EXHIBIT A

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BPL Trial Systems Electromagnetic Emission Tests
Metavox, Inc.
March 20, 2004

INTRODUCTION

Metavox, Inc, Dulles, VA, conducted electromagnetic emission testing of several BPL trial systems. This effort included the conduct of independent measurements of the radiated emissions from overhead power line systems distributing Broadband over Power Line (BPL) service to residential subscribers. This is a new technology and the tests were conducted on trial BPL systems deployed to test the BPL concept and hardware.

BPL systems use digital signal communications of wide bandwidth. The systems are known to occupy spectrum in the frequency region from 1.7 MHz (just above the AM broadcast frequencies) to 30 MHz, with harmonic content into the VHF spectrum. Some of these trial systems are licensed to conduct testing over a 1.7 MHz to an 80 MHz range.

The purpose of the tests conducted here is to measure the field strength of radiated emissions from BPL systems in order to provide a quantitative basis for assessing their potential for interference to licensed radio systems operating in the same frequency range. Most BPL systems seek to operate under limits established by the FCC for Part 15 devices as unlicensed, unintended emitters. The testing conducted here will assist in efforts to compare the observed BPL emissions to the emission limits established by FCC pertaining to unlicensed devices [ref. Appendix 4: FCC Part 15 Rules]. Specifically, FCC in Part 15 currently "requires that unlicensed devices operating below 30 MHz comply with a quasi-peak radiated emission limit of 30 μV/m at a distance of 30 meters at all frequencies over the range from 1.705 to 30 MHz."

On March 7th and 8th, 2004, measurements were taken at two BPL trial systems in eastern Pennsylvania, in the vicinity of Allentown. On March 15, 2004, measurements were taken at a BPL system trial in Manassas, Virginia. The test sites are detailed in Appendix 1: Sites. The results of the Metavox tests are tabulated in Appendix 2: Test Data and a description of the testing and test sites is described in the following sections.

APPROACH

Metavox outfitted a mobile van with calibrated emission-measuring equipment (see Appendix 3: Equipment). The mobility is used in the area of a BPL system to first locate specific positions where the BPL radiated emission is clearly detectable. A picture at the Emmaus-1 test site is shown in Figure-1. Figure-2 shows the electronics bench in the van interior with (from left to right on the bottom row of equipment) an HP 141T/8553L/8552A spectrum analyzer, a Tektronix 485 oscilloscope, and the Rohde & Schwarz ESH-2 test receiver. Above them is a Boonton 92A-S2 RF millivoltmeter and a Teac RD-111T PCM instrumentation recorder.

Figure 1 Test Van Set Up at Emmaus Test Site

For signal survey while underway, an ARA ODC-100/D rod antenna is mounted on the roof of the van. For signal level measurements, the ARA BBH-500/B active loop antenna is set out at about 5 to 10 meters from the vehicle as shown in Figure-1. The tripod positions the center of the loop at 160 cm above the ground. The full array of equipment is used in site selection to determine that the BPL signal is distinguishable and that the signal strength is adequately handled within the dynamic range of the instruments. However, in the test measurement process, only the active loop antenna, ARA model Model BBH-500/B, and ESH2 receiver are used for taking data. These instruments are calibrated to standards traceable to National Institute for Standards and Technology (NIST).

Each field strength measurement is accurate within +/- 1.5 dBμV/m since measurement accuracy is the combination of (uncorrelated) factors for the antenna (ARA model Model BBH-500/B) and the test receiver (Rohde & Schwarz ESH2) as given in the Appendix 2: Equipment.

The placement and orientation of the antenna is made considering all of the conductors of the surrounding power distribution system including the medium voltage power conductors, the secondary cable between transformers, and the secondary cables to houses. Figure-3 shows the typical array of overhead lines on a pole in a suburban neighborhood being served with BPL. The figure shows 3-phase medium voltage on top, the power transformer, the BPL equipment box with connection to one of the phases of the medium voltage and connections to the secondary-voltage side of the transformer. The secondary-voltage cables run in several directions from this transformer. Also on the pole are fiber-optic cabling, media/TV cabling, and telephone distribution cabling.

When possible, the antenna is placed such that the slant range from each one of the power conductors is at least 30 meters, and such that for the conductor closest to the antenna, the closest point to the antenna is:

-- near the center of the power line span between poles, and
-- at 30 meters slant range.

A measurement of the output of the active loop is first made using a 300 MHz bandwidth Tektronix 485 oscilloscope to insure the active circuits are not overloaded by a strong signal.. Measurements are then taken at three orthogonal orientations of the antenna for each frequency. The data presents individual measurements on all three orientations along with the combined 3 axis RMS of the 3 voltages expressed in dB. This value represents the expected maximum if the antenna were orientated for the maximum level.

Figure 3 Emmaus-1 Test Site Power Pole and Lines Including BPL Installation

TEST DESCRIPTION

Emmaus-1b

Testing was performed on a BPL system operating in Emmaus, PA (see Appendix 1: Sites, Emmaus-1b) on , March 8, 2004. The detailed results are presented in Appendix 2: Test Data, Emmaus-1b. For this test the H-field antenna was situated at 30 meters slant range from the nearest power line conductor and at a height of 1.6 meters above ground, permitting direct comparison with the FCC Part 15 limit. Three orthogonal orientations of the antenna were used: the antenna axis horizontal and parallel to the power lines, horizontal and perpendicular to the power lines, and vertical. Data was taken at 12 frequencies from 3.5 MHz through 20 MHz. These 12 frequencies were chosen on site as the BPL signal maximums free of other signals observed in a preliminary scan of the spectrum from 1.7 to 30 MHz. The BPL signal at this site was impulsive and distinctive and clearly distinguishable from 60 Hz power line noise

Emmaus-2

A second site in Emmaus, PA was chosen outside the area of the Emmaus BPL system in order to assess the background of radiated emissions (see Appendix 1: Sites Emmaus-2). The detailed results are presented in Appendix 2: Test Data, Emmaus-2. For this site, the H-field antenna was situated at 30 meters slant range from the nearest 3-phase power line conductor and a height of 1.6 meters above ground. Three orthogonal orientations of the antenna were used: the antenna axis horizontal and parallel to the power lines, horizontal and perpendicular to the power lines, and vertical. Data was taken at 27 frequencies from 1.71 MHz through 21.5 MHz. These 27 frequencies were chosen on site as being free of other signals observed in a preliminary scan of the spectrum from 1.7 to 30 MHz. No BPL signals were observed. Removing the antenna from the ESH-2 receiver resulted in a reduced signal level on all test frequencies. All measurements appear to represent the noise floor of the antenna and likely do not represent the external noise floor of the site.

