MEASUREMENTS OF BPL EMISSIONS FROM SP Ausnet TRIALS AT MT BEAUTY, VICTORIA 21st NOVEMBER 2006

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1. BACKGROUND

The WIA was contacted by a radio amateur, Ian Paul (VK3LJJ), who's operations had been severely effected by interference from the time of the commencement of the BPL trial by SP Ausnet at Mt Beauty Victoria.

On the 12th of November, 2006, Peter Young (VK3MV) carried out emission observations in the area and reported that the emissions observed were from the BPL trial, and at a level high enough to cause substantial interference to radio communications on affected frequencies within the trial area.

Peter Young's report entitled *Observations of BPL emissions from SP Ausnet trials at Mt Beauty, Victoria* can be found on the WIA website at:
http://www.wia.org.au/news/2006/documents/Mt_Beauty_BPL_Trial_Nov_2006.PDF

On the 21st of November Peter Young (VK3MV) and Phil Wait (VK2DKN) again visited the Mt Beauty BPL trial site to take field strength measurements using the FSM technique. The FSM technique is described at www.VK1OD.net/fsm and in Appendix A.

Peter Young repeated some of his previous observations and determined that the BPL signal was now not present above 23.5 MHz, except for a small band around 32-34MHz, and the BPL emissions appeared to have been reduced by about 10dB.

Peter Young's second report entitled *Additional Observations on RF Emissions from SP Ausnet trials at Mt Beauty, Victoria* can be found on the WIA website at www.wia.org.au

Phil Wait performed a series of measurements using FSM. The measurement data together with an evaluation of its effect on HF radio communications is presented in this report.

At the time of the Peter Young's second observation and at the time of recording the measurements in this report, the SP Ausnet BPL modem installed in the premises of Ian Paul was not working. The signal light on the front of the modem was not illuminated, suggesting that the modem was not receiving sufficient BPL signal to operate.

2. METHODOLOGY

The FSM technique was used for all measurements reported in this document. The technique is described at www.VK1OD.net/fsm and in Appendix A.

Measurements were taken at three locations on amateur bands subject to high level interference. As the small loop antenna used for measurement is not very sensitive, only amateur bands with very high level interference were measured. The exclusion of any amateur bands from these measurements is not to suggest that BPL interference was not present on those bands, rather that its level was not sufficient for meaningful measurements using the small test antenna. For a comprehensive list of frequencies affected by the BPL interference refer to the observation reports by Peter Young.

The FSM equipment was transported to each site in the rear of a vehicle, and the loop antenna positioned at each site away from the vehicle and at a distance of 10 meters from a line projected vertically downwards from the center of the power lines, (slant distance 11.4 meters).

A series of measurements were taken with the loop antenna oriented in X, Y and Z planes, and the S plane value calculated from the square root of the sum of the squares.

Receiver sensitivity was checked against a known noise generator prior to and after the series of measurements.

S -Plane loop antenna orientations to the 240V (LV) power line:

Position 1	vertical 0 deg	end-on
Position 2	vertical 90 deg	broadside
Position 3	horizontal	broadside to ground

S-Plane Calculations:

S=(X^2+Y^2+Z^2)^0.5
where X, Y and Z are the measured field strengths in V/m.

3. EQUIPMENT USED

The WIA FSM jump-kit was used for all tests. Details of the kit are at http://www.wia.org.au/news/2006/20061120-01.php

The kit consists of:

- 600mm a side unshielded un-tuned single turn loop antenna with 10 meters RG58 coax cable. (The loop antenna factor, including effects of line loss, was calculated and imported into the FSM software)
- Precision 50 Ohm step attenuator, (10dB steps / 30dB max)
- Alinco DX70 transceiver, (modified with audio output connection, set to LSB/Narrow IF bandwidth/Attenuator off/Preamp off, for all measurements)
- Calibrated RF Noise generator
- 50 Ohm resistive termination
- Toshiba Satellite laptop computer
- FSM software, version 1.12

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4. MEASUREMENT LOCATIONS

Sets of measurements were taken at the following locations consistent with Peter Young's observations:

Site 1 is close to the receiving antenna used by the radio amateur experiencing interference. Site 2 is randomly selected. Site 3 is adjacent to a repeater connected to both MV and LV power lines.

Site 1	Inside driveway, home of Ian Paul (VK3LJJ)
Site 2	Corner Nelse & Kaye Streets
Site 3	Corner Valley Ave & Wermatong Ave

5. AMBIENT NOISE MEASUREMENTS

Ambient noise measurements were not taken in the Mt Beauty area prior to activation of the trial as there was no prior warning of intention to trial BPL in the area.

Ambient noise measurements were performed by an EMC test house on behalf of SP Ausnet, however results have not been made public.

