

The BPL Dilemma

Hams claim Broadband over Power Lines will interfere with their on-the-air operations. The utility companies claim not. Read how they are both right . . . sort of.

By Gary Pearce,* KN4AQ

Because of the importance of the Broadband over Power Lines (BPL) issue, "FM" columnist Gary Pearce, KN4AQ, devotes his space this time to the investigation of a BPL test site and the surrounding area. He will be back in the next issue of CQ VHF with his regular column material. —N6CL

Since last fall, I've been up to my eyeballs in BPL—Broadband over Power Lines—and its effect on amateur radio. If you're up on current TV culture, you can call it "HF Eye for the FM Guy." Our area has been "lucky" enough to host one of the few BPL trials, courtesy of my local power company, Progress Energy, and equipment vendor Amperion. Several other local hams and I have been very busy learning about BPL, measuring the effects, working with the power company and vendor, and relaying what we've learned to our fellow hams. I thought you might be interested in a fairly intimate review of what I've been going through. It's not nearly over, but the deadline looms. They say that writers should write about what they know, and right now this is what I know. This will be a deep breath for me, and maybe some catch-up for you. Here we go.

Here we stop. I suppose I need to make sure you know what BPL is. It certainly has been the buzz of ham radio this winter, but there's a lot of misinformation about it. I'm always running into hams who have heard the initials but they only have a fuzzy idea of the basics, which is not surprising. For 99.9% of hams, BPL is

still academic. They haven't encountered it yet. I will provide a quick tutorial.

The basics of BPL are simple. It is a method of delivering high-speed internet to homes and small businesses using the local power lines that crisscross neighborhoods either overhead or underground. This is a brilliantly obvious idea ("the wires are already there!") that was delayed because the AC power grid is a really noisy, crappy signal-delivery medium for anything above 60 Hz. The march of technology, however, is making it feasible. It is the third method of doing that, following DSL (Digital Subscriber Line) on the phone lines and cable TV (nobody's come up with a cute name or acronym for broadband over cable TV; they just call it "cable"). Actually, wide-area wireless using microwave frequencies is really the "third" method of delivery, but it doesn't seem to be lighting any fires in the imaginations of the industry press, the public, or the FCC, the way BPL is (too bad). I'm told that it's a better system.

This Little Flaw...

BPL has lit fires. The FCC commissioners are mostly agog over it, as they love the idea of competition for phones and cable and the possibility of serving rural citizens ("the wires are already there..."). A little flaw exists, though. BPL puts radio signals on the wires in the HF and lower VHF spectrum, from 2 to 80 MHz, according to most vendors. Mull over the following phrase for a second: "puts radio signals on wires." What could we be describing? You, in the back...? That's right! Radio! Cable and DSL do the same thing, but generally at lower frequencies (below 3 MHz) and in either a shielded cable or a balanced pair



The BPL "injector" on this power pole feeds the RF energy onto the power line.

of wires that don't radiate (much). The power lines! Haven't you ever looked up at that magnificent infrastructure, long wires strung between tall towers, and thought what a great antenna system it would be?

Well, let's not go overboard. They won't put BPL on those big transmission towers. Those generally are carrying fiber-optic cable already, thanks to forward-thinking engineers a decade or two ago. BPL goes on the local wiring, from the substation to your home or business, across your back yard or beneath your

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This is the BPL hardware inside the ground-mounted pedestal.

front yard. It doesn't radiate like a kilowatt into a rhombic, but it does radiate, and it's regulated by Part 15. How it radiates, and how well, will come out as our story unfolds.

BPL appeared on the collective amateur radio radar screen in the U.S. some time last year. The more astute among us saw it long before then. I probably read Dave Sumner, K1ZZ's October 2002 *QST* editorial entitled "Radio Smog," which talked about general pollution (the physical kind in the air and water) and good old power-line noise, and introduced the con-



Bill Godwin; Will Roberts, AA4NC; Tom Brown, N4TAB; Frank Lynch, W4FAL; and Amperion's Garrett Durling measure BPL signal levels from the ground-mounted pedestal.

cept of BPL . . . gently, so as not to create mass panic. He didn't call it BPL back then. In 2002 the initials BPL only meant Brass Pounder's League, an exalted position that a CW operator can attain for passing lots of message traffic. If the editorial made any impression on me, it was probably something like "Sure . . . no way that's ever going to happen."

