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

In the Matter of	)	
	)	
Carrier Current Systems, including	)	(ET Docket No. 03-104)
Broadband over Power Line Systems	)	
	)	
Amendment of Part 15 regarding new	)	
requirements and measurement	)	ET Docket No. 04-37
guidelines for Access Broadband over	)	
Power Line Systems		

REPLY COMMENTS ON NOTICE OF PROPOSED RULE MAKING

To The Commission:

I have a B.S. in electrical engineering, have in the past worked for a power and distribution transformer manufacturer, a manufacturer of amateur radio equipment, and a manufacturer of semiconductor IC's, and I've been chief engineer for a couple AM radio stations while holding a First Class Radiotelephone license. I have held an amateur radio license for over forty years, of the extra class for thirty. I've published articles in two ham radio magazines and one company newsletter. I've had my share of experience on the ham bands including Worked-All-States (WAS) and Worked-All-Continents (WAC) certificates using no more than five watts output from or ten watts input into my transmitter, many evenings operating HF portable in the parks, and pedestrian mobile on ten meters. I have come across and dealt with various noise and interference problems from Part 15 devices which I've either solved, compromised with, or moved away from.

I am replying to comments filed on behalf of Ameren Energy Communications on 4/29/2004. I am looking at Figure A1. "Line Configuration" in Appendix A on page 15 of their filing. It shows a balanced BPL source connected on top of a 10 m. high pole to balanced lines spaced 1 m. apart going in either direction to balanced resistive terminations on other poles at 100 m. distance.

This is close enough to a model I used in my own comments on 3/17/2004, that we can compare apples with apples. Here's an excerpt from my comments:

> Where I currently live there is a power line that cuts through the property above a public-access stairs. There is no reason why this power line absolutely has to go through there as it loops back around to within a pole of the same line farther on. If the power company wanted to, it could connect their power at the other pole, disconnect it coming through my yard, and vacate that line. Suppose they did that and I wanted to use the vacated power line to feed my antenna. I would run a line of coax to one end and feed it through a balun (balanced to unbalanced transformer) and take the signal off

from the other end through another balun and line of coax off to an antenna some distance away. I don't know why I would ever do that, but suppose I did.

The double power line is balanced and spaced five feet apart. It runs above a public access stairs for fifty feet, but for the sake of our discussion, let's say it's 100 feet. I want to document it ... (A BPL company using the same power line would need to document that it's within Part 15 limits.) I have the formulas to use based on antenna gain with respect to an isotropic radiator. What gain (loss) would my feedline represent?

We want to be scientific, so let's look at the formulas.

> *Balanced and Unbalanced Transmission Lines.*[1]—A line is said to be balanced when its two sides are symmetrical with respect to ground. Thus a horizontal two-wire line, and four-wire lines, are balanced structures, while a two-wire line in vertical configuration and a concentric line are unbalanced structures. Except for the concentric line, in which the outer conductor acts as a shield, unbalance causes earth currents to flow, because part of the current that should be carried by the conductor having larger capacity to earth is diverted to the earth. This causes the current in the two sides of the transmission line to be unequal, and results in a component of current that flows out along the two transmission lines in parallel, and returns through the earth. Such unbalanced currents are to be avoided, because they give rise to extra energy loss, cause the radiation of the system to be greatly increased, and in general serve no useful purpose.
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> *Radiation from Transmission Lines*[2]—All transmission lines, except those of the concentric type, radiate some energy. Such radiation is often of importance, since it represents an additional energy loss. ...
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> The radiation from a two-wire nonresonant line is given approximately by the following formula,[3] provided that the length is at least twenty times the spacing and the spacing is not greater than one-tenth of a wave length and the line is nonresonant:
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> $$(\text{Radiated Power})/I^2 = 160(\pi D/\lambda)^2$$
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> where D/λ is the spacing in wavelengths, and I is the rms line current. This radiation is twice that resulting from a doublet antenna carrying the same current as the line and having a length equal to the line spacing. In addition to the radiation given by [that] equation, the terminating connections also produce radiation, so that the total radiation from the line with its terminations will be

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[1] Frederick Emmons Terman, Sc.D.,Professor of Electrical Engineering and Dean, School of Engineering, Stanford University, Past President, Institute of Radio Engineers, Radio Engineers' Handbook (New York: McGraw-Hill Book Co., 1943) p. 193.

[2] Ibid.

[3] E.J. Sterba, C.B. Feldman, "Transmission Lines for Short Wave Radio Systems," *Proc. I.R.E.,* Vol. 20, p. 1163, July, 1932.

> approximately four times the power radiated by a doublet having a length equal to the line spacing, and carrying the line current.
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> In the case of resonant lines the amount of energy radiated in proportion to the power transmitted to the load will be somewhat greater than is the case with the nonresonant line. However, unless the reflection coefficient of the load departs greatly from unity, the increase will not be great.