Whitehall-1a

Testing was performed on a BPL system in Whitehall Township, PA, (Appendix 1: Sites, Whitehall-1a) on March 8, 2004. The detailed results are presented in Appendix 2: Test Data, Whitehall-1a. The private property boundaries prevented the placement of the antenna at a 30 meter slant range. The tests were conducted with the H-field antenna situated at 12.6 meters slant range from the nearest power line conductor and at a height of 1.6 meters above ground. At this site, the radiated field strength was assessed at 15 frequencies from 3.2 to 30 MHz. These 15 frequencies were chosen on site as the maximums observed in a preliminary scan of the spectrum from 1.7 to 30 MHz. The BPL signal was a series of closely spaced carriers throughout the test range and was clearly distinguishable from 60 Hz power line interference.

A local AM broadcast station potentially overloaded the active loop antenna so it could only be used for measurements when it was oriented to minimize the strength of this signal. This precluded the 3 orthogonal measurements that were conducted at the other sites.

Controversies in methods for extrapolation of data for distance between antenna position and conductors of the system make comparison with the FCC Part 15 limit difficult (see Appendix 4: FCC Part 15 Rules; Section: Example and Section Comments on Extrapolation Method)

Emmaus-1a

Testing was performed on a BPL system operating in Emmaus, PA (see Appendix 1: Sites, Emmaus-1a) on, March 15, 2004. The detailed results are presented in Appendix 2: Test Data, Emmaus-1a. At the same location as the Emmaus-1b site described above, measurements were taken at a second placement of the antenna to provide some experience with extrapolation methods (see Appendix 4: FCC Part 15 Rules; Section: Example and Section Comments on Extrapolation Method). At the closer placement the slant range from antenna to the nearest power-line conductor (240 volt secondary hung below the 3-phase medium voltage lines) is 17.6 meters.

For the various frequencies tested, the greatest field strength was found at different orientations of the antenna for the different ranges.

Manassas-1

Testing was performed on a BPL system operating in Manassas, VA (see Appendix 1: Sites, Manassas-1) on, March 15, 2004. The detailed results are presented in Appendix 2: Test Data, Manassas-1. For this site, the H-field antenna was situated at 30 meters slant range from the nearest power line conductor and at a height of 1 meter above ground, permitting direct comparison with the FCC Part 15 limit. Three orthogonal orientations of the antenna were used: the antenna axis horizontal and parallel to the power lines, horizontal and perpendicular to the power lines, and vertical. Data was taken at 18 frequencies from 3.5 MHz through 20 MHz. These 18 frequencies were chosen on site as the BPL signal maximums free of other signals observed in a preliminary scan of the spectrum from 1.7 to 30 MHz. The BPL signal at this site was impulsive and distinctive and clearly distinguishable from 60 Hz power line noise

CONCLUSIONS

In general, positioning a test antenna at 30 meters from a radiating power line while also avoiding other radiating line was difficult. Streets tend to be about 10 meters wide with overhead power lines running down one or both sides. Moving more than 10 meters puts the test antenna off of the public right of way and onto private properties. Even then, the antenna will end up closer than 30 meters from internal house wiring and overhead low voltage lines that will likely carry BPL signals. For compliance testing in residential neighborhoods, standards should be set using a more practical distance than 30 meters.

Extrapolations are controversial for good reason and do not resolve the problem. Our Whitehall-1 set of measurements illustrate the difficulties and contradictions of this problem. See Appendix 4: FCC Part 15 Rules for more detail.

Similar problems arose with our measurements at Manassas-1 where they were done in a drainage culvert. Levels are probably a little bit low due to the slight depression of the antenna position from the surrounding land. This further illustrates the problems we encountered in achieving a 30 meter distance.

At the same time, distances less than 30 meters would be more representative of the distances residential users are constrained to for radio receiving antennas. This would create better correlation between the specification levels and the interference experienced by radio users. At the same time specifications at these lesser distances would provide a more objective measure for compliance testing.

The trial BPL systems seemed to be lightly loaded and very few data bursts were heard or observed. The observed emissions were deduced to be keep-alive or synchronization signals. More realistic loading for a neighborhood with multiple users conducting streaming audio and downloads would represent a more realistic situation for worst case emission tests for interference and specification compliance.

Measurements were made using the receiver's CISPR mode. The CISPR measurement mode provides an objective measure of the effect of an interference on the reception of radio telephony. The observed interference at Emmaus and Manassas were pulse-like in nature but the unloaded repetition rate was rather low so the meter was observed to fluctuate over 3-4 dB during the measurement. The peak reading over an observing period of 10-20 seconds was recorded. A more fully loaded system is expected to register a steadier reading. Also a longer decay time on the instrument such as provided by the peak measuring option would be expected to give a more objective reading less sensitive to the observer or observing time and to reflect measurements on a system fully loaded with data transfers.

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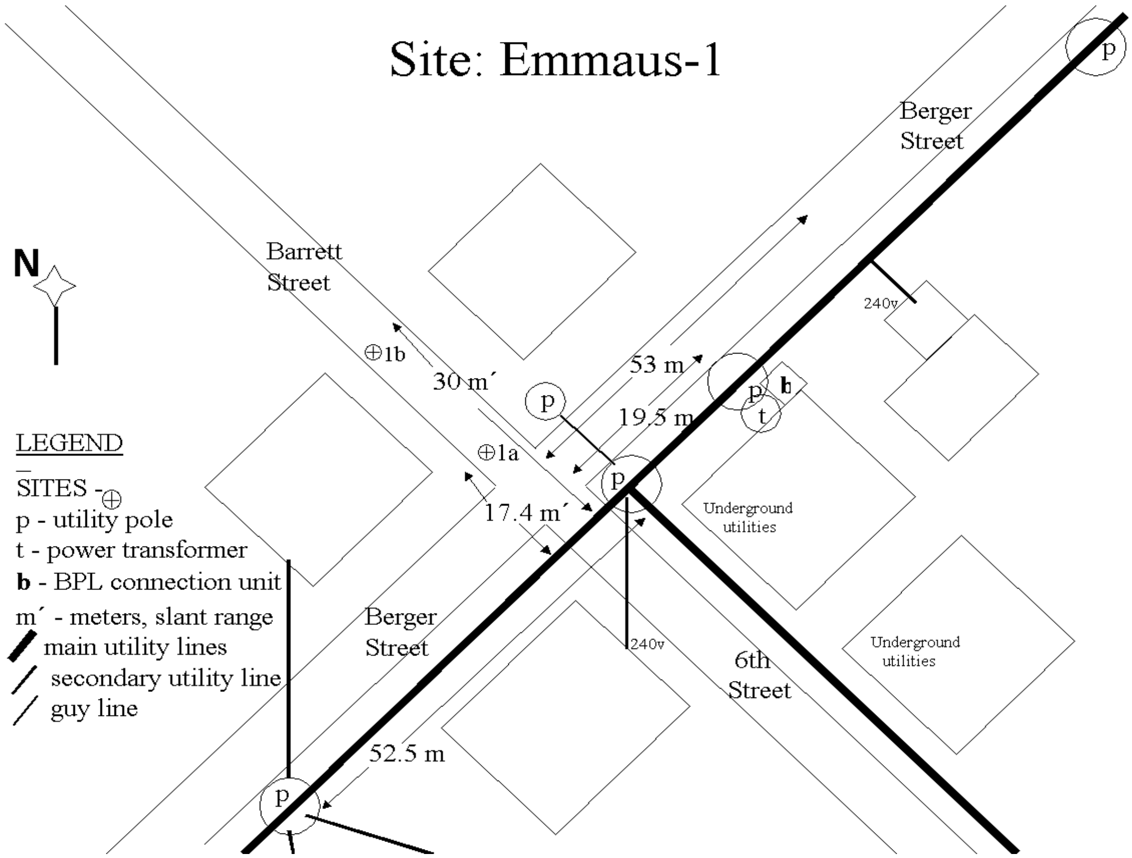
Emmaus-1b