It was already happening in Europe and Asia, and in early 2003 power companies around the U.S. were building trial areas to see what this was all about. In April, the FCC issued a Notice of Inquiry, asking if Part 15 needed to be modified to accommodate BPL. Thousands of hams responded. I was late to the party, but I finally got on the FCC website and said something about the need to pay attention to the interference problem.

Eye Opener Number 1

The ARRL's Lab Manager, Ed Hare, W1RFI, was on the case early. Last summer, he equipped a car with radios, a shortened dipole, and a video camera. He visited some of the trial areas. The video is available for download on the ARRL web page (www.arrl.org) and plays on all the usual media players on your computer. I finally got around to downloading it, and suddenly I was very interested in BPL. To a ham, it was frightening.

We've been battling noise on the ham bands since the beginning. Heck, a lot of the noise was there long before we had receivers to detect it. Over the decades we've created a lot more of our own. Power-line noise is a familiar ham complaint. Computers and clock/processor-based devices have escalated the man-made RF noise problem since the late '80s. What I saw on Ed's video took things to a new level. Heck again . . . it skipped a level or ten. This was an exponential leap in interference. Ed recorded crackling and clattering with S-9 signals that extended over hundreds of kilohertz. You can see him spinning the dial on his TS-440, flying across the spectrum, and the noise never changes. I played this video at a radio club meeting and jaws dropped. It seemed like the future of amateur radio dropped. Then anger rose. The FCC Notice of Inquiry drew more than 5000 comments and reply comments, mostly from angry hams, but some from a BPL industry claiming that there was no interference problem at all!

Then it got personal. A short article in the business section of the local newspaper and a TV news report or two announced that Progress Energy, the power company for much of eastern North Carolina and a big part of Florida, had quietly been testing BPL almost in my back yard. Actually, it was on the other side of town, where a small test occurred over a few blocks in a new subdivision. In a review to the FCC, the utility noted that there were "no reports of interference." Well, duh! Nobody knew about it. No hams lived in the new, severely antenna-restricted neighborhood. Even if a ham had heard it, the person wouldn't know what it was, so why would the power company be called? It didn't sound like power-line noise (more on what it sounded like in a minute).

As Public Information Officer for the local club and ARES group, I began contacting the press that carried the story, and I wrote some bulletins for quick distribution on area club mailing lists. Area hams reacted by writing and calling Progress Energy to protest the development of this technology—technology we really didn't know much about, except that it could fill the ham bands with garbage.

A few local hams did more than just file general protests. Our

(Continued on page 80)

technical community is small enough such that hams know engineers and engineering managers in just about every company around. Some of them made discrete inquiries to contacts at Progress Energy. The power company realized that they needed to talk to hams, but they couldn't talk to all of them at once. They first reached out to the ARES Emergency Coordinator for the county, Tom Brown, N4TAB. Tom is an engineer at a small company doing equipment development for several government agencies. Then they called me, and a third ham, Frank Lynch, W4FAL. Frank is an ARRL Technical Specialist, and an RF engineer for Nortel, the giant telecommunications company. Last October, the three of us discussed ham radio and BPL with Bill Godwin, an engineer, who became our contact at Progress Energy.

Bill visited my shack, and I showed him some ham radio basics. We listened to weak signals and talked about interference and notching.

Eye Opener Number 2

We learned from Bill that the Phase I trial, concluded earlier in the summer, had been successful from the company's point of view. The equipment, supplied by Amperion, worked well and provided throughput beyond expectations. We also learned that although the test was over, the equipment was still in place and some of it was still turned on. Tom and I both have HF-equipped mobiles, and we went to listen.

A ham at Progress Energy told me to listen on 10 meters along a certain stretch of road near the trial neighborhood. As I approached the site, I wondered what I was going to hear. Ed Hare's video showed a different company's technology with a different RF "signature" at each trial site, so I didn't know quite what to expect. I cranked up the volume and paid careful attention to every pop and squawk from the speaker as I tuned up and down the band. Ten meters was quiet that day, with only a few ham signals here and there.

Then I heard it, faintly at first, but quickly getting stronger as I drove. This "signature," from the Amperion system using something called the "DS-2 Chip Set," was both extremely familiar and yet like nothing I had ever heard before. It was familiar because it was just carriers—nearly pure CW carriers, although some had a little tick-tick-tick clock sound on them. I was in SSB mode, so



KN4AQ's mobile transmits on 29.6 MHz while under the active power line. The quick transmit test was inconclusive. However, AMRAD's tests show problems when amateur radio operators transmit.

each carrier appeared as a note or tone. What's different was how many of them there were, how close together they were, and how much of the band they occupied. A lot. Very. And All.

