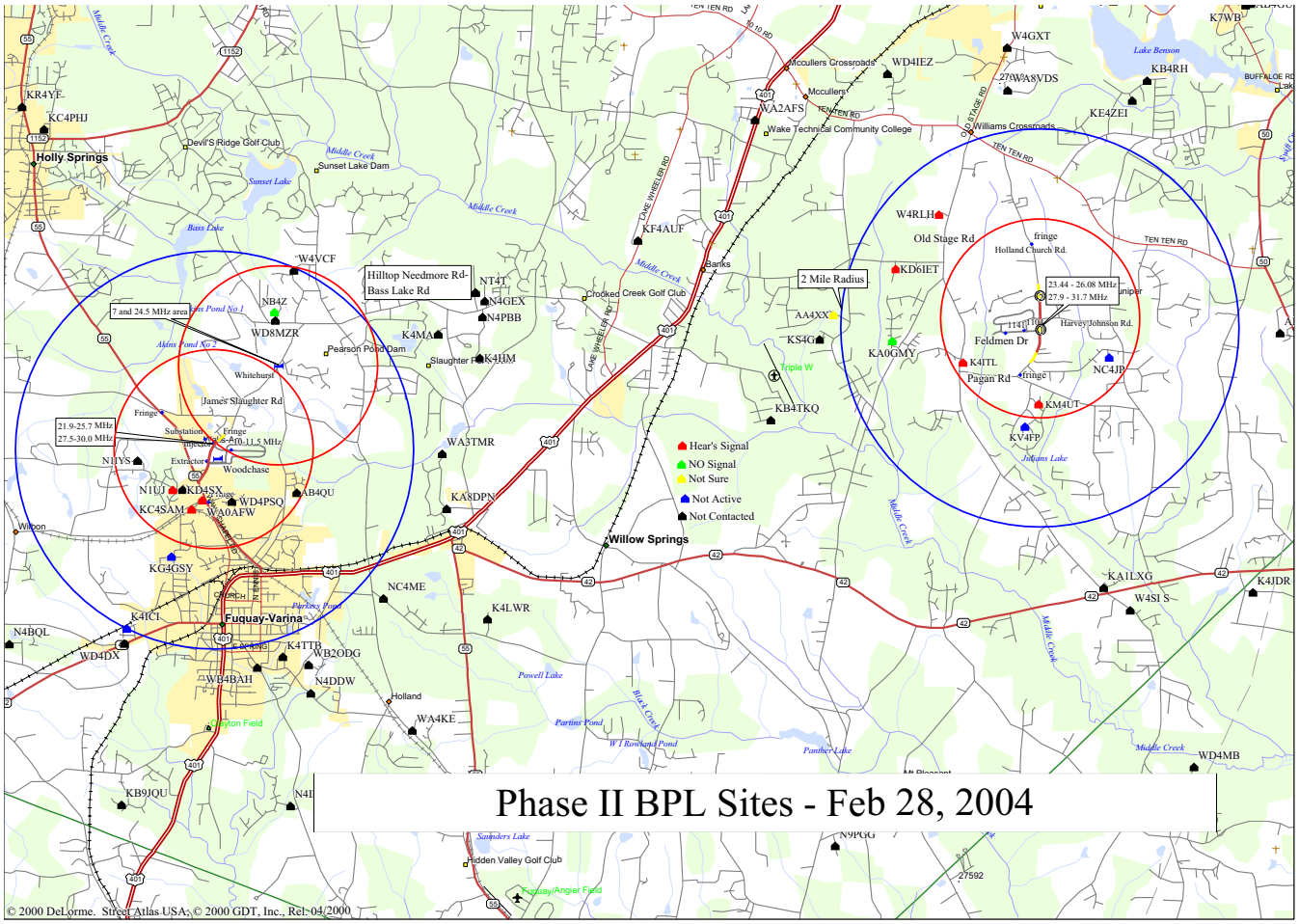
We surveyed all the hams we could reach inside the two-mile radius of the Holland Meadows and Woodchase trials, and found several active on the high frequency bands. We asked each to monitor the 28 MHz band. Every active ham within the one-mile radius was able to hear at least a weak signal that

could be positively identified as BPL. A ham with a directional antenna array on an 80-foot tower was able to hear the signals 1.5 miles away. Hams at greater distances were not able to hear the signals at all. Tom Brown and I visited several of these ham's stations to confirm that they were receiving the BPL signal.

