The FCC finds power line communication exceeds radiation limit

The Federal Communications Commission (FCC) is the agency which regulates wireless systems in the United States. The FCC issues licenses to users of the wireless spectrum, to ensure that one transmitter does not interfere with another. The agency also investigates complaints of interference.

In the years 2003 to 2004, the FCC Laboratory measured seven Power Line Communication (PLC) systems, and found that it could clearly pick up the radiation from all of them. This was also the case where the electrical cables were underground, though underground cables clearly radiate less than aerial power lines.

Some of the FCC measurements were in response to complaints from radio amateurs, who were located up to 0.7 miles (1100 meters) from power lines carrying PLC signals.

The seven PLC systems were all of the Broadband over Power Line (BPL) type.

The FCC Laboratory found that one of the BPL systems violated the United States radiation standards, while two other systems reached the limit. The FCC limits are much higher than those in Europe and Japan.

Keywords: Power line communication, broadband over power lines, power line network, line source, Federal Communications Commission, power line radiation, interference, PLC, BPL, PLT, FCC

Making the reports public

The technical reports covering the seven PLC/BPL systems were not intended to be made public. They consist of approximately 150 projection slides all together.

When the FCC took no action against commercial BPL systems interfering with HAM radio operators, it was sued by the American Radio Relay League (ARRL). The ARRL is the U.S. organization of radio amateurs.

The FCC released the reports during the lawsuit, but blanked out important information.

The United States Court of Appeals ordered the FCC to release the blanked out information (D.C. circuit 2008, 524 F. 3d 227), though it took a year and a Freedom of Information request to get it released.

The court also ordered the FCC to address the complaints by the ARRL, which it did (see later).

The measured systems

The FCC Laboratory measured seven PLC/BPL systems, located in four Eastern states. The locations are listed in the following table[1]:

Town	Operator	Frequencies	Lines	Wireless to house
Allentown, PA	Amperion	2-6 MHz, 20-30 MHz	overhead	yes
Allentown, PA	Main.Net	3-17 MHz	over & under	
Potomac, MD	Current Technologies	30-50 MHz	overhead	
Briarcliff Manor, NY	Not specified	19-23 MHz	over & under	
Holland Meadows, NC	Amperion/Progress Energy	17-21 MHz	overhead	yes
Whitehurst, NC	Amperion/Progress Energy	23.2 MHz	underground	
Woodchase, NC	Amperion/Progress Energy	21-25 MHz	over & under	

Two of the systems were a hybrid of PLC and wireless. The signals were carried to the area from a central location, using BPL on the power lines along each street. The short distance into each house was handled by wireless Wi-Fi. Equipment to convert between the wireline PLC/BPL signals and wireless was mounted on utility poles or on ground-mounted transformers.

Some systems carried the BPL signals on overhead power lines, some on underground lines. Some did both.

The report stated that Amperion used an OFDM frequency division protocol with narrow bands for some of their sites. The frequency bands were specified for some systems, while some had to be estimated based on the charts, as shown in the above tables.

The Whitehurst system used a single carrier frequency of 23.2 MHz.

Results

The FCC Laboratory reports consist of a series of individual presentations on slides. The most important slides are referenced in the following.

The measurements of the three Allentown and Potomac systems were done so the FCC Laboratory could become familiar with the new technologies and experiment with different methods for doing the measurements.

The four systems in New York and North Carolina were measured in response to complaints from radio amateurs, whose radio systems were interfered with. In North Carolina, the radio amateurs were located from 0.4 to 0.7 miles (600 to 1100 meters) from the power lines carrying the BPL signals.[a]

It was apparently a surprise to the FCC engineers that the power lines themselves act as significant antennas for the BPL signals. They seem to have expected that the main source of radiation would be the equipment (coupler), but they found that even 230 meters (700 ft) down the line from a coupler, the radiation was still significant:

> *NOT A POINT SOURCE. Emissions exhibit no noticeable decay 230 m down line from coupler*[b]

Also:

> *Strong fields follow power line for 0.5 mile. Not a point source.*[c]

That it is not a point source is important, since the radiation levels diminish rapidly with distance from point sources, and much slower from line sources. This means that the BPL radiation reaches further from a line than if it was coming from a box or small antenna. It also means that any section of the power line can radiate. See also slides.[d,e]

The Allentown Main.Net system was found to exceed the FCC emissions limits.[f,g]

The PLC systems in Potomac, MD, and Holland Meadows, NC were both found to reach the FCC radiation limit.[h,i]