This was BPL 101 for me, the beginning of the education. The signal quickly peaked at S-9 as I pulled under the active overhead power line. I pulled off the road and analyzed it. The individual carriers were about 1 kHz apart, so as I tuned up the band, I could hear beat notes from two carriers at once. There was always a BPL signal in the speaker, and they all were about the same signal

strength. I tuned, and I tuned across the whole 10 meter band, and down below into the CB band. *The BPL covered it all.*

The signal did fade relatively quickly as I drove away from the power line, fading to almost nothing a few hundred feet away. The overhead line was on the main road, but the neighborhood into which I was driving had all underground power. I didn't know if the 10-meter signal fed the whole neighborhood, or even if there was anything left turned on away from that overhead line. Still, I could imagine a ham with a dipole or a beam in the air somewhere nearby. They'd get a much



Tom Brown, N4TAB, listens on 24 MHz at Roland Erickson, WA0AFW's home near the second trial area. The signal was weak, but audible on Roland's attic-mounted dipole, about a half mile from the BPL site.



Amperion's Phillip Hunt shows FCC Chairman Michael Powell the hardware inside the ground-mounted pedestal.

stronger signal than I did with my Outbacker mobile antenna. Watching Ed Hare's tape was powerful. My hearing these "invader" signals in the 10-meter band was even stronger.

Progress Energy planned a Phase II trial to begin in early 2004, and Bill Godwin promised that we would be invited to see it. This one would be bigger. It would have a new generation of technology, but mostly it would be a marketing test. Would people want this stuff? Going head to head with cable and DSL, would there be any advantages? Meanwhile, I learned more. The BPL industry was still denying that there was any interference, while the ARRL was showing that there was. Hams were fuming on message boards, plotting more revenge than strategy. On websites such as DSL Reports, a more balanced story was told, but non-hams who were writing replies called us old men practicing a dying art that should well be sacrificed for the greater good. That would be downloading music from Kazaa, sitting in chat-rooms, playing on-line video games, and maybe getting a little work done, right?

In early January we got the call. Thursday, January 15th, was our day. The location was kept secret. Tom, Frank, and I headed south from Raleigh, North Carolina early on a chilly morning (for you guys up north, it was a balmy summer day). We met Bill Godwin, several other Progress Energy engineers (some hams included), and Garrett Durling, an engineer Amperion had flown down just to meet with us. We drove out to an isolated neighborhood of brand-new homes in an otherwise rural area, and Garrett described the system.

Because this was a trial area, the data was piped in on a 5-GHz dish mounted on a power pole, and then fed into the BPL equipment to run down an overhead line along the highway for about a half mile. Then the data was pulled off, and an 802.11b Wi-Fi system bridged the highway and brought it into the neighborhood, where it was put back on the buried power line as BPL. Every 2000 feet or so the power line came up out of the ground to run through a "repeater" in a green cabinet on the ground.

Some BPL systems bring data right into the home using the power line. You plug a stand-alone box into the wall outlet and connect an Ethernet line between a port on the box and your computer. The providers promote the fact that you can plug this box into "any outlet in town" and get high-speed internet. Amperion does it a little differently. They place 802.11 Wi-Fi nodes around

the neighborhood, and you hook up with a Wi-Fi card in your computer or other wireless device, such as a Palm.

All that was pretty cool, but we were interested in spectrum use. Time for school: BPL 201. The following description applies to the Amperion system, and not necessarily to other BPL technologies.

The data goes on the power line using two blocks of RF spectrum, one for upstream and one for downstream. The upstream block is 2.5 MHz wide, and the downstream block is 3.5 MHz wide. Within each of those spectrum blocks are the carriers I heard—thousands of them, completely filling the block. The blocks can be anywhere between 2 and 50 MHz, and can be as close together as 100 kHz or as far apart as opposite ends of the spectrum. Amperion tends to use frequencies above 6 MHz and below 31 MHz. At each repeater the data moves to a new set of carriers on two new blocks of spectrum. The spectrum blocks can't be reused for several power-line legs, about a mile, so they don't hear each other.