This Emmaus site is on the west corner of Berger (running northeast - southwest) and Barrett Streets (Barrett is the continuation of 6th Street). The properties on these street are suburban residential served by utility lines along Berger Street with a junction (a “T”) running from the utility pole on the east corner of the intersection to the southeast down 6th Street. At this utility pole on the east corner, the medium voltage 3-phase power line transitions to a vertical stacking from horizontal lines on crossbars on the adjacent poles along Berger Street. At the closest point to the antenna placement, which is 16.5 meters down Berger street from the pole, the utility lines consist of (from top to bottom) the three medium voltage conductors, separated vertically, a fiber-optic cable, the low voltage secondary power cable, the media cable, and cabled telephone distribution. The fiber-optic cable is likely carrying the broadband Internet communications to the BPL system. Power transformer and a BPL connections (between one-phase of the medium voltage and the secondary cable) are on an adjacent utility pole to the northeast on Berger Street (19.5 meters from the intersection).

Emmaus-1a

At the same location as the Emmaus-1b site, measurements were takes at a second placement of the H-field antenna to provide some experience with extrapolation methods (see Appendix 4: FCC Part 15 Rules; Section: Example and Section Comments on Extrapolation Method). The configuration of the utility distribution is the same as described for the site Emmaus-1b with only the placement of the H-field antenna closer - 17.6 meters slant range from the nearest power-line conductor (240 volt secondary hung below the 3-phase medium voltage lines).

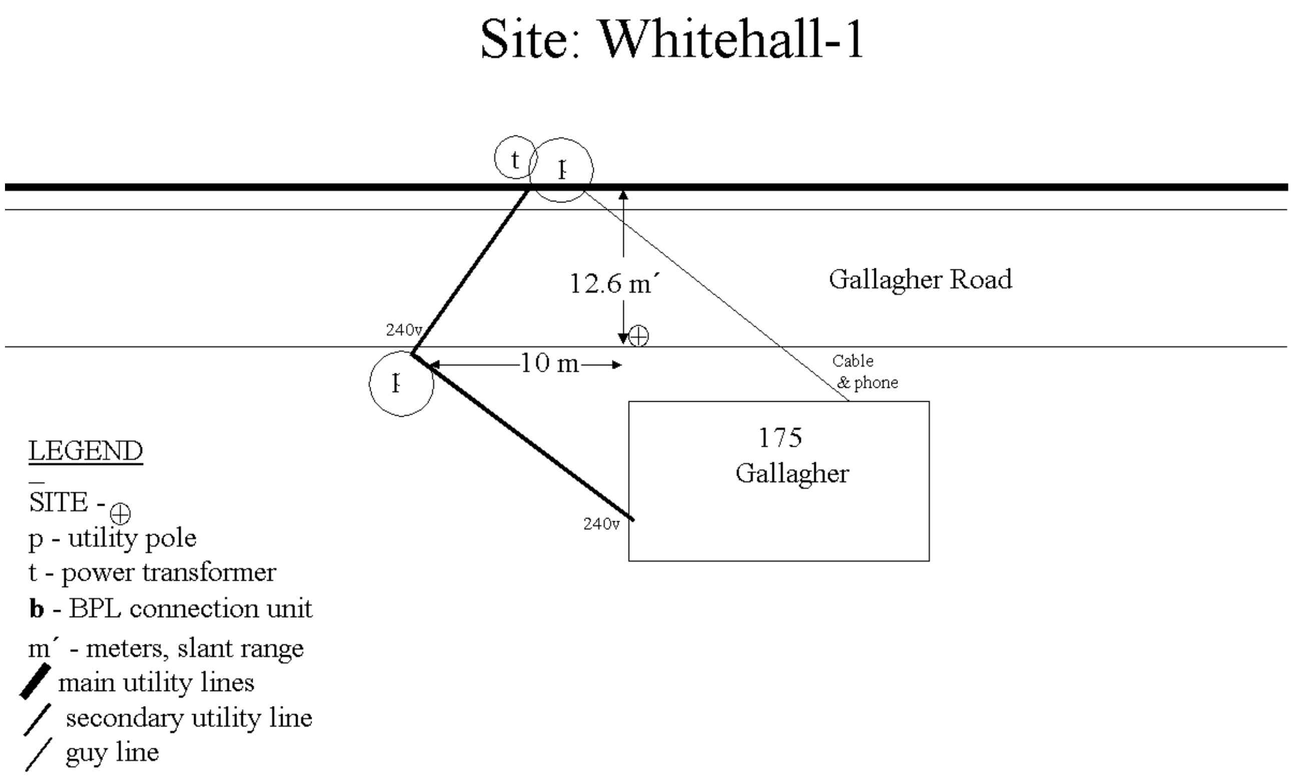

Site: Emmaus-1
N
Berger Street
Barrett Street
⊕1b
30 m´
53 m
19.5 m
p
b
t
⊕1a
17.4 m´
240v
Underground utilities
LEGEND
SITES - ⊕
p - utility pole
t - power transformer
b - BPL connection unit
m´ - meters, slant range
main utility lines
secondary utility line
guy line
Berger Street
6th Street
52.5 m

Emmaus-2

This Emmaus site, about 1.5 kilometer from the site of Emmaus-1a&b, is on Farr Road at the entrance to the Pool Wildlife Sanctuary. The site was chosen outside the area of the Emmaus BPL system in order to assess the background of radiated emissions in the area. This portion of Farr Road is a secondary road surrounded by open fields with a typical 3-phase power line along the side of the roadway. No transformers or secondary lines were in the vicinity. Five fiber optic cables were vertically stacked below the power lines. No map is provided for Emmaus-2.

Whitehall-1

This Whitehall Township site is on Gallagher Road, off Mauch Chunk Road, in a suburban residential area. The residence at 175 Gallagher Road and adjacent properties on both sides of the street are served by utility lines along the road. The configuration is 3-phase medium voltage cables stacked vertically, with media cable and telephone cable underneath. The residential properties constrained the placement of the antenna to the road-width (approximately 10 meters on the ground).



