

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC. 20554**

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

COMMENTS OF MICHAEL KEANE

Michael Keane, on behalf of himself, submits these comments in the above captioned proceeding.

Introduction

I am a licensed amateur radio operator (K1MK) and I am writing to express my concerns over deployment of Broadband over Power Line (BPL) systems under the existing Part 15 of the Commission's rules without due consideration for the harmful interference that widespread deployment of Access BPL operating under Part 15 will cause to authorized users of the HF spectrum including the amateur radio service.

BPL is an interesting technical development that shows some promise. Nevertheless, important technical issues remain unresolved; BPL is not yet a panacea. If facilitating deployment of Access BPL systems implies modification of the "non-interference basis" for unlicensed operation under Part 15 of the rules, the Commission must address fundamental questions of spectrum management policy.

Background

I am a member of the Amateur Radio Emergency Service (ARES); through ARES I volunteer my skills and my equipment as an emergency communicator for my local town Office of Emergency Management (OEM) and the local Red Cross chapter. I participate in the National Weather Service's severe weather spotting program (SKYWARN) and I am a member of the U. S. Army Military Affiliated Radio System (MARS).

With its 75-year plus tradition of volunteer service in times of local, regional and national emergency, amateur radio represents the communications option called upon "when all else fails." Decentralized and capable of functioning independently of vulnerable infrastructure, the amateur service is the quintessential multiply redundant emergency communications system.

ARES, SKYWARN, Red Cross and MARS all utilize HF communications to greater or lesser degrees. The ability of volunteers from the amateur radio service to continue providing communications support in emergencies and related public safety activities will be put at risk by BPL deployment on anything other than a non-interference basis.

I expect to be personally effected by the outcome of this *Inquiry*. I have made an investment of thousands of dollars in equipment for use in the amateur radio service. This equipment has been

acquired with the expectation that achieving background noise limited performance is a requirement. This equipment would be rendered useless and the bulk of my personal investment worthless by the interference that would result if my local utility's overhead electrical distribution lines radiated wideband signals across the HF spectrum at the field strengths permitted by the current Part 15 rules¹.

Finally, amateur radio is a purely avocational activity. A high level of interest in the amateur service is what currently leads to volunteering my time, my skills and my equipment in support of emergency communications and other public safety activities. It is difficult to envision how this same degree of enthusiasm could be maintained in the event that what are today routine HF communications become frustrated, obstructed and made near to impossible by the introduction of interfering signals.

Response to the NOI

I will now provide my responses to some of the questions raised by the Commission in its *Notice of Inquiry (NOI)*².

Interference from BPL Emissions

- *Is there a need to define frequency bands that must be avoided in order to protect the licensed users on the same frequencies as those used by Access BPL systems?*

At a minimum the allocations of the maritime mobile, aeronautical mobile, radiolocation, radio astronomy, amateur radio, amateur satellite and broadcast services all need an additional degree of protection from harmful interference by Access BPL systems above what the Part 15 rules currently provide for carrier current systems operating as unintentional radiators.

The radiated emissions by Access BPL systems within these allocations need to be reduced by > 50 dB below the field strength allowed under the present Part 15 rules¹.

- *Since Access BPL equipment is installed on medium voltage lines that supply electricity to a residential neighborhood, should this equipment be treated as operating in a residential (Class B) or commercial (Class A) environment?*

Obviously Class B. Access BPL equipment will operate in a residential *environment* even though it will not operate from within *residences*. Such equipment, though owned by a commercial entity, will be placed in residential neighborhoods and connected to the power lines that servicing residences. Were it not being installed in a public right of way by a public utility, local land use agencies typically would not sanction installation or use of commercial equipment in residential zones. The radiated emissions, which would be the cause of any harmful interference to authorized spectrum users, do not respect the physically arbitrary boundaries one might be tempted to draw between private property and public rights of way.

¹ See Appendix A.

² *Inquiry Regarding Carrier Current Systems, including Power Line Broadband Systems*, ET Docket 03-103, *Notice of Inquiry*, FCC-03-100A1 (2003).

- *What mitigation techniques are used by In-House BPL systems to avoid possible interference with licensed radio services, such as amateur radio, fixed, mobile and broadcast services? Is there a need to define frequency bands that must be avoided in order to protect the licensed services that use the same frequencies as In-House BPL systems?*

The allocations of the amateur radio, amateur satellite and broadcast services need special protection from harmful interference by In-House BPL systems above what the Part 15 rules currently provide.