Complaints and changes, fringes and notches

On March 5th, Tom, Frank, three other area hams and I attended a demonstration of BPL for FCC Chairman Powell and the media, presented by Progress Energy and Amperion in the Whitehurst subdivision. I spoke at length with Amperion CEO Phillip Hunt, who mentioned among other things that his company had not received *any* complaints of interference from Amateur Radio operators. Other utilities were saying the same thing. And it was probably true. Despite documenting interference at several trial sites around the country, Amateurs appeared to be "working with" local utilities, and not filing complaints with the FCC. It may have been disingenuous to say there were no complaints – the utilities were by now well aware of the evidence of interference being collected by us, by Ed Hare of the ARRL and others. But evidently there was nothing "on the record" as far as they were concerned.

Figure 1: map of hams located near the Progress Energy Phase II Trial locations



So on March 13, 2004, I filed my first official complaint with both Progress Energy and the FCC (*see Appendix A*), detailing the interference I received at the Phase I trial, and the Holland Meadows and Woodchase sites of the Phase II trial. I understand that several other hams filed complaints at about the same time.

Although I received no formal reply from either the FCC or Progress Energy, I did observe what appeared to be an attempt to move spectrum used on the overhead power lines *off* the Amateur Radio spectrum. On March 20, 2004, listening to signals from the overhead power line at the Woodchase subdivision, I observed clear, strong BPL signature signals from 21.5 to 24.90 MHz, and 25.49 to 28.0 MHz, only just brushing the 12 meter band. But I also noted something new, as I was paying more attention to the "band edges" of the BPL signals. They did not end abruptly with one final carrier on a discrete frequency. Instead, they dropped in amplitude significantly over the course of about 20 kHz, and then trailed off slowly over another 50 or more kHz. These signals were weak, but plainly audible, and remained inside the 12 and 10 meter Amateur Radio bands. I was able to hear them 50 to 75 feet from the power line with my mobile station, and I estimate that a home station with a dipole or better antenna would hear them for a block or two. In my second complaint, I referred to them as "residual" signals. Later, in a reply to the FCC, a Progress Energy attorney would call them "fringe" signals.

Still on March 20, I visited the Holland Meadows site and found no changes.

On March 28, 2004, I returned to the Holland Meadows site and found that RF on the overhead lines had been rearranged, using the following spectrum:

14.29 - 16.805 MHz (including the top 60 kHz of the 20 meter ham band)

17.33 - 21.00 MHz (including the whole 17 meter ham band)

24.53 - 28.00 MHz (with an apparent notch across the 12 meter ham band)

Observations were difficult because this area was now saturated with a high ambient hash-type noise level, typically called "power line noise," although the true source was not identified.

On March 29th, 2004, I filed my second interference complaint with the FCC and Progress Energy, based on those observations (*see Appendix B*).

Again, I received no formal reply from the FCC or Progress Energy, but I did get a call from Bill Godwin, requesting a meeting in the trial areas to review the spectrum used and clear up a few questions. Tom Brown, Bill Godwin and I met the afternoon of April 6th, first at Holland Meadows, and then at Woodchase. At Holland Meadows, I showed Bill the remaining full-strength BPL signal covering the top 60 kHz of the Amateur 20 meter band, and the "fringe" carriers encroaching on the bottom 50 or more kHz of the 15 meter band.

This time, I had a better chance to observe the notches used on 12 and 17 meters in the Woodchase trial, where the ambient noise level was still low. We heard that the bands were indeed notched, but the notch depth was not sufficient to completely eliminate the signal. We still heard carriers throughout both bands, while we were about 75 feet from the power line. As with the "fringe" carriers at the BPL band edges, I estimate that a home station could hear the signals in the notches a block or two away from the power line.

Bill Godwin had arranged in advance to have an Amperion technician standing by to make real-time adjustments to the spectrum used and attempt to address any remaining complaints. That technician did not answer his phone, did not return messages, and could not be found by other Amperion employees during the course of our two-hour meeting.

I confirmed these results in an e-mail to Bill Godwin, but did not file a third complaint with the FCC.

Progress Energy responds to FCC – says they fixed it, or it's "not harmful."

On April 20th, 2004, Progress Energy's attorney for Regulatory Affairs Len Anthony sent e-mail to the FCC's James Burtle, Chief of the FCC's Experimental Licensing Division, claiming that after moving the BPL signals off the ham bands, their system "is not causing any harmful interference and is in full compliance with the FCC's Part 15 rules." (See *Appendix C* for the full e-mail.)

Referring to the April 6th observation that Bill Godwin, Tom Brown and I made of the weak signals remaining in the notched 12 and 17 meter bands, and the "fringe" signals falling in ham bands adjacent to the erstwhile edge of the BPL spectrum, Anthony wrote, "These tests revealed a small level of interference at the fringes of certain frequencies. Since that time, further modifications have been made to address this fringe interference. It is PEC's position and interpretation of the FCC's rules with regard to 'harmful interference' that any interference that may still exist is not 'harmful' as that term is defined by the FCC's rules. This level of interference does not seriously degrade ham radio operation or transmissions or cause repeated interruptions."