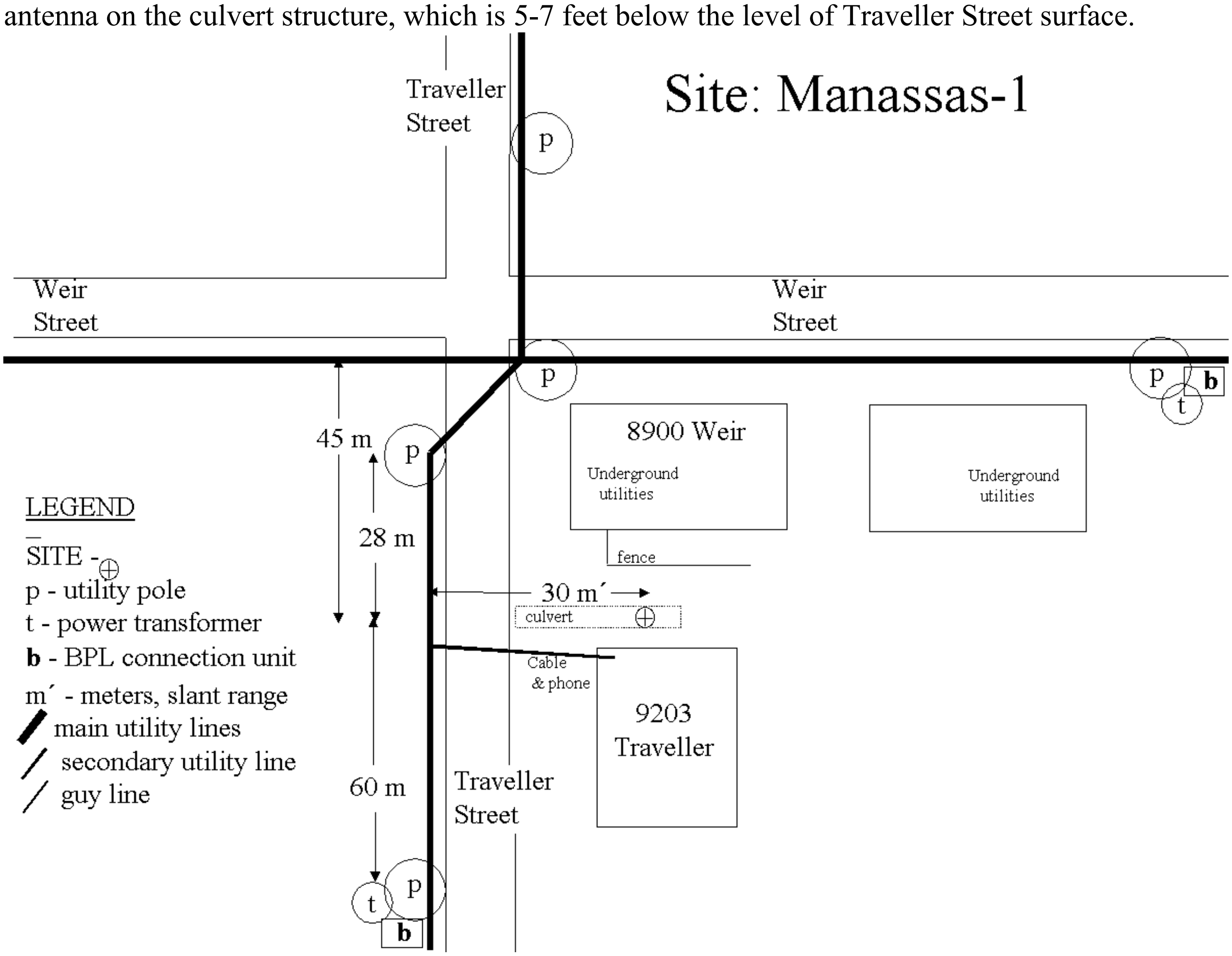
Manassas-1

This site at the Manassas BPL system is on Traveller Street near the intersection with Weir Street in a suburban residential area.. It is possible to get off Traveller Street to a distance of 30 meters slant range from the power line conductors along the street by using a drainage culvert on the side of the property at 9203 Traveller Street and behind the property at 8900 Weir Street.

The point on the line closest to the site is 28 meters from the nearest utility pole, and the total length of the span is 88 meters with the power transformer and BPL connections at the far end. The utility lines consist of (from top to bottom) a single-phase medium voltage power cable, a secondary power cable, a media cable, and a telephone cable. This single-phase medium-voltage power line connects to a three-phase line running down the near side of Weir Street.

A utility pole at the near corner of Traveller and Weir Streets is approximately 45 meters from the antenna placement and is the mounting point for the BPL system's connection to fiber-optic cable. No transformer is mounted, but a BPL unit interconnects one of the medium-voltage phases and the secondary cables. The utility lines on this pole, which run along Weir Street, consist of (from top to bottom) three-phase medium power cables on a cross bar, secondary power cable, 2 fiber-optic cables which turn at this juncture to cross Weir Street and extend along Traveller Street in the opposite direction, a ground cable supporting the media/TV cable, and a telephone distribution cable. All utilities to the corner house adjacent to this pole are underground.

Reception of the BPL emission is probably limited at this site by the low elevation of the antenna on the culvert structure, which is 5-7 feet below the level of Traveller Street surface.



Appendix 2: Test Data

Emmaus-1b

Site: **Emmaus-1b**

Monday, March 8, 2004 — **H-Probe Antenna**: ARA Model BBH-500/B

Berger & 6th, West corner

Emmaus, PA

Frequency MegaHertz	‖ Cable ‖ #1 ⇓ (blue) dB loss	[‖Antenna ‖ ⇓ $dB_{1/meter}$	**Receiver Indicated Strength** Factor (equiv. electrical, interpolated)] // to Line Gain base	// to Line dBμV +meter	| to Line Gain base	| to Line dBμV +meter	Vertical Gain base	Vertical dBμV +meter	**Field Strength** // to Line $dB_{\mu V/m}$	| to Line $dB_{\mu V/m}$	Vertical $dB_{\mu V/m}$	RMS (3-axis) $dB_{\mu V/m}$
3.50	1.2	-6.09	30	14.0	30	14.0	20	8.0	**39.1**	**<u>39.1</u>**	**23.1**	42.2
5.62	1.2	-6.87	30	16.0	40	6.0	20	10.0	**38.3**	**<u>40.3</u>**	**24.3**	42.5
6.86	1.5	-6.87	30	16.0	40	7.0	30	8.0	**40.6**	**<u>41.6</u>**	**32.6**	44.5
8.01	1.8	-6.87	40	15.0	40	16.0	30	6.0	**40.9**	**<u>50.9</u>**	**30.9**	51.4
8.75	1.7	-6.87	40	12.0	40	13.0	30	7.0	**46.8**	**<u>47.8</u>**	**31.8**	50.4
11.01	1.6	-6.54	30	7.0	30	12.0	20	12.0	**32.1**	**<u>37.1</u>**	**27.1**	38.6
11.23	1.6	-6.47	30	11.0	40	7.0	20	16.0	**36.1**	**<u>42.1</u>**	**31.1**	43.4
14.00	2.0	-5.57	30	13.0	30	14.0	20	12.0	**39.4**	**<u>40.4</u>**	**28.4**	43.1
15.01	2.1	-5.25	20	14.0	30	7.0	20	7.0	**30.9**	**<u>33.9</u>**	**23.9**	35.9
17.25	2.2	-4.52	20	13.0	30	15.0	30	7.0	**30.7**	**<u>42.7</u>**	**34.7**	43.5
18.68	2.2	-4.06	20	13.0	30	9.0	20	11.0	**31.1**	**<u>37.1</u>**	**29.1**	38.6
20.01	2.2	-3.63	10	14.0	20	10.0	10	15.0	**22.6**	**<u>28.6</u>**	**23.6**	30.5