So in order for my transmission line to be properly constructed, of good engineering, it must be balanced so as not to "give rise to extra energy loss, caus[ing] the radiation of the system to be greatly increased, and in general serv[ing] no useful purpose." But having a balanced line five feet apart I can use that formula for frequencies up to the 15 meter (21 MHz) ham band, beyond which the spacing becomes larger than a tenth of a wavelength. It's radiation is approximately equal to twice that of a five foot doublet carrying the same line current, with another five foot doublet on either end to account for the connections.

Now, this is not much and pedestrians passing under the feedline will not be harmed by rf, especially as they are not standing still. Okay, let's say instead of my ham feedline a BPL company uses the same 100 feet of line to transmit its signal. Assuming it's fed balanced and taken off in a balanced load, it would represent the same equivalent radiation from four doublets of five feet each carrying the line current. That's not too bad. And even if the load wasn't perfectly matched, as long as it was somewhere in the ballpark, the radiation wouldn't be that much higher.

From (**FCC 04-29, ¶ 22 & 23**) BPL companies are saying "that BPL emissions drop off very rapidly away from the BPL source and that emissions fall off in point-source fashion," and "that its research to date would suggest that a BPL signal injection point can appear like a point-source radiator, with the power line having characteristics somewhere between a waveguide and an antenna." Since the radiation from such a *balanced transmission line* is spread along the whole line, if we assume an infinite balanced line, then indeed we would have a point source equivalent to a five foot doublet carrying the line current, and the radiation from the line would by unmeasurable as it is spread out along an infinite distance, and the end would never radiate because the signal would never reach it. In that model the BPL signal would in fact radiate like a point source.

I am not disputing their modeled results. The results I obtained from a similar model were not worrisome to me. What I take issue with is their statement (page 4), "AEC believes that these salient features will be maintained even by more complex models." To refer again to my earlier comments (3/17/2004):

Okay, now let's look at the real world. I don't think any hams use feedlines with a five foot spacing, more like the two to six inches unless they are using ladder line and then it's less. Mostly we just use coax. We go to great lengths to make sure our balanced line carries balanced currents. I use the right kind of balun for my application, and usually spring for a commercially made one though I can construct them myself, just to get a better quality. I will twist the line to keep it balanced, make no sharp bends,

avoid large metal objects, and keep it away from the sides of a building. ... When hams string balanced feedline, it's not so much they fight the environment as they orchestrate it, so that not only is the feedline designed balanced but the whole space it traverses is designed to keep that balance too.

Where I go to eat dinner, as I stand in line I look at the power line going down the street. It's a horizontal line, but at a certain pole it switches to vertical, and farther down the road to horizontal again, then some blocks later back to vertical. Ham lines and power lines are like the difference between East and West.

Power companies can't seem to keep a balanced line in a straightforward run down the street, not to mention any tricky situation. They never needed to before, so they never did. Even if we were to use some kind of HF isolation transformer after the house wiring——with its attendant imbalanced wiring such as single sided light switches——, and we limited our runs to straight lines——no corners——there are buildings on one side that would unbalance the line. If we moved the buildings back, there is traffic on the road beneath: cars, trucks, buses, and motorhomes; and that traffic passing underneath would upset the capacitance to ground for the adjacent wire more than the far one causing unbalance, so what are we to do? Block off the street? No, BPL intends to use the "the existing electric power lines" (**FCC 04-29, ¶ 3**), "using existing electrical lines" (**FCC 04-29, ¶ 18**), "Access BPL systems use existing electrical power lines as a transmission medium" (**FCC 04-29, ¶ A. of Appendix A**). So we may expect an inherently unbalanced line, and often spaced greater than five feet. So let's see what that results in.

> Unbalanced currents[4] are much more effective in producing radiation than the normal balanced currents because of the considerable distance between the two sides of the circuit through which the unbalanced currents flow. The amount of radiation depends both on the height of the line above ground and on the line length. The order of magnitude of the factors can be estimated with the aid of Fig. 56.

Looking at the figure (which I am unable to reproduce) I see two graphs of Watts per Amperes Squared vs. Line Length in wavelengths: one for a height of a quarter wavelength and one for a half wavelength. The half-wavelength height produces more radiation as would be expected: "The higher the antenna, the more energy radiated."[5] They each reach a plateau the lower one after about one and a half wavelengths, the higher one not yet after five. There is sort of a sine wave superimposed on the main graph.

This is pretty consistent with the BPL proponents' assertions that "BPL emissions drop off very rapidly away from the BPL source" (**FCC 04-29, ¶ 23**), and with your assertion that "the primary source of emissions will be the individual couplers, repeaters and other devices and, to a lesser extent, the power line immediately adjacent thereto"

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[4] Terman, p. 194.

[5] George E. Sterling, The Radio Manual *For Radio Engineers, Inspectors, Students, Operators, and Radio Fans* (New York: D. Van Nostrand Co., 1938) p. 52.