- *What are the probable interference environments and propagation patterns of Access BPL and In-House BPL systems? Are there specific issues of interference that we should address, e.g. an increase in the level of the noise floor?*

BPL emissions, be they OFDM or DSSS (CDMA), can be expected to be wideband and an Access BPL system will operate at a 100% duty cycle. There will be no frequencies within a given band free of BPL interference. Such interfering “signals” will appear “noise-like” to an HF user, making a noise floor approach appropriate.

Stations in the amateur service operating at HF are typically external noise limited with slim, if any, positive signal-to-noise margins³. These stations have only a minimal tolerance for an increase in the level of the noise floor before harmful interference must inevitably result.

For a “noise-like” interfering signal such as BPL, I could support a definition of harmful interference as a +1 dB increase in the noise floor above the local ambient noise floor. This interference evaluation would be made on a case-by-case basis using *in situ* measurements taken at the licensee’s station.

- *Are there test results from field trials of Access BPL that may assist in the analysis of harmful interference?*

Studies conducted in the Netherlands^{4,5}, the United Kingdom⁶ and Japan^{7,8} have already demonstrated that BPL operations result in widespread harmful interference to licensed HF services including the amateur radio service.

³ Communications between stations in the amateur radio service at HF are routinely made with $S/N = +0$ dB and often with formally negative S/N .

⁴ Vereniging voor Experimenteel Radio Onderzoek Nederland (VERON) EMC Committee. March 2002. *The radio amateur and the effects of the use of the 230 Volt power line for broadband data communication (PLC)*.

⁵ —. April 2003. *HF radio reception compatibility test of an in-house PLC system using two brands of modems*.

⁶ UK Technical Working Group on Compatibility Between Radio Services and VDSL + PLT Systems Operating between 1.6 and 30 MHz, Radiocommunications Agency, London. April 2001. *Final Report of Technical Working Group*.

⁷ Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT), Tokyo. August 2002. *Report of Power Line Communication Study Group*.

⁸ Muto, C., Mori, N. & Kondoh, T. March 2003. *On Radio Interference Assessments of Access PLC System*. in 7th International Symposium on Power Line Communications and Its Applications.

- *Are the existing Part 15 rules for low speed carrier current systems adequate to protect authorized users of the spectrum who may be affected by the new high speed BPL technology? What changes to these rules, if any, are necessary to protect authorized radio services?*

The existing Part 15 rules protect radiocommunications services in three complementary ways. First, the rules establish appropriate technical requirements that minimize the potential for interference to other services⁹. Second, the rules delineate an authorization program to ensure that equipment is manufactured in compliance with the technical requirements¹⁰. Finally, the rules obligate operators of Part 15 devices to remedy any harmful interference¹¹.

A model-independent analysis of the Part 15 field strength limits is presented in Appendix A. The comparison is made between the permissible field strength of 30 $\mu\text{V}/\text{m}$ at 30 m (100 feet) and the ambient noise levels at frequencies between 1.705 MHz and 30.0 MHz.

This analysis is intended to succinctly demonstrate that operation of a Part 15 compliant device *in close proximity to an authorized spectrum user* results in a high signal levels that can readily exceeds the ambient noise floor by 50 dB or more. The illustrative example highlighted for this analysis is in no way an extreme or unrepresentative case. The compliance distance of 100 feet (30 m) is in fact quite representative of the separations that will exist between authorized spectrum users' equipment located on residential lots and the overhead lines electrical lines¹² carrying Access BPL signals that adjoin and/or cross the users' properties.

If a Part 15 device's emissions were narrow-band or if a Part 15 device's emissions were highly intermittent in time then *harmful* interference to the proximate authorized user(s) is not an inevitable result even with such high signal levels. However, wide-band signals operating at 100% duty cycle, as would be the case for Access BPL, *guarantee* that harmful interference will result at such signal levels and below.

The radiated emission limits presently specified in Part 15 are insufficient to prevent the occurrence of harmful interference between Access BPL systems and authorized spectrum users under typical circumstances. Consequently, I ask the Commission to consider reducing the permissible field strength of radiated emissions from carrier current systems that are operating as *unintentional* radiators.

⁹ See 47 C.F.R. §§ 15.107, 15.109.

¹⁰ See 47 C.F.R. § 15.101; see also Part 2, Subpart J of the rules, 47 C.F.R. §§ 2.901-2.1093 (inclusive).