Site Monitor: antenna output scope (peak-peak)

typical: 20 mV

maximum: 60 mV

Notes:
underline: orientation of max field
a: antenna noise floor
b: marginally above noise floor
c (or blank): definite BPL signal
d: data burst
p: peak BPL in frequency region

Site: **Emmaus-1a**

Sunday, March 7, 2004 — **H-Probe Antenna**: ARA Model BBH-500/B

Berger & 6th, West corner

Emmaus, PA

Frequency MegaHertz	‖ Cable #1 ⇓ (blue) dB loss	[‖Antenna Factor (equiv. electrical, interpolated)] ‖ ⇓ $dB_{1/meter}$	Receiver Indicated Strength: // to Line Gain dBμV base	// to Line meter	| to Line Gain dBμV base	| to Line meter	Vertical Gain dBμV base	Vertical meter	Field Strength: // to Line $dB_{\mu V/m}$	| to Line $dB_{\mu V/m}$	Vertical $dB_{\mu V/m}$	RMS (3-axis) $dB_{\mu V/m}$
1.71	1.2	-2.69	10	13.0	10	15.0	10	10.0	**21.5** a	**23.5** a	**18.5** a	26.4
2.00	1.2	-4.05	10	12.0	10	13.0	10	10.0	**19.2** b	**20.2** a	**17.2** b	23.8
2.82	1.2	-5.51	10	10.0	20	13.0	10	11.0	**15.7**	**28.7** b	**16.7** c	29.2
3.00	1.2	-5.83	20	16.0	30	9.0	10	15.0	**31.4**	**34.4**	**20.4**	36.2
3.50	1.2	-6.09	40	6.0	30	16.0	20	14.0	**41.1**	**41.1**	**29.1**	44.3
5.12	1.2	-6.87	30	8.0	30	13.0	20	5.0	**32.3**	**37.3**	**19.3**	38.6
5.62	1.2	-6.87	30	14.0	30	15.0	20	10.0	**38.3** p	**39.3**	**24.3**	41.9
6.54	1.4	-6.87	30	10.0	30	14.0	20	12.0	**34.5**	**38.5**	**26.5**	40.2
6.74	1.4	-6.87	20	10.0	20	9.0			**24.5**	**23.5**		27.1
6.86	1.5	-6.87	30	14.0	40	11.0	20	16.0	**38.6** p	**45.6**	**30.6**	46.5
7.63	1.7	-6.87	30	10.0	40	9.0	20	14.0	**34.8**	**43.8**	**28.8**	44.5
8.01	1.8	-6.87	40	12.0	50	10.0	30	12.0	**46.9**	**54.9**	**36.9**	55.6
8.75	1.7	-6.87	40	11.0	40	16.0	30	11.0	**45.8**	**50.8**	**35.8**	52.1
10.04	1.4	-6.86	30	8.0	40	10.0	20	12.0	**32.5**	**44.5**	**26.5**	44.9
11.01	1.6	-6.54	30	12.0	30	16.0	20	15.0	**37.1**	**41.1**	**30.1**	42.8
11.23	1.6	-6.47	40	8.0	40	12.0	30	8.0	**43.1** p	**47.1**	**33.1**	48.7
14.00	2.0	-5.57	30	12.0	30	16.0	20	14.0	**38.4**	**42.4**	**30.4**	44.1
14.10	2.0	-5.54	30	5.0	30	10.0	20	10.0	**31.5**	**36.5**	**26.5**	38.0
14.21	2.0	-5.51	30	2.0	30	7.0	20	11.0	**28.5**	**33.5**	**27.5**	35.4
14.30	2.0	-5.48	30	5.0	30	8.0	20	12.0	**31.5**	**34.5**	**28.5**	37.0
14.35	2.0	-5.46	30	7.0	30	12.0	20	16.0	**33.5**	**38.5**	**32.5**	40.5
15.01	2.1	-5.25	30	5.0	30	6.0	20	11.0	**31.9**	**32.9**	**27.9**	36.1
16.00	2.1	-4.93	20	6.0	20	8.0	20	16.0	**23.2**	**25.2**	**33.2** d	34.2
17.00	2.2	-4.60	20	6.0	30	15.0	30	10.0	**23.6**	**42.6**	**37.6**	43.8
17.25	2.2	-4.52	30	10.0	40	8.0	30	12.0	**37.7** p	**45.7**	**39.7**	47.2
18.00	2.2	-4.28	20	10.0	30	8.0	20	12.0	**27.9**	**35.9**	**29.9**	37.4
18.68	2.2	-4.06	30	8.0	30	10.0	20	12.0	**36.1**	**38.1**	**30.1**	40.7
19.00	2.2	-3.95	20	12.0	20	12.0	20	5.0	**30.2**	**30.2**	**23.2**	33.7
20.01	2.2	-3.63	20	8.0	20	10.0	20	7.0	**26.6** a	**28.6**	**25.6**	31.9
21.00	2.2	-3.23	10	14.0	20	2.0	10	10.0	**23.0** d	**21.0** a	**19.0** a	26.0
21.50	2.2	-3.03	10	4.0	10	11.0	10	10.0	**13.2** a	**20.2** a	**19.2** a	23.2

Site Monitor: antenna output, scope (peak-peak)

typical: 20 mV

maximum: 60 mV

Notes: underline: orientation of max field

a: antenna noise floor

b: marginally above noise floor

c (or blank): definite BPL signal

d: data burst

p: peak BPL in frequency region

Site: **Emmaus-2**

Sunday, March 7, 2004 **H-Probe Antenna**: ARA Model BBH-500/B
Farr Road
Emmaus, PA