On April 21st, I rechecked all the spectrum used on the overhead lines in the Holland Meadows and Woodchase trials. It appeared to me that contrary to Mr. Anthony's claim, no changes had been made since our April 6th observation. Given that claim, I was very surprised to observe that the full-strength BPL signal remained on the top 50 kHz of the 20 meter band. Fringe carriers remained inside the 15 and 10 meter bands. And the notch depth in the 12 and 17 meter bands appeared unchanged.

From that time until my most recent observation on April 28th, the only changes I have seen are some minor adjustments to the beginning and end of the notches and the edge of the spectrum that abuts the 15 and 10 meter bands, so that somewhat weaker signals appear inside the bands.

Mobiles don't count?

In my complaints to the FCC, I recognized that all my complaints, and those of several other hams, were based on observations from mobile stations. I asserted that these observations were valid for two reasons. First, there were no hams living in the trial areas. The mobiles acted as "surrogates" for home station observations, albeit with reduced efficiency antennas. Keep in mind that these were trials, and were supposed to illuminate both the promise and problems that could be expected from a full-scale system. Second, mobile HF is a popular aspect of our service in its own right. The ARRL estimates that there are 70,000 active HF mobile operators today. Several high-power, compact, full-feature radios (like my Icom 706 MKIIG), and a wide variety of antennas have made HF mobile a relatively easy proposition.

In his letter to the FCC, Len Anthony asserts, "Given that any interference experienced by a mobile operator only occurs within close proximity to the BPL facilities, such interference would be very short lived. Thus, PEC is not causing any harmful interference and is in full compliance with the FCC's Part 15 rules." This would appear to write off mobiles as any source of complaint about BPL interference.

In practice, a mobile traveling on a highway at 35 miles per hour can be in interference range of a BPL-carrying power line running alongside the road for a minute or more, and then may run into another line carrying BPL in the same spectrum just a few miles down the road. Add the variables of stop-and-go traffic, traffic lights, or the possibility that the mobile may stop in a driveway or parking lot, and the duration of the interference can be come much longer. Clearly, mobiles are subject to interference as much as, and perhaps more than home stations.

What is Harmful?

Part 15, pre- or post-NPRM, provides that unlicensed devices are not permitted to cause harmful interference to licensed services. The Amateur Radio rules define "harmful" this way:

§97.3(a)

(23) Harmful interference. Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with the Radio Regulations.

Mr. Anthony claims that the weaker carriers remaining in the notched 12 and 17 meter bands, the "fringe" carriers inside the edges of the 15 and 10 meter bands, and *any* interference to a mobile station, are not harmful. The language is subjective, of course, and open to fairly wide interpretation. I don't know if any more precise language is possible or desirable, but a case can be made that the type of interference created by even weak BPL signals, audible for a block or two, are harmful to stations in the Amateur Radio service. Hams routinely tune through quiet spectrum, looking for weak signals from distant or very low power stations. The presence of a continuous series of weak signals, occupying the entire band, can compromise this operation. Obviously if BPL signals actually block the reception of any signals, they have *obstructed* or *repeatedly interrupted* operation. *Degrade* is the operative word for signals that hover in the background, creating a tone, crackle or pop behind signals that can still be understood, but with greater difficulty.

It appears that there is no large body of case histories that help apply the term "harmful" to specific instances of interference. With BPL, that will probably change quickly.

Amateur Radio operators have had to deal with a variety of noises – some natural, and some man-made – since the dawn of radio. The rise of clock and processor based electronic devices have escalated the problem in the past two decades. Part 15 has somewhat held this onslaught at bay, though at any given ham's station, HF is dotted with hash, whistles and gurgles emanating from computers, monitors,

modems, and other equipment (today, for me, it's my neighbor's electric blanket controller, creating clicks from VLF to beyond UHF). But most of these signals occupy a narrow bandwidth, not 6 or more MHz, and radiate for few feet, not a few hundred (that electric blanket is an exception). Again, BPL is a *sea change* in the quantity, duration and strength of signals expected to share the HF radio spectrum. Only a politically inspired definition of the word "harmful" will keep it from being widely applied.

Extrapolation from the trials to real life

The BPL trial areas are designed to be a representation of a complete system. What would the RF landscape look like with BPL operating on every power line in a dense suburban or urban environment? We must extrapolate from the small, isolated trial areas to get an idea.

Based on my experience observing the Progress Energy trial areas, I think I can get an idea of what BPL might look like in the moderately dense neighborhoods of my town, Cary, North Carolina, a suburb of Raleigh.