Ambient noise observations were made by Peter Young in a nearby area not affected by BPL emissions after trial activation, and are documented in his first report. See *Observations of BPL emissions from SP Ausnet trials at Mt Beauty, Victoria, at:*
http://www.wia.org.au/news/2006/documents/Mt_Beauty_BPL_Trial_Nov_2006.PDF

6. SUMMARY OF MEASUREMENT RESULTS

A summary of measurement results is presented below in tabular and graphical form.

Full FSM measurement data including S-plane calculations are listed at Appendix B.

The key measurement is the Quasi-peak (QP) value. "The Normalised QP Field strength is a sound comparative figure, incorporating a fairer measure of interference impact than RMS measurements, and corrected to a common bandwidth with acceptable errors.*"* (Duffy*).* FSM's Normalised QP values (1Hz bandwidth) are extrapolated to 9 kHz bandwidth in the table below.

Summary of measurements in tabular form:

Frequency (MHz)	Site	Slant Distance to power line (m)	Measured Field Strength extrapolated to 9kHz (dBµV/m)	The median expected ambient noise level specified in ITU-R P.372-8 for a residential environment	Emission Field Strength relative to expected ambient noise (dB)	Measured Field Strength extrapolated to 30m distance (dBµV/m)	Expected Rx power from half wave dipole (S units)
7.1	3	11.4	51.1	9.7	41.4	34.2	S9+20
10.1	3	11.4	41.8	8.5	33.3	25.0	S9+10
14.2	1	11.4	45.5	7.4	38.1	28.7	S9+10
14.2	2	11.4	52.0	7.4	44.7	35.2	S9+15
14.2	3	11.4	56.6	7.4	49.2	39.8	S9+20
18.1	1	11.4	48.6	6.6	42.1	31.8	S9+10
18.1	3	11.4	54.6	6.6	48.0	37.8	S9+20
21.1	3	11.4	53.6	6.1	47.5	36.7	S9+15

Explanation of terms:

Term	Description	Explanation
Slant Distance to Power Line (m)	The approximate distance from the measuring antenna to the power lines	
Measured FS Extrapolated to 9kHz (dBuV/meter)	Field strength in decibels with respect to one microvolt per meter in a 9kHz bandwidth	9kHz is the bandwidth specified for EMC measurements below 30MHz
The median expected ambient noise level specified in ITU-R P.372-8 for a residential environment	The minimum value of ambient noise is typically more than 10dB lower than the median.	
Emission Field Strength relative to expected ambient noise (dB)	The difference in decibels between the measured emission level and the expected ambient noise level.	
Measured Field Strength extrapolated to 30m distance (dBµV/m)	The measured emission level extrapolated to 30m distance using the factor set out in FCC Part 15.	**See Note 1**
Expected Rx power from half wave dipole (S units)	An indication of the expected S-meter reading on an amateur SSB receiver connected to a dipole antenna exposed to the same field strength as measured at the measurement position. (based on the quasi-peak emission levels and assumes that S9 = 50uV and one S unit = 6dB)	The S-unit calculations shown in the table are based on quasi-peak measurements. Assumes that 10 meters is not an unrealistic distance for a dipole antenna to be located from power lines in a suburban situation. **See Note 2**

Note 1 - The field strength measurements were extrapolated to a distance of 30m using the method set out in FCC Part 15.31 which prescribes an extrapolation factor of 40*log(d1/d2) at frequencies below 30MHz for the purposes of measurements under that standard.
The extrapolation of field strength in this way is quite contentious, and it is likely that measurements at a distance of 30m might be higher than the extrapolated value.