Measurements were done on the ground below overhead power lines. It was found that there was little difference whether the measurements were done directly below the line or 10 meters (30 ft) to the side.[b]

It was speculated that the ground wires on the electrical poles were a source of radiation.[j,k]

Measurements were also done on underground lines. It is clear that underground lines radiate as well, but much less than overhead lines. How much underground lines reduce the radiation is not possible to say from the presented data.[m,n]

In the Whitehurst, NC test, the radiation from the underground wires could be picked up by an AM-type radio.[o]

On the Main.Net system, it was found that a signal was transmitted 85% of the time (duty cycle), with a 20 Hz pulse rate.[p] The Potomac system was found to have duty cycles of 69% and 77%.[q]

Video demonstrations

The FCC Laboratory engineers recorded a series of videos demonstrating how the radiation from the PLC/BPL signals interferes with shortwave radio reception.[2]

The videos record the sound of a shortwave receiver in various places, where the PLC/BPL signals can be easily heard as wireless static.

A particularly poignant video is the *Briarcliff Video #5*[2], which is about seven minutes long. It shows the FCC staff driving through the town of Briarcliff Manor with a shortwave receiver. The static increases dramatically as the car reaches the area served by PLC/BPL, with reception being totally drowned out in some areas. As the car again leaves the area, the static disappears. The video also demonstrates that the radiation is throughout the length of the powerline, not just where the transmitters are located. The location of the transmitters are noted in the video.

Interference with wireless users

The FCC laboratory provided a list of wireless users which may see their communication affected by BPL in the 2 MHz to 54 MHz band. They include:[r,s]

- public safety
- federal communications (customs, etc.)
- radio amateurs
- shortwave radio
- other mobile wireless

Limiting emissions

The FCC Laboratory report provided some suggestions to limit interference with wireless users, including:[t]

- Ban BPL on overhead power lines
- Restrict the emissions level
- Allocate abandoned VHF television channels for the use of BPL (54-72 MHz)
- Block out (notch) certain frequencies

Later comments by the FCC

The FCC issued an official report in 2011, regarding PLC/BPL systems (called Access BPL by the FCC). The report was in response to the ARRL lawsuit, to clarify the agency's rationale and respond to the complaints, as ordered by the court.[3]

The FCC stated that its overall intent is to promote the use of BPL, and thus place as few restrictions on it as possible:

> . . . the benefits of Access BPL for bringing broadband services to the public are sufficiently important and significant so as to outweigh the limited increase in potential for harmful interference that may arise. (paragraph 14)

The FCC also distanced itself from the FCC Laboratory findings in various ways, such as:

> the assessments and recommendations in the redacted portions of the presentations merely reflect the views of the Laboratory engineers who performed the testing and analysis. (paragraph 19)

The FCC disagrees with the ARRL's assertion that BPL "would cause power lines to act as miles of transmission lines all radiating RF energy along their full length" (paragraph 22).

The FCC does accept that sometimes their emission standards do not always protect users of radio, navigation systems and radio astronomy against interference, but says it is up to those affected to complain to the FCC, which then may provide assistance for specific cases. (paragraphs 23, 38, etc.)

The ARRL radio amateurs had requested the FCC reduce the radiation at certain frequencies by 35 decibels (5000 times), called "notching". The FCC originally (in 2004) only required a reduction of 20 decibels (100 times). With this new ruling, the agency increased the reduction to 25 decibels (316 times) (paragraphs 2, 25, 29, 42, 45).

The FCC also requires operators of BPL systems to register in a publicly accessible database, so people with interference problems can find them that way (paragraph 101).

Discussion

It is clear that PLC/BPL systems can add to the electrosmog of an area, which is a growing health concern.

The FCC was here concerned only with the interference with wireless users, and not at all with any health issues.

The results demonstrate that residential power lines can radiate the frequencies of PLC signals into nearby households, even if they do not use any PLC service (i.e. smart meters, internet service, etc.).

The documentation that PLC systems turn a power line into a line source "antenna" (not a point source) is important, as that means greater distances are needed to reduce the radiation levels. This may explain why the radio amateurs in North Carolina complained about interference, even though they were 0.4 to 0.7 miles (600 to 1100 meters) away from the lines carrying the PLC signals.

That the power line is a line source also means that the line itself radiates. Radiation emissions are not just from the equipment injecting the signal into the power line. Given the political stance of the FCC, it is not surprising that the FCC officially does not accept this.

It is unfortunate that the FCC did not measure emissions from household wiring, as a result of PLC signals travelling into the home on the power feed.