Frequency MegaHertz	‖ Cable ‖ #1 ⇓ (blue) dB loss	[‖Antenna Factor (equiv. electrical, interpolated)] ‖ ⇓ dB$_{1/meter}$	// to Line Gain dBµV base	// to Line meter	| to Line Gain dBµV base	| to Line meter	Vertical Gain dBµV base	Vertical meter	// to Line dB$_{µV/m}$	| to Line dB$_{µV/m}$	Vertical dB$_{µV/m}$	RMS (3-axis) dB$_{µV/m}$
			Receiver Indicated Strength						**Field Strength**			
1.71	1.2	-2.69	10	11.0	10	13.0	10	11.0	**19.5** a	**21.5**	**19.5**	25.1
2.10	1.2	-4.23	10	11.0	10	12.0	10	11.0	**18.0** a	**19.0**	**18.0**	23.1
3.00	1.2	-5.83	10	11.0	10	12.0	10	11.0	**16.4** a	**17.4**	**16.4**	21.5
3.50	1.2	-6.09	10	11.0	10	11.0	10	11.0	**16.1** a	**16.1**	**16.1**	20.9
5.12	1.2	-6.87	10	12.0	10	13.0	10	11.0	**16.3** a	**17.3**	**15.3**	21.2
5.61	1.2	-6.87	10	12.0	10	11.0	10	11.0	**16.3** a	**15.3**	**15.3**	20.5
6.55	1.4	-6.87	10	11.0	10	11.0	10	10.0	**15.5** a	**15.5**	**14.5**	20.0
6.74	1.4	-6.87	10	11.0	10	11.0	10	10.0	**15.5** a	**15.5**	**14.5**	20.0
6.86	1.5	-6.87	10	11.0	10	11.0	10	10.0	**15.6** a	**15.6**	**14.6**	20.1
7.63	1.7	-6.87	10	10.0	10	11.0	10	10.0	**14.8** a	**15.8**	**14.8**	20.0
8.01	1.8	-6.87	10	10.0	10	10.0	10	10.0	**14.9** a	**14.9**	**14.9**	19.7
8.72	1.7	-6.87	10	10.0	10	10.0	10	10.0	**14.8** a	**14.8**	**14.8**	19.6
10.04	1.4	-6.86	20	8.0	20	9.0	20	11.0	**22.5** a	**23.5**	**25.5**	28.8
11.00	1.6	-6.55	20	5.0	20	9.0	20	12.0	**20.1** a	**24.1**	**27.1**	29.4
11.23	1.6	-6.47	20	5.0	20	5.0	20	10.0	**20.1** a	**20.1**	**25.1**	27.3
14.00	2.0	-5.57	10	7.0	10	7.0	10	7.0	**13.4** a	**13.4**	**13.4**	18.2
14.10	2.0	-5.54	10	8.0	10	9.0	10	9.0	**14.5** a	**15.5**	**15.5**	19.9
14.15	2.0	-5.53	10	8.0	10	7.0	10	7.0	**14.5** a	**13.5**	**13.5**	18.6
14.36	2.0	-5.46	10	10.0	10	9.0	10	8.0	**16.5** a	**15.5**	**14.5**	20.4
15.01	2.1	-5.25	10	7.0	10	5.0	10	8.0	**13.9** a	**11.9**	**14.9**	18.5
16.00	2.1	-4.93	10	6.0	10	5.0	10	6.0	**13.2** a	**12.2**	**13.2**	17.6
17.00	2.2	-4.60	10	4.0	10	4.0	10	4.0	**11.6** a	**11.6**	**11.6**	16.4
18.00	2.2	-4.28	10	4.0	10	3.0	10	3.0	**11.9** a	**10.9**	**10.9**	16.1
19.00	2.2	-3.95	10	3.0	10	3.0	10	3.0	**11.2** a	**11.2**	**11.2**	16.0
20.01	2.2	-3.63	10	4.0	10	3.0	10	3.0	**12.6** a	**11.6**	**11.6**	16.7
21.00	2.2	-3.23	10	3.0	10	3.0	10	2.0	**12.0** a	**12.0**	**11.0**	16.4
21.50	2.2	-3.03	10	3.0	10	3.0	10	2.0	**12.2** a	**12.2**	**11.2**	16.6

Site Monitor: antenna output
scope (peak-peak)
typical: 50 mV
maximum: 50 mV

Notes:
underline: orientation of max field
a: antenna noise floor
b: marginally above noise floor
c (or blank): definite BPL signal
d: data burst
p: peak BPL in frequency region

Site: **Whitehall-1a**

Monday, March 8, 2004 **H-Probe Antenna**: ARA Model BBH-500/B
175 Gallagher Road
Whitehall Township, PA

	|| Cable || #2 ⇓	[||Antenna Factor (equiv. electrical, interpolated)] || ⇓	Receiver Indicated Strength // to Line Gain dBμV			to Line Gain dBμV	Vertical Gain dBμV	Field Strength // to Line $dB_{\mu V/m}$		to Line $dB_{\mu V/m}$	Vertical $dB_{\mu V/m}$
Frequency MegaHertz	dB loss	$dB_{1/meter}$	base+meter		base+meter	base+meter			
3.24	0.7	-5.95	20	13.0			**27.7**		
4.22	0.8	-6.46	10	14.0			**27.3**		
4.29	0.7	-6.50	20	8.0			**18.2**		
5.07	0.6	-6.87	30	6.0			**21.7**		
5.54	0.5	-6.87	20	5.0			**18.6**		
7.35	0.5	-6.87	30	8.0			**31.6**		
9.52	0.7	-6.87	30	11.0			**34.8**		
10.07	0.8	-6.85	30	11.0			**35.0**		
10.32	0.8	-6.77	30	12.0			**36.0**		
22.64	0.8	-2.57	10	7.0			**15.2**		
24.25	0.9	-1.93	10	7.0			**16.0**		
26.95	1.0	-0.84	20	7.0			**27.2**		
28.85	0.9	-0.08	20	7.0			**27.8**		
29.03	0.8	-0.01	20	12.0			**32.8**		

Site Monitor: antenna output
scope (peak-peak)
typical: 200 mV
maximum: 200 mV
Strong AM broadcast
Antenna oriented to null AM broadcast
Orthogonal measurement not possible

Notes: underline:orientation of max fie
a: antenna noise floor
b: marginally above noise floor
c (or blank): definite BPL signal
d: data burst
p: peak BPL in frequency region

Site: **Manassas-1**

Monday, March 15, 2004 — **H-Probe Antenna**: ARA Model BBH-500/B
Traveller & Weir Streets
Manassas, VA

