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

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

COMMENTS ON NOTICE OF INQUIRY

To the Commission:

INTRODUCTION

This submission presents the results of a simulation of the radio frequency energy (RFE) that might be radiated by a Broadband Over Power Line (BPL) system operating in a typical rural or low-density suburban neighborhood. The specific power line environment analyzed represents the primary distribution network which traverses the front of the respondent's residential housing lot located at 10 Marshall Terrace, Wayland, MA 01778.

The respondent, Dr. Lewis D. Collins, is a consulting radio engineer doing business since 1994 as RLC Consultants with offices located at 10 Marshall Terrace, Wayland, Massachusetts 01778. He previously held communications engineering positions with Tiernan Communications, Inc., Wang Laboratories, Inc., and the Massachusetts Institute of Technology. He holds the degree of Bachelor of Science in Electrical Engineering (with highest distinction) from Purdue University, and the degrees of Master of Science and Doctor of Science in Electrical Engineering from the Massachusetts Institute of Technology. He holds a General Radiotelephone Operator's License (PG-1-8954), and formerly held a Radiotelephone Operator's License, First Class (P1-1-21144). He is a member of the Institute of Electrical and Electronics Engineers (IEEE), the Society of Broadcast Engineers (SBE), and the National Association of Radio and Telecommunications Engineers (NARTE). He holds NARTE certification as a Senior Engineer, First Class in Broadcasting, Cable Television, and Computer Communications (E1-02247) and has been certified by the SBE as a Certified Broadcast Technician (CBT).

Additionally Dr. Collins has been a licensed Amateur Radio Operator since 1955, and he currently holds an Extra Class Amateur Radio License with station call sign W1GXT.

The Installation

The Primary (9,600 V/60 Hz) and Secondary (240V/60 Hz) distribution network operated by NSTAR Electric in Wayland, MA is typical of that found in many low- and medium-density residential neighborhoods in the United States. The Primary circuit, which is the subject of this analysis, consists of one 9,600 V line wire mounted on appropriate insulators at the very top of creosote-treated wood poles of approximately 30 feet above ground. The conductor is #8 hard-drawn copper. When originally constructed in about 1954, the secondary voltage was likely 2,400 or 4,800 volts. Subsequent increases in line voltage provided for an increased kVA capacity without requiring replacement of wires or circuit protection equipment.

The Neutral wire, which is common to the Primary and Secondary circuits, is also #8 hard-drawn copper, located approximately 6 feet below the line wire.

Line poles are spaced approximately 150 ft. apart and run the length of the street. There is only one line (phase) wire on the street.

BPL Assumptions

For this analysis it is assumed that the total power delivered to the communications circuit is +17dBm, uniformly spread over a 6 MHz bandwidth that can be located anywhere within the 2 MHz to 80 MHz spectrum.

Consequently the "conducted" spectral power density of the BPL signal $P_t = +17.0\ dBm - 67.8\ dB/Hz = -50.8\ dBm/Hz$

Furthermore, it is assumed that a broadband resistive termination approximately equal to the characteristic impedance (Z_0 = 800 ohms) of the Primary circuit is attached at the end farthest away from the BPL signal and 60 Hz power source. This results in a radio frequency wave traveling down the length of the Primary circuit, with minimal power being reflected back toward the source. This was verified by means of a VSWR analysis of the radiating system.

The Analysis

The Method of Moments implemented in the EZNEC 3.0 antenna analysis software was used to compute the radiated field strength of the subject system. The isotropic transmitter antenna gain, G_t, was computed for ten discrete frequencies from 2 to 50 MHz, representing frequencies allocated to the Amateur Radio Service.

The results obtained would be similar for frequencies in the internationally allocated Short-wave Broadcasting bands.

For the purpose of this study, only a 150-ft long segment of the transmission line was analyzed. Because of the manner in which the transmission line is terminated, it can be reasonably expected that the results obtained will be independent of location along the line. This assumption considerably speeds the calculation of the radiated field strengths.

The assumed receiving antenna was a half-wave dipole mounted sufficiently high above ground (greater than one-half wavelength) so as to minimize interaction between the antenna and the ground beneath it.

The assumed receiver was a high-frequency communications receiver having a 3kHz IF bandwidth, typical of the receiver state of the art for at least the past 50 years.

Results

At each frequency in this study, it was assumed that a simple half-wave dipole antenna was being used for the receiving station and that feedline losses were negligible. The receiving antenna was located 75 ft (22.9m) from the power line, and parallel to it. This is typical of the house "set-back" distances from the street in the neighborhood.

Table 1 below shows the peak "transmit" antenna gain, G_t, of the BPL system referenced to an isotropic radiator computed at ten frequencies, the received power, P_r in dBm, and the receiver's "S-meter" reading, referenced to a 50 μV signal at the receiver's antenna terminal taken as "S-9."

F(MHz)	*Gt (dBi)*	*Pr(dBm) in 3kHz BW*	*S(dB above S-9) Ref. Level = 50 μV*
2	-27.9	-47.5	+25.6
4	-22.3	-47.9	+25.1
7	-30.2	-60.6	+12.4
10	-16.2	-49.7	+23.3
14	-19.3	-55.8	+17.3
18	-11.3	-49.9	+23.1
21	-10.2	-50.2	+22.8
24	-7.4	-48.5	+24.5
28	-6.0	-48.5	+24.5
50	-2.3	-49.8	+23.2

Table 1 – Results of BPL Simulation

From Table 1 we observe that the received interference from BPL is approximately constant with frequency, because we have assumed an approximately constant aperture transmitting antenna, and a constant gain receiving antenna.

The variations in the above data apparently arise from changes in the pattern of the BPL antenna with frequency. At low frequencies, the transmitter antenna pattern displays one major lobe. As the frequency is increased, additional lobes appear, accompanied by an equal number of nulls.

Conclusion

From Table 1 above, one can readily conclude that a half-wavelength short-wave receiving antenna located 75 feet from a single-phase residential or rural primary distribution circuit which includes a BPL signal of conducted power density approximately –50 dBm/Hz will experience broadband "noise-like" interference at least 12dB stronger than an "extremely strong" (i.e., "S-9") desired signal. Typically, the interference will be "20 dB over S-9." Under most circumstances, HF radio reception is impossible at these noise levels.

The conducted BPL signals would need to be in excess of 60 dB weaker than the levels predicted in this brief study to be inaudible in the short-wave receiving setup analyzed here. This implies a conducted maximum power spectral density approximately –110 dBm/Hz.

BPL as it is presently proposed would not be a good radio frequency "neighbor" in a typical suburban neighborhood.

Respectfully submitted,

Lewis D. Collins