Most of the neighborhoods in Cary are like the Progress Energy trial areas, neighborhoods with underground utilities, with overhead feeders lining the main roads. The nearest overhead line to me is one-third of a mile away - borderline for me to hear notched or fringe signals in the ham bands, but easily within range for me to hear moderate signals in other parts of the spectrum. I could expect to hear moderate signals from the underground lines on my block, and possibly an the streets in front of and behind my house.

So far, Progress Energy has not attempted to notch or otherwise mitigate the BPL signals covering the ham bands in any of its underground lines. They continue to operate at full strength, albeit with less coverage than the signals on the overhead lines. Assuming that they can incorporate notches on the all the underground lines affecting my station, I might end up "lucky." By accident of location, I might be in an area where little or no BPL interference is heard, but it that is not guaranteed.

Can the same be said for all my neighbors in town?

I'm afraid not. Progress Energy has identified only three spectrum blocks that give them the required 6 MHz of spectrum (plus 100 kHz separation between blocks) without covering ham bands, although each requires that one of the smaller ham bands be notched to round out the total 6 MHz:

7.30 - 14.0 MHz, with notch for 10.1 - 10.15 MHz (30 meters)
14.35 - 21.0 MHz, with notch for 18.068 - 18.168 MHz (17 meters)
21.45 - 28.0 MS, with notch for 24.89 - 24.99 MHz (12 meters)

There are *no* 6 MHz wide spectrum blocks below 30 MHz with no ham spectrum at all. And while Amperion says they can operate up to 50 MHz, they seem reluctant to do so. They would be covering spectrum used by several state government agencies, including the Highway Partrol.

Therefore, any ham living within a block or two of an overhead line would find BPL signals in at least the 30, 17 and 12 meter bands, and possibly "fringe" carriers in 50 or more kHz at the edges of any

of the other bands.

Even without the problem of notches that aren't deep enough, would the identified spectrum give Progress Energy enough spectrum blocks to place BPL on all the overhead power lines, without causing self-interference? That's a question only Amperion can answer, but if the answer is "no," then there will be problems on additional ham bands.

Proactive mitigation?

Would the power company proactively avoid and notch ham radio spectrum in advance? One would hope so. The spectre of working with a utility's Customer Service to resolve a problem as complex as RF interference is frightening. But there is no requirement in Part 15, or the NPRM, that they do so. The burden is placed on the party receiving interference to identify it, find the appropriate party to complain to, find the appropriate channels though the utility or service provider's bureaucracy, and lodge a complaint cogent enough that it will allow the utility to clear up the interference correctly, without creating one or more new problems while correcting the initial problem. This qualifies as a "nightmare scenario" for anyone dealing with a large utility.

Shortwave broadcast - and the rest of the spectrum?

So far, the only spectrum I've discussed in that allocated to Amateur Radio. But what about the users of the rest of the spectrum? The NPRM proposes that a BPL operator have the ability to avoid interference by remote control, and Amperion claims to be able to delete carriers on a spot basis, by block moves and notches (although their opportunities to demonstrate that capability were never realized, and the results of the changes they made on their own were less than perfect). The NTIA has listed hundreds of individual frequencies across the HF spectrum that should be avoided. But the *big* gorilla in the tent is Shortwave Broadcast.

International shortwave broadcasting uses the following bands:

Meter Band	Freq (kHz)	Reception
120	2300-2500	Infrequent reception
90	3200-3400	Winter nights
75	3900-4000	Winter nights
60	4750-5060	Tropical stations, winter nights
49	5900-6200	Best at night
41	7100-7350	Best at night (hams share with some European Broadcasts)
31	9400-10000	Best at night, some day
25	11600-12160	Best at night, some day
22	13570-13870	Best day, some night
19	15100-15800	Best day, some night

16	17500-17900	Best day, some night
15	18900-19020	Best day
13	21450-21750	Best day
11	25600-26100	Best day

With this list, a great deal more of the radio spectrum comes into play. The ITU Radio Rules require that the administration protect reception of international shortwave broadcast from harmful interference. Can a utility proactively protect this spectrum as well? Many shortwave broadcast signals are very strong, but others are weak, and once again, even notched BPL signals may create a problem. The interference is bad enough for Amateur Radio operators who are generally more technically competent to analyze interference and find the source. Shortwave listeners can not be expected to understand the source of this kind of interference. They are essentially defenseless against it.

Mitigation - Part 15 needs to be stronger

Clearly, the use of the high frequency radio spectrum for a service that radiates a signal for this distance across this much spectrum is inadvisable. The rules should make it commensurately difficult to do, and should provide an overarching degree of protection for those who might be harmed. Until the advent of BPL, Part 15 did a fairly good job. BPL stands Part 15 on its head. Some suggestions to remedy this:

Identification - add a voice beacon

The NPRM provides for a public database so that an interfering signal can be identified. This would be useful only for those who are aware of BPL and understand how to access and utilize the database. A much more useful user-friendly identification scheme is needed. **Each BPL transmitter should have a continuous identification beacon** understandable by the "least common denominator" of receiver appropriate for the spectrum used. For HF, that would be a voice modulated AM transmitter. The beacon should describe the BPL signal and define the spectrum it is associated with, and provide a clear point of contact for mitigation. It should be 10 dB in strength above the amplitude of the rest of the BPL signals in its spectrum block so that it can be clearly received. This signal would be subject to mitigation itself, of course, and would contribute to spectrum congestion. The BPL system operator would be required to identify appropriate spectrum for the beacon and coordinate its operation.