(**FCC 04-29, ¶ 36**) (although in the latter case I am not making comparisons with the radiation generated by the source). That doesn't mean the ARRL is wrong, because according to their research BPL will raise the noise floor near its source from 50 dB to 66 dB. That is from 100,000 times to 4 million times. My graph cannot depict a 100,000th down to the noise floor, not to mention a 4 millionth; it couldn't even do a thousandth or a hundredth for that matter.

I am not sorting out the numbers here; what I am showing is that such a radiator is not a properly installed transmission line in the ordinary sense. That radiated power is lost; it's not coming back. That the power lines farther along don't radiate as much is only because there is less left to radiate as it has gone out already. That means the BPL companies will have to install repeaters/boosters to pick it back up, each of them contributing additional radiation.

If I had a ham antenna fed by an unbalanced line, that hybrid "having characteristics somewhere between a waveguide and an antenna" (**FCC 04-29, ¶ 22**) would be treated by the FCC as an antenna for purposes of restricting harmful radiation, not as a feedline which may be ignored. That's because "**essential phases of the operation which control the external effects shall at all times conform to the requirements of good engineering practice**."[6] If you treat BPL by the same rule, then their systems using the existing unbalanced power line infrastructure would not conform to the standard of "properly designed and operated."

But that is the very language you use in ¶ 37. You also state, "We seek comment on the appropriate period of time that we should allow for BPL systems to come into compliance with any new requirements that we may adopt pursuant to this rule making proceeding" (**FCC 04-29, ¶ 42**), as if the BPL companies could have a "properly designed and operated" system without the power companies first having balanced their lines with respect to rf signals. When would the power companies ever get around to that? They have other priorities.

Excerpt from EWEB[7] Pipeline[8]

Lessons from the Blackout

EWEB electrical system very reliable, but age, growth and new technology spur need for capital spending

The massive outage that hit the North-eastern United States on Aug. 14, 2003 was a wakeup call for the entire nation about the risks of an aging and overworked electric power system. ...

One of the lessons we can learn is the need for utilities to maintain and upgrade their electric system "infrastructure"—the network of generating plants,

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[6] F.C.C RULES AND REGULATIONS 32.6 (*c*)

[7] Eugene Water & Electric Board is Oregon's largest customer-owned utility.

[8] Pipeline is a biannual customer newsletter produced by EWEB's Public Affairs department, www.eweb.org

> transmission lines, poles, wires, substations and other facilities that are designed to keep power on; get it back on quickly when there is an outage; and minimize surges and other fluctuations in power that can disrupt sensitive electronic equipment.
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> Most utilities across the country see an increasing need for capital investments to maintain reliability. ...
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> One area of concern is the vast network of 23,000 power poles that EWEB owns or maintains. About 60 percent of the mostly-wooden poles are at least 30 years old. ... Weather and decay can weaken poles over time so that they no longer are strong enough to safely support lines and equipment.
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> "The system is getting older. It's still working well now, but we want to deal with our aging system before it's too late, before reliability starts to slip," says Ken Beeson, a senior resource planner for EWEB.

It probably will not be in our lifetimes we see any such balancing of the lines.

So here is what bothers me about **FCC 04-29**. In ¶ 36 I see "the power line immediately adjacent to the individual couplers, repeaters and other devices [being] the primary source of emissions" just as antenna theory shows us. Then in the next paragraph (¶ 37) I see you talking about a "properly designed and operated" system, just as one would expect from a well designed and implemented rf transmission line. And in between the two paragraphs I see no waiting for the power companies to redesign their lines to conform to good rf practice, nor indeed as a practical matter can we expect them to. So how did power-lines-as-antennas get transformed so suddenly into power-lines-as-rf-transmission-lines?

Sorry to think I had to repeat my own comments all over again, but I thought it good to make a comparison with AEC's comments. Of course, the interference is going to be most severe in the vicinity of the source. That point is not in dispute. What is in dispute is the extrapolation of a *balanced* model to account for the unbalanced——at HF——lines that will actually be used. The measurements done by the ARRL, and now the modeling by NTIA, bear out that interference will be more problematic than the BPL companies such as AEC have led us to believe. It is unfortunate that policy had already been set, up to presidential level, before the proper scientific data was in.

As for Ameren wanting to do away with the data-base requirement, that requirement was not *my* idea. My idea is a manned hotline and a readable i.d. tag on each BPL signal, with automatic mitigation upon receipt of a complaint. But if you want to have a data base too, and the privacy of subscribers is at issue, just don't include their names in the data base. All that's important is the location, emission frequency & modulation, and BPL provider to contact. Why would we even need to know the names of the subscribers? It seems to me a lot of hams wouldn't want the subscribers to know the names of the hams who interfere with their system either.

Respectfully submitted,
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