Frequency MegaHertz	‖ Cable #1 ⇓ (blue) dB loss	[‖Antenna Factor (equiv. electrical, interpolated)] ‖ ⇓ dB 1/meter	Receiver Indicated Strength: // to Line Gain dBμV base	// to Line meter	| to Line Gain dBμV base	| to Line meter	Vertical Gain dBμV base	Vertical meter	Field Strength: // to Line dB μV/m	| to Line dB μV/m	Vertical dB μV/m	RMS (3-axis) dB μV/m
3.50	1.2	-6.09	20	15.0	20	11.0	10	12.0	**30.1**	**26.1**	**17.1** a	31.7
4.00	1.2	-6.35	20	14.0	20	12.0	10	15.0	**29.9**	**26.9**	**19.9** b	31.9
5.62	1.2	-6.87	20	14.0	20	12.0	10	14.0	**28.3** p	**26.3**	**18.3**	30.7
6.86	1.5	-6.87	20	13.0	30	7.0	10	16.0	**28.6**	**31.6**	**20.6**	33.6
7.10	1.5	-6.87	20	13.0	30	7.0	20	17.0	**27.6**	**31.6**	**31.6**	35.4
8.01	1.8	-6.87	30	9.0	30	7.0	10	15.0	**33.9** p	**31.9**	**19.9**	36.2
8.75	1.7	-6.87	30	10.0	30	10.0	10	15.0	**34.8**	**34.8** p	**19.8**	37.9
10.15	1.4	-6.82	20	10.0	30	10.0	20	9.0	**24.6**	**34.6**	**23.6**	35.3
10.93	1.6	-6.57	20	16.0	30	9.0	20	9.0	**31.0**	**34.0**	**24.0**	36.1
11.01	1.6	-6.54	20	9.0	20	13.0	10	11.0	**24.1**	**28.1**	**16.1**	29.7
11.23	1.6	-6.47	20	10.0	20	14.0	10	13.0	**25.1**	**29.1**	**18.1**	30.8
12.18	1.8	-6.16	20	15.0	20	15.0	10	13.0	**30.6** p	**30.6**	**18.6**	33.8
14.00	2.0	-5.57	20	15.0	20	14.0	10	12.0	**31.4**	**30.4**	**18.4**	34.1
14.36	2.0	-5.46	20	11.0	20	7.0	10	11.0	**27.5**	**23.5**	**17.5**	29.3
15.01	2.1	-5.25	20	8.0	20	6.0	10	9.0	**24.9**	**22.9**	**15.9**	27.3
17.25	2.2	-4.52	10	15.0	20	8.0	10	7.0	**22.7**	**25.7**	**14.7**	27.7
18.68	2.2	-4.06	10	11.0	10	12.0	0	13.0	**19.1**	**20.1**	**11.1** a	23.0
20.01	2.2	-3.63	0	15.0	10	11.0	0	14.0	**13.6**	**19.6**	**12.6** b	21.2

Site Monitor: antenna output
scope (peak-peak)
typical: 20 mV
maximum: 20 mV

Notes:
underline: orientation of max field
a: antenna noise floor
b: marginally above noise floor
c (or blank): definite BPL signal
d: data burst
p: peak BPL in frequency region

Appendix 3: Equipment

Metavox tests used equipment calibrated to standards traceable to National Institute for Standards and Technology (NIST):

- Amplified magnetic-field antenna
- Receiver capable of tuning HF frequencies, with quasi-peak detection matching CISPR specifications.

Amplified H-Field Antenna: ARA Technologies, Inc., Model BBH-500/B, Serial Number 311

Reference: "Data Book, Magnetic Field Antennas, BBH-500/B", page 42; Antenna Research Associates, Inc, Beltsville, Maryland, 20705

The BBH series of broadband magnetic field (H field) receiving antennas are designed to provide maximum sensitivity for receiving magnetic field signals in the VLF, 100 Hz, through VHF, 100MHz, spectrum. These antennas are responsive primarily to the magnetic component of an electromagnetic field with practically no sensitivity to the electric component. The electrical balance with respect to ground and cable renders them almost immune to common mode interference. They exhibit remarkably clean reception in environments of locally generated man-made noise.

The far-field receiving pattern is that of an elementary dipole with nulls of approximately –20 dB occurring off the ends of the rod. Integral active networks ensure the highest possible sensitivity. The BBH antennas yield much greater accuracy in measuring the tangential field of a source at close range than is possible with typical air core loops.

An internal power supply and rechargeable batteries in these antennas minimize disturbances and permit operation under practically any condition.

Magnetic field strength indication from the H-field antenna device is converted to electric field strength by the free space impedance with the common value of 377Ω:

$$af^{electric}_{(dB/m)} = af^{magnetic}_{(dB/m)} + 51.35_{dB\Omega}$$

The noise floor of the H-field antenna, referred to the field strength input (by the manufacturer's specifications, and referenced to the CISPR bandwidth of 9kHz, i.e. 9.54 dB relative to 1kHz) is:

Frequency, MHz:	1	3	10	30
Noise Floor Field Strength, $dB_{\mu V/m}$:	34.9	5.9	2.9	10.9

Calibration: The Antenna Research Associates Model BBH-500/B, Serial Number 311, was calibrated by Liberty Laboratories Inc., 1346 Yellowwood Road, Kimberton, IA 51543, on Thursday, February 19, 2004, with Certification number: 2004021814 issued to Metavox, Inc.

Traceability: Certificates of Liberty Laboratories state that:

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to traceability is on file and is available for examination upon request. Measurement procedures per Military Handbook 52A as guidance for

Military Standard (MIL-STD) 45662A, ANSI/NCSL Z540-1-1994, ISO/IEC 17025 and Liberty Labs,Inc. procedure OP-2.

Accuracy: The electrical equivalent antenna factor $af^{electric}_{BBH\ (dB/m)}$ is accurate within 0.9 dB for the frequency range from 1 to 30 MHz and certified by the calibration.

Receiver: Rohde and Schwarz Model ESH2, Serial Number 831436/006

Reference: "Data Sheet, Test Receiver ESH 2", Rohde & Schwarz, Republic of Germany.

The Test Receiver ESH 2 is a manually operated, highly sensitive and overload-protected test receiver offering a very wide dynamic range. Compact design, the wide range of power supplies that can be used, and low power consumption make the receiver suitable for use in fixed stations as well as for mobile and portable applications, such as field-strength measurements.

The ESH 2 can tune from 9kHz to 30MHz and operates as a selective voltmeter in a level range from –30 to +137 $dB_{\mu V}$ in 50 Ω systems. Overload of the input or of other important circuits is detected and signaled by the test receiver.

Selection of "CISPR quasi-peak weighted" detection provides an IF bandwidth (-6 dB) for measurements according to CISPR Publications 1 and 3 with 9kHz bandwidth for the HF frequency range.

Calibration: The Rohde & Schwarz Model ESH2, Serial Number 831436/006, was calibrated by Industrial Process Measurement, Inc, Edison, NJ,08820, on February, 5, 2004, with Certificate number 23725-01.

Accuracy: The frequency accuracy in the range of 1-30 MHz is +/- 0.00050 MHz.
The frequency response over the 0.01-30 MHz range, at a signal level of 80.0 $dB_{\mu V}$, is accurate to +/- 1 $dB_{\mu V}$ and certified by the calibration.