Time limit: 30 minutes, 24/7

The current Part 15 rules, and the NPRM, are open ended on how long the party responsible for causing interference has to solve the problem. Each case that goes as far as FCC Enforcement is battled out individually. Since BPL is an interfering signal deliberately placed on a power line and is known in advance to radiate over a considerable distance, the burden to mitigate the problem quickly should be high, and should be based on the needs and convenience of the party receiving the interference, not the party

generating it.

A BPL utility or service provider should be required to do whatever it takes to remove the interference from a complaining party's receiver **within 30 minutes.** This service should be available day and night, every day of the year, as there is no predicting when someone will buy a radio, erect an antenna and experience interference.

Penalty

Strong requirements without significant penalties are useless. I'll suggest a fine of $1,000 the first day if the interference isn't mitigated in the 30 minute time limit, and $10,000 per day thereafter until it is cleared up. If the interference is disputed, and the dispute is resolved in favor of the complaining party, the fine covers the time period beginning when the complaint was filed.

Radiated power limit

The current radiated power limit is far to high for effective interference mitigation to mobile receivers, and there is no practical method that would allow a mobile operator the opportunity to have interference mitigated in a useful time period. Therefore, the radiated power limit should be reduced to the point that a mobile operator on the street below the BPL energized power line would receive a signal only marginally above the noise level – about the strength of the notched and "fringe" carriers in the current Amperion system.

Conclusion

The public has enjoyed relatively unrestricted access to monitoring the radio spectrum for all kinds of signals – ham radio, CB, broadcast, shortwave, business, military, government, aviation and more. If it is transmitted "in the clear," we have enjoyed the privilege of receiving it, if we chose to possess the needed equipment. That access to shortwave radio is being threatened by a service that believes that it needs this spectrum for another task, and is attempting to use a section of the rules, Part 15, to accomplish a back-door takeover.

BPL manufacturers and the utilities that want to deploy the systems would have us believe that there is no interference problem, or if there is (an odd turn of the question, but then they are attempting to have their cake and eat it, too), they can solve it. Our field observations have shown us that there are some things they can do, and there probably will be more that they can do in the future, but they can't defy physics. The amount of radio energy needed on the power lines to be useful for BPL is also enough to radiate an interfering signal for a half-mile or more. Given the ubiquity of the power grid, that is essentially *everywhere*.

The Part 15 rules should be strengthened to the point that Broadband over Power Lines, if it is to operate at all, does not interfere with other users or listeners to the spectrum it intends to use.

Appendix A

KN4AQ's first complaint

to the FCC and Progress Energy

Len Anthony, Progress Energy Regulatory Affairs
cc:
Bill Godwin, Progress Energy
Anh Wride, FCC
James R.Burtle, FCC
Riley Hollingsworth, FCC (FYI)
Ed Hare, ARRL
Frank A. Lynch, ARRL

Saturday, March 13, 2004

This e-mail letter is a formal complaint of interference received from several Broadband over Power Line (BPL) installations operated by Progress Energy in the Wake County, North Carolina area.

I am:

Gary Pearce KN4AQ
116 Waterfall Ct.
Cary, NC 27513
919-380-9944
kn4aq@arrl.net

I encountered all of this interference while mobile, or visiting the stations of other amateur radio operators. I do not hear any BPL interference at my home in Cary at this time.

November 16, 2003. I first encountered BPL interference on this date, near the Wakefield subdivision in north Raleigh, along Falls of the Neuse Road near Wakefield Pines Rd. The interference appeared as a series of closely spaced RF carriers, approximately 1 kHz apart, covering the lower half of the 10 meter amateur radio band, from 28 to near 29 MHz (and some spectrum below that band, including the 40 CB radio channels near 27 MHz). Some of the carriers had a little "tik-tik-tik" sound at about a 2 Hz rate. The interference was strong - S-9 - for about a half mile along Falls of the Neuse Road, and obliterated several amateur radio signals that I was monitoring.

I understand this was the Phase I trial area, and the test has been discontinued.