This system used 25- and 28-MHz spectrum for the overhead line, just like the Phase I system I'd heard in the fall. Sure enough, there it was when we tuned in. Once again, the signal was S-9 when we drove under the line and faded a few hundred feet away. The underground legs used other HF spectrum. I heard signals at 7, 10, 11, 15, and 18 MHz, crossing ham and shortwave broadcast bands and everything in between. One put a fat beat note on WWV while listening in AM mode. The signals on the buried line segments could only be heard while near the above-ground pedestals; about a hundred feet away was the limit. Keep in mind that this was with a mobile antenna. How much more would a home station with a bigger antenna hear? We don't know, but more than the mobile, for sure. Once again, there were no hams living in the neighborhood. We called one ham we knew who lived nearby, a little over a half-mile from the overhead line. He tuned the 10-meter band and the signal was clear, if not really strong.

A group called AMRAD (Amateur Radio Research and Development Corporation) had published details of an extensive test of reverse interference—ham radio shutting down BPL. They had a lot of, well, success, I suppose, causing problems. Low-power signals totally blanked data throughput in some cases, and higher power always did. We tried a brief test. We didn't have a computer connection, but Garrett called his NOC (Network Operations Center) and had them loop some data through the system. We keyed up on 29.6 FM with 5 watts, right under the wire that was using 28 MHz, and sure enough, it stopped. It started up again as soon as we unkeyed. Then we tried it with 100 watts, maybe hoping for a longer lasting effect. We caused a hiccup, but didn't shut it down. That's all the time we had for a transmit test. Don't read too much into the results.

The Solution!

We learned the source of our salvation, the solution to our worries. The system is frequency agile. If there's an interference problem, the NOC can move the carriers around in the spectrum and notch out some of them. I heard echoes of this when I read the NPRM released in late February; that's just what the FCC is proposing they'll have to do. How fortunate they already can. This is where the industry hangs its hat on the question of interference to hams. They can move . . . except not today. During our visit, I asked them to move this interference off the 10-meter band (and the other block of spectrum off the

12-meter band). No can do. The NOC is busy provisioning another system.

It is still on the 10-meter band as I write this column, almost 60 days later.

I'm getting ahead of myself. Our next job was to see just how significant the interference problem was. The FCC database and Street Atlas mapping program came together to help me plot all the hams in the area. One by one, from a zip code delimited list, the map filled in. There are lots of hams on the south end of Raleigh and the suburb of Garner, a bit north of the trial site. Fewer are out here in the country, but there were three hams within a one-mile radius and four more within a two-mile radius. I contacted them, found out who was active, who wasn't, and who heard the signal. Tom and I visited several of them to verify their reception. The result: Hams with simple dipole antennas clearly heard the 10-meter signal from the overhead lines up to a mile away. A ham with a large beam on an 80-foot tower heard it at a mile and a half away.

Everyone in town thought they heard it. BPL has become the new intermod—the catchall name for any squeak and squawk we think we shouldn't expect from a speaker.

We learned of a second trial area five miles to the west that they hadn't told us about. It was a similar setup, with an overhead line on 12 and 10 meters and a neighborhood with underground wiring. I plotted the locations of those hams, with similar results. There were a few more hams in the zone, as this was closer to a town. They heard about the same level of signals.

While all this was happening, the FCC released its Notice of Proposed Rulemaking (NPRM) for modifying Part 15. It was a good-news/bad-news deal. The good news: It prominently mentions the interference problem and proposes some steps that would "mitigate" it. The bad news: They think these steps will work. The steps include creating a database so anyone experiencing interference can look up and find the location and frequencies used by nearby BPL, and the "adaptive interference mitigation techniques" such as frequency agility and shutdown capability by remote control that I mentioned earlier.

The comment period on the NPRM will have closed by the time you read this, but the reply comment period should still be open.

Customer Service?

What this sounds like to me is ham radio by customer service. Congratulations on passing your exam. Here's your CSCE and a card with the phone number of your local utility. Give them a call and they'll try to have some bands clear of interference at your house by the time your ticket arrives. However, call right away. . . . They're a little backed up, and they're running out of spectrum.

Running out of spectrum? Well, I'm not the ultimate authority, but I did a little noodling and tried to put all the puzzle pieces together. They didn't fit.

I'll make the assumption that BPL can't operate without using ham frequencies. If it could, they'd just do it, but the interference zone from an overhead wire is at least a mile in diameter. In just about any mile-diameter circle there is an active ham, and that's in rural territory! The ham population is much denser in real suburbs or urban areas. How are they going to put up BPL and not interfere with hams, no matter how they can slice and dice their spectrum? It's a question I'll be posing to our power company after I file this story. I wish I could give you the company's answer, if they have one, and probably they will.

Even if they have a good answer, there's another problem—mobiles. How do you mitigate interference to a mobile?