It is disturbing that three of the seven systems had measured emissions at or above the FCC radiation limits, especially since the FCC limits are much higher than those in Europe and Japan. An industry article on the subject characterizes the situation in the United States as:

> FCC . . . can be regarded as highly generous for high speed PLC and in no way obstructing the spreading of PLC technology.[4]

The NATO military alliance has also produced a comparison of the various national regulations of PLC systems, which clearly shows the FCC limits to be particularly high.[5]

The FCC Laboratory report briefly mentions that the grounding wire on electrical poles appears to be a source of radiation. In most areas of North America, this grounding wire is connected to the neutral wire on the pole, and is a source of ground currents/stray voltage. The frequencies of a PLC system can then also be carried by the ground currents, which may be a problem for people sensitive to them.

Underground wires appear to help on health issues with PLC systems, but will not eliminate the radiation and is no help on the ground current issue.

The measured duty cycles of 69 to 85% essentially means that the PLC systems operate continuously, with no respite for sensitive people.

The measured PLC systems all transmit in the 2 – 50 MHz band, which is the frequency range that has been investigated the most due to interference with wireless communication and shortwave broadcasting. Some types of PLC systems transmit at lower frequencies, though the concerns about the possible human effects remain the same.

The antenna effect has also been documented by other national agencies, for a variety of frequencies.[6]

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References

1. Federal Communications Commission, ET Docket 04-37, April 29, 2009.

   The reports can be retrieved through the FCC electronic document system:

   http://apps.fcc.gov/ecfs
   proceeding number: 04-37
   posted: 5/1/2009

   The entire set of reports is also archived at:
   http://www.eiwellspring.org/plc/FCCLaboratoryBPLreport.pdf

2. FCC Laboratory videos, http://transition.fcc.gov/oet/info/bpl/#description

   The Briarcliff Manor video #5 is also available on YouTube: http://youtube.com/watch?v=1FX3YXp_sIY

3. Federal Communications Commission Second Report And Order, FCC-11-160, ET Docket 04-37 and 03-104, October 24, 2001. http://www.fcc.gov/document/access-broadband-over-power-line-systems

4. *PHYSICAL AND REGULATORY CONSTRAINTS FOR COMMUNICATION OVER THE POWER SUPPLY GRID*, Martin Gebhart et al., University of Karlsruhe, IEEE Communications Magazine, May 2003.

5. *POTENTIAL EFFECTS OF BROADBAND WIRE-LINE TELECOMMUNICATIONS ON THE HF SPECTRUM*, Arlo Chubukjian et al., IEEE Communications, November 2008 (also available as NATO unclassified document RTO-MP-IT-083).

6. Power Line Communication, www.eiwellspring.org/plc.html

Referenced slides in FCC Laboratory report:[1]

a. Raleigh, "Fixed Amateurs", slide 31, 12/22/04

b. Allentown/Amperion, "Under-Line Field Strength vs. Distance Down Line", slide 17, 12/22/04

c. BPL summary Briarcliff, "New Information Arguing for Caution on HF BPL", slide 17, 9/8/04

d. Allentown, "Major Conclusions", slide 3, 6/20/03

e. Main.Net, "Conclusions Regarding Access BPL", slide 50, 6/20/03

f. Main.Net Overhead/Allentown, "Quasi Peak", slide 21, 12/22/04

g. "Conclusions Regarding Main.Net", slide 48, 6/20/03

h. Current Technologies, "Conclusions", slide 35, 4/22/03

i. Raleigh, "Compliance Tests on 19.2 MHz…", slides 13-14, 12/22/04

j. Main.Net, “Conclusions Regarding Testing”, slide 31, 12/22/04

k. Main.Net, “Summary of Relative Average Levels”, slide 40, 6/30/03

m. Amperion Ground-Based System, “Quasi Peak away Buried Power Cable”, slide 27, 12/22/04

n. Main.Net Ground Based System, “Effect of buried Power Cable”, slides 25-27, 12/22/04

o. Raleigh, “BPL on Underground Wiring”, slide 17, 12/22/04

p. Amperion Ground-Based System/Allentown, “Temporal Measurements”, slide 14, 12/22/04

q. Current Technologies, “Temporal Measurements”, slides 21-22, 12/22/04

r. Briarcliff Manor, “BPL Spectrum Tradeoffs and Proposal”, slide 21, 9/8/04

s. Briarcliff Manor, “Part 90 Land Mobile Licensees”, slide 14, 9/8/04

t. Briarcliff Manor, “HF Issues and Options”, slides 19-21, 12/22/04