January 15, 2004. On this and several subsequent dates, I received interference while driving along Holland Church road between 1010 Road and Pagan Rd. in southern Wake County, specifically in the vicinity of Feldman Dr. The signature of the interference was the same: closely spaced carriers, about 1 kHz apart, some with a tik-tik-tik modulation, and occasionally a longer burst of what sounded like data. The interference covered two blocks of spectrum, from 23.44 - 26.08 MHz (including the amateur radio 12 meter band) and 27.9 - 31.7 MHz, (including the amateur radio 10 meter band). The interference was strong - S-9 - for about a half mile along Holland Church road, and audible in places along Pagan Rd. It obliterated several amateur radio signals that I was monitoring as I drove through the area.

I also received interference with the same signature in several spots along Feldman Dr., in various other segments of the high-frequency spectrum - near 11 and 15 MHz in particular. The signals were weaker, but plainly audible. Onc caused a "beat note" against the 15 MHz WWV time and frequency reference signal.

I have subsequently been through this area several times, and the interference is still present. My last visit was on February 28th.

February 20, 2004. On this and several subsequent dates, I received interference while driving along NC Highway 55 and James Slaughter Rd, just north of the town of Fuquay-Varina. The interference was strongest along James Slaughter Road, opposite the Woodchase subdivision. Again, the signature of the interference was RF carriers, about 1 kHz apart, with a bit of digital modulation now and then, including the tik-tik-tik at about a 2 Hz rate.

This interference was across 21.9-25.7 MHz (including the amateur radio 12 meter band) and 27.5-30.0 MHz (including the amateur radio 10 meter band). The interference was S-9 along James Slaughter Road, and S-5 in the Food Lion parking lot at NC-55, and obliterated several amateur radio signals that I was monitoring.

In the Woodchase subdivision, I also heard the "BPL signature" signals on several other points in the high frequency spectrum. The signals were weaker, but plainly audible. I also heard signals in the 7 and 24.5 MHz area about a mile further north on James Slaughter Road, near the Whitehurst subdivision. These signals were S-6 to S-9 for about 1/4 mile along James Slaughter Road.

I most recently heard this interference on March 5th, 2004.

Finally, on February 28, 2004, I personally visited the homes of three amateur radio operators who live in the vicinity of the Progress Energy Phase II BPL trials, and observed interference as received at their stations as follows:

Mike Payne KM4UT
Raleigh, NC

Mile lives .7 miles south of the trial site on Holland Church Road. He is using a dipole antenna at about 30 feet. I observed that he was receiving a clear but weak BPL "signature" in the top half of the 10 meter band, above 28.8 MHz, and many smaller clusters of individual carriers in the band below that.

Ted Root N1UJ
Fuquay-Varina, NC

Ted is about a half mile southwest of the James Slaughter Road site. He is also using a dipole antenna at about 40 feet. He was receiving weak but clear BPL signature signals across the 25 and 28 MHz areas.

Roland Erickson WA0AFW
Fuquay-Varina, NC

Roland is about a half mile south of the James Slaughter Rd. site. He is using a dipole antenna in the attic of a retirement village building. He has a very high ambient noise level (S-6) across the 25 and 28 MHz bands, but was receiving the BPL signature signals clearly above that noise level across those bands.

You might ask if my complaint of interference while mobile, some distance from my home, is justified. I contend that it is, for several reasons.

First, amateur radio is a very "mobile" service. Tens of thousands of amateur radio operators have and use high frequency mobile equipment, and we can be found anywhere, using all hf bands, at completely unpredictable times.

Second, the Progress Energy Phase II trials are in very limited area tests. There are no amateur radio operators living inside the neighborhoods being served, though there are several within interference range - about a mile. We are justified in traveling to the sites with normal amateur radio equipment, operated in a normal manner,

to observe and complain about interference we receive. This observation must be extrapolated to a wider geographic area to anticipate the kind of interference that would be received if BPL were to be widely deployed, especially in denser suburban and urban neighborhoods.

You might also ask if weak BPL signals constitute harmful interference. I contend that they do. Amateur radio operation is unlike most other radio operation, in that amateurs tune across their band segments looking for signals. Often we are looking for weak signals from distant parts of the world. Our predominant modes are single sideband and cw. In those modes, a series of carriers 1 kHz apart presents a most irritating series of "beat notes" - tones that vary in pitch as the spectrum is tuned. At 1 kHz spacing, they are continuously present in a receiver using customary bandwidth filters. And even weak BPL signals can make weak amateur radio signals difficult or impossible to receive.

The presence of any BPL signal of any strength at either a home or mobile station at any location is an unwarranted incursion in the amateur radio bands, and is also a problem for anyone tuning shortwave broadcast or other radio services.

Thanks for your consideration. I look forward to hearing the results of the investigation into my complaints.