Appendix 4: FCC Part 15 Rules

Portions of the FCC Part 15 Rules relevant to these tests are the following:

TITLE 47--TELECOMMUNICATION
CHAPTER I--FEDERAL COMMUNICATIONS COMMISSION
PART 15--RADIO FREQUENCY DEVICES
Subpart A--General

The FCC requires that unlicensed devices operating below 30 MHz comply with a quasi-peak radiated emission limit of 30 μV/m at a distance of 30 meters at all frequencies over the range from 1.705 to 30 MHz. Emissions are required to be below the limit in all directions, in each of three representative locations.

...

Sec. 15.31 Measurement standards.

(f) To the extent practicable, the device under test shall be measured at the distance specified in the appropriate rule section. The distance specified corresponds to the horizontal distance between the measurement antenna and the closest point of the equipment under test, support equipment or interconnecting cables as determined by the boundary defined by an imaginary straight line periphery describing a simple geometric configuration enclosing the system containing the equipment under test. The equipment under test, support equipment and any interconnecting cables shall be included within this boundary.

(1) At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

...

(h) For a composite system that incorporates devices contained either in a single enclosure or in separate enclosures connected by wire or cable, testing for compliance with the standards in this part shall be performed with all of the devices in the system functioning. If an intentional radiator incorporates more than one antenna or other radiating source and these radiating sources are designed to emit at the same time, measurements of conducted and radiated emissions shall be performed with all radiating sources that are to be employed emitting. ...

...

(k) A composite system is a system that incorporates different devices contained either in a single enclosure or in separate enclosures connected by wire or cable. If the individual devices in a composite system are subject to different technical standards, each such device must comply with its specific standards. In no event may the measured emissions of the composite system exceed the highest level permitted for an individual component.

Extrapolations of Emission Limit of FCC Part 15 Rules

The rules [see above] allow making field strength measurements at a closer distance than that specified in the regulations (i.e. 30 meters for frequencies below 30 MHz), when necessary, and extrapolating to the specified distance at 40dB/decade of range, with admonition that "an attempt should be made to avoid making measurements in the near field."

A field characteristic of 40db/decade of range implies field F (V/m) is inversely proportional to the square of range in the region:

$$Fr = Fr_0 * (r_0/r)^2$$

and $[Fr]_{dB} - [Fr_0]_{dB} = 20*\log_{10}[(r_0/r)^2] = 40*\log_{10}[r_0/r]$, i.e. 40 dB per decade of distance.

The Part 15 emission limit for r_0 = 30 meter distance, $F^0_{30} = 30\ \mu V/m$, is equivalent in dB to $[F^0_{30}]_{dB\mu V/m} = 29.5 dB\mu V/m$.

The *extrapolation* of field strength measurements for a distance r different from 30 meters, Fr, is denoted as $[Fr]_{dB30}$ – the field strength Fr relative to a distance of 30 meters. Also, field strength Fr *dual referenced* to distance 30 meters and field strength 1μV/m is denoted as $[Fr]_{dB30\text{-}\mu V/m}$ The extrapolation of field strength measurement is (relative to $r_0 = 30$):

$[Fr]_{dB\mu V/m} = [Fr]_{dB30\text{-}\mu V/m} + 40*\log_{10}[r_0/r]$
or $[Fr]_{dB30\text{-}\mu V/m} = [Fr]_{dB\mu V/m} - 40*\log_{10}[r_0/r]$

Equivalently, the extrapolation of the limit at 30 meters to distance r is:
$[F^0r]_{dB30\text{-}\mu V/m} = [F^0_{30}]_{dB\mu V/m} + 40*\log_{10}[r_0/r] = 29.5 dB\mu V/m + 40*\log_{10}[r_0/r]$

- Example

For example, at site Whitehall-1a (see Appendix Sites) the antenna was located at a slant range of r = 12.6 meters from the nearest power line conductor. Thus,
$[F_{12.6}]_{dB30\text{-}\mu V/m} = [F_{12.6}]_{dB\mu V/m} - 40*\log_{10}[30/12.6] = [F_{12.6}]_{dB\mu V/m} - 15.07dB$

Similarly, the Part 15 limit extrapolates to
$[F^0_{12.6}]_{dB30\text{-}\mu V/m} = 29.5 dB\mu V/m + 40*\log_{10}[r_0/r] = 44.6\ dB\mu V/m$

The following Table-2 summarize the results for the 4 highest of the assessed field strengths at Whitehall-1a making extrapolations by two methods – 40dB/distance-decade and 20dB/distance-decade.

Table-2 Extrapolated Field Strength, **dBμV/m**

	distances extrapolation at **40** dB/decade 40·log10[30/12.6] = 15.07dB			distances extrapolation at **20** dB/decade 20·log10[30/12.6] = 7.54dB		
Range:	**12.6 meter**		**30 meter**	**12.6 meter**		**30 meter**
Part 15 emission limit:	extrapolated		stated limit	extrapolated		stated limit
	44.6	←	29.5	37.0	←	29.5
Surveyed Field Strength:	measured		extrapolated	measured		extrapolated
7.35 MHz	31.6	→	16.5	31.6	→	24.1
9.52 MHz	34.8	→	19.7	34.8	→	27.3
10.32 MHz	36.0	→	20.9	36.0	→	28.5
29.03 MHz	32.8	→	17.7	32.8	→	25.3

underline: highest measurement

At 10.32 MHz, the Whitehall Township BPL system is within 1 dB of the FCC Part 15 limit according to the method extrapolating field strength by 20 dB per decade on distance.

Comments on Extrapolation Method

ARRL *Comments to FCC* dated July 7, 2003, pertaining to "ET Docket No. 03-104", (Exhibit C, Para 6.6, pg 72).

> "Making measurements at distances closer than 30 meters and extrapolating at 40 dB/decade can easily result in an underestimation of the actual maximum field at 30 meters distance, by over 20 dB in some cases."

ARRL's further consideration in Exhibit D, of the same *Comments* (Para, 4, Near Field Considerations pgs 102-103) references the FCC Part 15, § 15.31(f)(1) and (2) cited above.

> "... in the reactive or radiating near-field region of physically large, complex, radiating systems, the fields vary in such complex ways that a .proper extrapolation factor simply does not exist. For a particular large-radiator, power-lines system, these ARRL analysis show that 40 dB/decade can be exactly backwards in the near field region – that is that electric or magnetic field strength can actually increase with distance such that the magnetic field at 30 meters is found slightly higher than it is at 10 meters distance. Such results are due to the peaks and nulls in field strength throughout the region, which are not easily anticipated in planning to survey a system."
>
> "The ARRL analysis data for the large radiator systems of overhead power lines has resulted in NO cases approaching 40 dB per distance decade. For a typical case on 14 MHz in frequency with the strongest magnetic field at 3 meters in distance from the radiator system, the ARRL analysis yields the extrapolation factor of 15 dB per distance decade for the 3 to 30 meter distance ratio. Another case on 3.5 MHz yields the factor of 24 dB per distance decade."

Metavox's measurements with the measuring antenna at two positions at Emmaus-1a and Emmaus-1b suggest that the 40 dB/decade extrapolation factor is not suitable for use in compliance testing on BPL systems.