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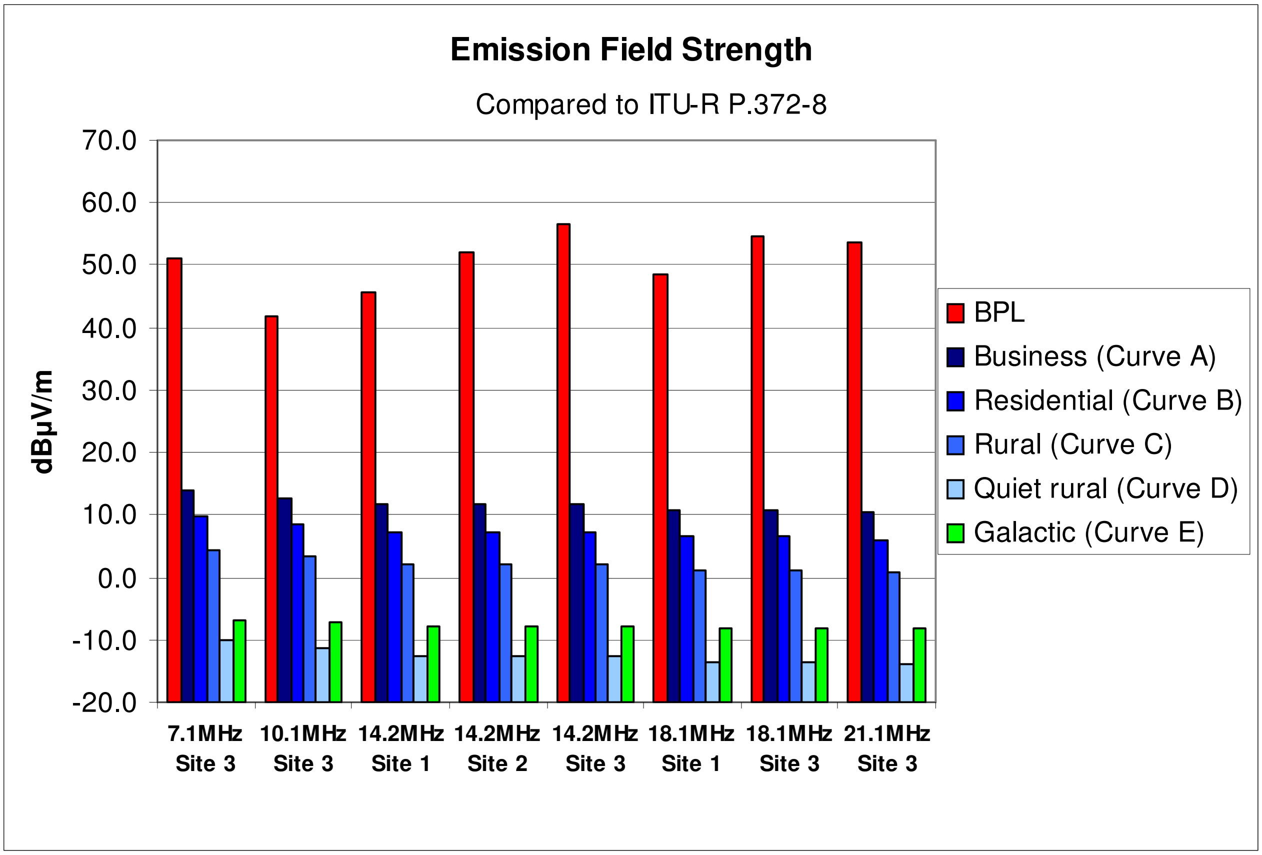
Note 2 - For the purpose of receiver impact assessment, the average gain of a dipole is taken as -1dBi and receiver effective noise bandwidth is taken as 2kHz which is typical of an SSB receiver.

Graphical representation of field strength related to various ambient noise conditions:



Explanation of chart:

The chart shows measured field strength from the BPL emissions at various locations and on various amateur bands, (red bar).

The BPL signal is compared to the expected ambient noise conditions for different environments according to the International Telecommunications Union in ITU-R P.372-8, (other bars).

The difference between the BPL signal and expected ambient noise is a measure of the degradation of the noise floor or radiocommunications capability caused by the BPL emissions.

In the case of the most left hand set of bar graphs: At Site 3 on 7.1 MHz the degradation in the noise floor for a typical residential environment – curve B ambient noise would be 42dB (or seven S-points above ambient noise if one S-point = 6dB).

The worst case was 14.2 MHz at Site 3 where the BPL emissions were 49.2dB above the expected ambient noise level.

7. MEASUREMENT UNCERTAINTY

Field strength measurements using professional measuring equipment, in a controlled environment, rarely yield an accuracy of much better than +/- 6dB.

The Field strength measurements in this report were taken in a residential area containing power cables, buried wires, fences and buildings, and other objects which will have an effect on the intensity of the field. However the results obtained are consistent with observations by Peter Young, and are similar to other BPL trials measured in Australia and internationally.

8. CONCLUSION

The measurement results show a very high level of radio frequency interference emission from the BPL enabled power lines.

The interference level was measured at between approximately 33 dB and 49 dB above the expected ambient noise conditions for a typical residential environment.

The interference was found to be at such a level that would effectively prevent HF radio communications on the 40, 30, 20, 17, and 15 meter amateur bands at various locations within the trial area.

The strength of interference which would be received using a dipole antenna exposed to the same field strength, expressed in S units, was calculated to be between S9+10dB and S9+20dB. This signal level would mask all but the very strongest of HF radio communication signals.

Additionally, stations experiencing this level of interference would be prevented from transmitting, as they would be unable to determine if the frequency was in use by another station as required under the terms of their licence.

The measurement results confirm Peter Young's observation in his second report that, at the time of testing, there was "a significant reduction or "notch" of radiated emission levels from BPL signals between 23500 kHz and 28500 kHz, thus indicating that the system technology employed has the capacity to vary levels and adjust frequency bands accordingly".

We are advised that both the frequency spectrum and level of emissions have varied after the time of these measurements, again suggesting that the system technology is being adjusted to vary power levels and frequency usage.

The results contained in this report confirm Peter Young's observation that "based on these recent observations the levels recorded on some parts of the HF spectrum would exceed the US FCC part 15 levels, noting however, that this standard has only been adopted by the US regulator. In fact 6 of the 8 measurements exceed the Part 15 limit and the worst case is 10dB above that limit.

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ACKNOWLEDGEMENTS

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