Sincerely,

Gary Pearce KN4AQ

Appendix B

KN4AQ's second complaint

to the FCC and Progress Energy

To: Len Anthony, Progress Energy Regulatory Affairs

From: Gary Pearce KN4AQ
116 Waterfall Ct.
Cary, NC 27513
919-380-9944
kn4aq@arrl.net

cc:
Bill Godwin, Progress Energy
Anh Wride, FCC
James R.Burtle, FCC
Riley Hollingsworth, FCC (FYI)
Ed Hare, ARRL
Frank A. Lynch, ARRL

Monday, March 29, 2004

This e-mail letter is a second formal complaint of interference received from several Broadband over Power Line (BPL) installations operated by Progress Energy in the Wake County, North Carolina area. This complaint covers interference on NEW frequencies that was not present in my first complaint filed on March 13th.

In my March 13th complaint I detailed interference that I observed while operating my mobile amateur radio equipment in the vicinity of the Progress Energy Phase II BPL trial areas in southern Wake County, North Carolina. No one from either Progress Energy or the FCC has contacted me as a result of that complaint (except a request from the FCC to drop David Solomon from the recipient list, which I have done). I have seen Bill Godwin in a somewhat chance encounter at the Holland Church site, and we had a good discussion on the state of the trial.

I have observed that Progress Energy has changed the spectrum used for the overhead line segments in both trial areas. If I'm correctly assuming that this was done to respond to complaints, and demonstrate frequency agility and the ability to mitigate interference by avoiding amateur radio spectrum, the attempt is appreciated, but it was not completely successful. New amateur radio and shortwave spectrum is now receiving interference, and that is the basis of this complaint.

On March 20, 2004, in the Woodchase subdivision area near Fuquay-Varina, where BPL signals had covered the 12 and 10 meter bands, I observed clear, strong BPL signature signals from 21.5 to 24.90 MHz, and 25.49 to 28.0 MHz. This almost cleared amateur radio spectrum, but not quite.

The lower segment, from 21.50 to 24.90 MHz, encroached clearly on the bottom 10 kHz of the 12 meter band, from 24.89 to 24.90 MHz, and what I'll call "residual" BPL carriers - carriers at the edge of the main spectrum that trail off in amplitude over the course of 10 to 20 kHz - encroached further. The residual carriers present a correspondingly decreasing problem of interference, but when the bulk of the BPL carriers are strong, the residual carriers can also interfere with weak amateur radio signals.

Note that if a BPL operator is attempting to place a BPL block adjacent to the bottom of an amateur band, they should be aware that these residual carriers will fall across an area of extreme interest where amateurs use Morse code to communicate with distant, often very weak, amateurs in remote parts of the globe. Additional care should be taken to avoid letting this "residual" interference cross the bottom few kHz of any amateur band.

The higher segment, from 25.49 to 28.0 MHz, also left some residual carriers encroaching on the bottom of the 10 meter band at 28 MHz. The main carriers did cover all 40 CB channels and interfered with signals I monitored there.

Then I drove through the Holland Church Road trial site and observed no change since my March 13th complaint - the BPL signals still covered the 12 and 10 meter ham bands and adjacent spectrum.

On March 23, 2004, I returned to the Holland Church Road trial area. That's when I ran into Bill Godwin and two other Progress Energy engineers, observing and reporting on some difficulty that Amperion was having moving the spectrum on the overhead line. The signals were gone from the 12 and 10 meter bands, and appeared erratically elsewhere. Since this was an effort in progress, I didn't worry about the signals I received.

On March 28, 2004, I returned to the Holland Church site again. This time I monitored signals on the following spectrum blocks:

14.29 - 16.805 MHz
17.33 - 21.00 MHz
24.53 - 28.00 MHz (with 12 meter notch?)

Reception was somewhat difficult because of a high general noise level (what we usually refer to as "power line noise," ironically in this case. The true source of this particular noise is unknown). The BPL signature signals were generally strong and clear above this noise.

After observing what appeared to be an attempt to completely avoid amateur radio spectrum at the Woodchase trial area, I was disappointed to see that two busy amateur radio bands were partially or fully covered here: 20 and 17 meters. The BPL carriers interfered with many signals as I tuned from 14.29 to the band-edge of 14.35 MHz in the 20 meter band. Strong signals were audible, but BPL carriers placed a loud "beat note" behind them, making reception irritating at best. Weaker signals were rendered unreadable.

I had the same situation across the entire 17 meter band, from 18.068 to 18.168 MHz. Weaker signals were impossible to receive, while stronger ones were accompanied by a loud heterodyne whistle.

I also tried listening to some shortwave broadcast signals in the spectrum immediately above the 20 meter ham band. Switching to AM reception with a 6 kHz band pass filter, I noticed that the BPL signals were a continuos "blanket" across the spectrum. Since the BPL carriers were 1.1 kHz apart, I heard the expected 1.1 kHz heterodyne tone as part of that interference blanket.