This agility solution works for most of the other HF services, the ones which use specific channels that can be deleted from the carriers on the wire. Ham radio is different. We roam our spectrum, operating on whatever frequencies we choose. We look for weak signals, so just because BPL is weak doesn't mean it doesn't interfere.

The rules prohibit Part 15 devices from causing harmful interference to licensed services, and I expect future arguments to turn on the definition of "harmful":

§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 radio-communication service operating in accordance with the Radio Regulations.

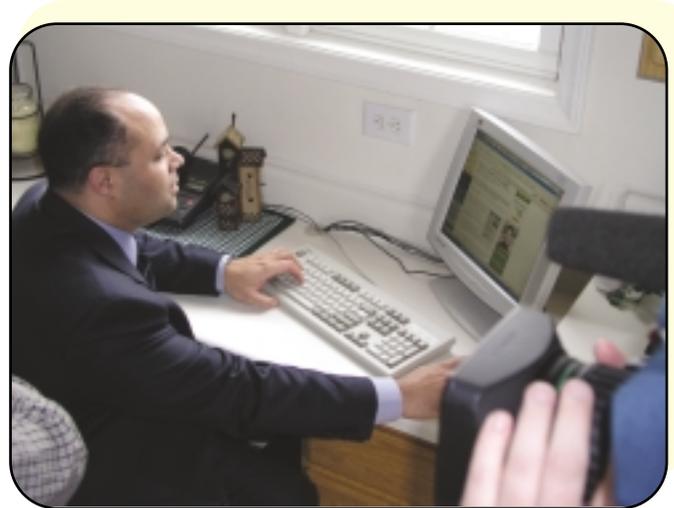
They're going to say that their weak signals aren't harmful. We're going to say they are.

Meet the Commish

Just as this episode was coming to a close, I got word that FCC Chairman Michael Powell was coming to town to see the BPL trial, an event open to the press. Tom, Frank, and I (and a few other interested hams) hastily rearranged our schedules to be present.

We arrived at the home of a trial BPL subscriber about an hour before Powell was scheduled to arrive. I introduced myself to the top BPL guy at Progress Energy, Matt Oja, and the CEO of Amperion, Phillip Hunt. There wasn't much happening yet, so we had an interesting discussion. I had realized long ago that this is serious, big business. They needed to know we hams are just as serious.

Powell arrived, along with two other top FCC officials, Robert Pepper (Chief, Policy Development) and Chris Libertelli (Senior Legal Advisor). I got to talk with the chairman for a few seconds while the Progress Energy people were getting their demo ready. He saw my callsign badge and said, "Hey,



FCC Chairman Michael Powell uses a computer receiving internet data via BPL.

KN4AQ, good to meet you!” I told him that we thought the interference problems were worse than what was being described by the FCC and the industry, to the point where we didn’t think they could be solved.

I talked at some greater length with Robert Pepper, who approached me after I talked with Powell. Then, while I observed the Progress Energy presentation, Chris Libertelli stayed outside to talk with the rest of the assembled hams. He said he understood that one of our main concerns was enforcement, should BPL cause harmful interference.

Is the Game Fixed?

Something doesn’t add up. The FCC admits that BPL will not be allowed to interfere with ham radio or other licensed

services, per Part 15. They remain bullish on the technology, however. They have all their chips on the ability to mitigate interference. We are an inconvenient technicality.

I’m not expecting any surprises from the NPRM. Hams will say it won’t work. The industry will say it will work. The NPRM should become a Report and Order with little change, and the BPL industry will be off with a pat on the back from the FCC.

Then, if I’m right, the complaints will begin. How will they be handled? How can they be? Will the FCC really tell any utility to turn off its BPL in an affected ham’s area (about a square mile)? Will they address mobile problems?

A lot of hams are saying the game is fixed and the deck is stacked. Time will tell. One way or another, I’ll be very

happy to get back to concentrating on FM . . . and I’m keeping the phone number of my local utility handy.

Note: There is an MP3 file with a sample of what Amperion’s BPL signals sound like on the air, narrated by yours truly. It’s on the web at <<http://www.cq-vhf.com/BPL.html>>. ■

BPL Comment Deadline May 3

The FCC Notice of Proposed Rule Making on BPL, ET Docket 04-37, was published in the Federal Register on March 17. Comments are due by May 3, with reply comments due by June 1. We urge you to learn all you can from articles here and elsewhere, read the NPRM, and file comments via the FCC’s Electronic Comment Filing System, or ECFS, at <<http://gullfoss2.fcc.gov/ecfs/Upload/>>.