The 15 MHz signal from WWV was completely inaudible. Stronger shortwave signals were audible with varying degrees of interference. Weaker signals on 15.160, 15.205, 15.300, and 15.350 MHz were detectable but not readable. This was just a brief sample of the many shortwave signals that received interference from the BPL energy.

I could not observe any "residual" carriers spilling into the 15 meter ham band as the "power line noise" made it difficult to hear the weakest BPL carriers. With some difficulty I observed what appeared to be a notch in the 24.53 - 28.0 MHz block. The carriers were at least attenuated in the 24.89 - 24.99 MHz area (the 12 meter ham band), but I thought I could hear some weaker carriers through the "power line noise".

That is my report. I'll repeat my contention from my first complaint that interference reports from mobile stations are warranted because:

- amateur radio is a very mobile radio service,

- these are very limited trial areas, and the experience and results must be extrapolated to predict the effect BPL will have if widely deployed in densely populated areas.

I'll conclude with an example of truly random interference caused by BPL to a mobile ham who was not part of, or recruited by, our investigation team:

Over the past few weeks I've had an e-mail exchange with Andy Stoy K4MTN, from Wake Forest, NC. Initially, Andy's e-mail sounded like many that Tom Brown N4TAB, Frank Lynch W4FAL and I have received from area hams who suspect that they are hearing BPL interference from areas where none is known to exist. Andy said he had been hearing loud interference - he called it "static" - for months along a half-mile stretch of Falls of the Neuse Road near the Woodfield subdivision. He was describing the Phase I trial area which we believed to have been disconnected, and his description of "static" didn't sound like the BPL signature we're used to.

I pressed him for more specific details, and he finally described the exact location, and the signature sound (closer-spaced carriers with a clicking sound) of Amperion's BPL. Tom Brown traveled to the site and confirmed that the Phase I equipment was still operating on the overhead line along Falls of the Neuse Rd. Andy traveled that route daily, and regularly operates on the 10 meter band. He had been receiving interference and loss of communications on that stretch of road since at least last fall, but didn't know what caused the problem until we began publicizing the trials. Then he contacted us. He will be filing his own report of interference.

Andy's story may seem isolated, a rare, chance occurrence. It is significant for several reasons. One is that it happened at all, since there is a total of less than two miles of BPL coverage along Wake County highways. Another is that hams don't know what BPL is yet. We've reached a few with our message, but many more have never heard of it. So there may be a few more Andy Stoy's out there who have passed through the existing trials areas, received interference, and didn't know what it was or who to call.

I appreciate the fact that Progress Energy and Amperion are responding to our reports and complaints of interference. I'd prefer to just call them "reports," but public proclamations that "there have been no interference complaints" have pushed us to this formal posture. My goal is to make you (Progress Energy and the FCC) aware of the real conditions for radio amateurs and other HF spectrum users in the trial area so that you can anticipate the level of difficulty you can expect in a broader implementation.

I'd expect that Progress Energy and Amperion could completely avoid amateur radio spectrum in the overhead segments of this limited trial area. I'm surprised that after the first complaints, you moved to occupy different amateur radio spectrum. But even if you had completely missed ham bands in this first move, success in this limited arena is not a good predictor of the ability to mitigate interference in a full system, where you will be constrained to use more spectrum and not re-use spectrum for several line segments. And the question of interference from the underground line segments has not been addressed at all.

Sincerely,

Gary Pearce KN4AQ

Appendix C

Progress Energy reply to the FCC

From: Anthony, Len
To: James Burtle (FCC), KN4AQ, N4TAB, W4FAL
Cc: Oja, Matt, Godwin, Bill
Subject: Progress Energy Carolinas BPL Trial
Date: Tue, 20 Apr 2004

PEC has met with representatives of the ham radio operators in the Raleigh area. Joint measurements of the impact of PEC's BPL system on ham radio transmissions in and around the two subdivisions where BPL service is offered were taken. These measurements occurred subsequent to PEC modifying it BPL system to minimize interference with ham radio transmissions. These tests revealed a small level of interference at the fringes of certain frequencies. Since that time, further modifications have been made to address this fringe interference. It is PEC's position and interpretation of the FCC's rules with regard to "harmful interference" that any interference that may still exist is not "harmful" as that term is defined by the FCC's rules. This level of interference does not seriously degrade ham radio operation or transmissions or cause repeated interruptions. Importantly, since PEC can make modifications to completely eliminate any interference with fixed ham operators, the!
only impact of any kind upon ham operations is upon mobile operators. Given that any inteference experienced by a mobile operator only occurs within close proximity to the BPL facilities, such interference would be very short lived. Thus, PEC is not causing any harmful interference and is in full compliance with the FCC's Part 15 rules.