¹¹ See 47 C.F.R. §§ 15.5(b) & (c).

¹² This would include both distribution lines, referred to in the *NOI* as "medium voltage" lines, and residential service drops, referred to in the *NOI* as "low voltage distribution."

A reduction in the radiated emissions limits from a carrier current system operating as an unintentional radiator from its current value of 30 $\mu\text{V}/\text{m}$ at 30 m for 1.705 MHz to 30.0 MHz¹³ to a value of 1 $\mu\text{V}/\text{m}$ at 30 m for 1.705 MHz to 30.0 MHz is well warranted. If the Commission were to decide this limit to be inappropriate for *all* carrier current systems, the reduced limit should still apply, at a minimum, to the special case of Access BPL systems. A field strength of 1 μV at 30m for frequencies below 30 MHz is consistent with a -40 dB per decade extrapolation¹⁴ of the “Class B” radiated emissions limit of 100 $\mu\text{V}/\text{m}$ at 3 m for a frequency of 30 MHz¹⁵.

In addition, the Commission should consider making the “Class B” conducted limits¹⁶ of 46 dB μV (average), 50 dB μV (peak) below 5 MHz and 50 dB μV (average), 60 dB μV (peak) above 5 MHz applicable to carrier current devices as well. Again, if this is deemed inappropriate for *all* carrier current systems, these conducted limits should nevertheless be applied to the special case of Access BPL systems.

- *How should the Part 15 rules be tailored both to ensure protection against harmful interference to radio services and to avoid adversely impacting the development and deployment of this nascent technology?*

Preservation of all three elements in the protective triad of the current Part 15 rules: emission limits; equipment certification *and* the obligation to remedy any harmful interference, is necessary in order to ensure protection against harmful interference to radio services.

The application of the radiated emission limits for intentional radiators to an Access BPL system intended to be operated as an unintentional radiator presently specified in Part 15 is insufficient to minimize the likelihood of Access BPL systems causing harmful interference to authorized users under normal circumstances¹⁷. If those emission limits are not tightened it follows that the “no harmful interference” protection will need to be routinely invoked by authorized spectrum users in regards to BPL systems. This would be an unsatisfactory state of affairs for the Commission, for authorized spectrum users and for BPL system operators.

Entering the broadband marketplace with a significant chance¹⁸ of having to suspend service to hundreds or thousands of one’s customers cannot be a good business strategy. One expects such a lack of predictability would be particularly worrisome to potential BPL operators as well as to their potential investors.

To assist in resolving such uncertainty I ask the Commission to consider how it will address those cases of harmful interference from unlicensed BPL systems that will occur.

¹³ See 47 C.F.R. § 15.109(e).

¹⁴ See 47 C.F.R. § 15.31(f)(2).

¹⁵ See 47 C.F.R. § 15.109(a).

¹⁶ See 47 C.F.R. § 15.107(a).

¹⁷ See Appendix A.

¹⁸ See Appendix B.

- *Since all carrier current systems inject RF signals into the power line for communication purposes, would conducted emission limits be more appropriate to protect authorized radio services?*

If the limits on conducted emissions were established correctly, it would make it easier for BPL equipment manufacturers to comply and could result in an overall reduction in interference levels. If the limits were set incorrectly, the use of conducted emissions limits could result in an increase in the radiated levels from BPL systems.

Measurement Methods

- *How should Access BPL systems be tested for compliance, given that they generally operate in an environment where signals travel on overhead medium voltage lines? Could a standardized measurement method be developed for testing Access BPL in a laboratory or at an open area test site, using a specialized LISN or some characterized pole and wiring assembly? If so, how?*

It will be in the best interest of Access BPL system operators for compliance testing to accurately reflect the equipment's true potential for causing interference. As the Part 15 rules presently note:

"limits specified in this Part will not prevent harmful interference under all circumstances"¹⁹.

The possession of certified equipment does not confer upon its owner a vested right to use that equipment²⁰. Nor would use of certified compliant equipment lessen in any way a BPL system operator's obligation to take all steps necessary, up to and including cessation of operation, in order to rectify the problem should harmful interference occur. Under Part 15, the protection from harmful interference caused by unlicensed devices afforded to authorized users is absolute²¹.

Given the difficulty of compliance testing and that use of compliant equipment does not assure operators of non-interfering operation, I again ask the Commission to consider how it will address those cases of harmful interference from unlicensed BPL systems that will occur.

Equipment Authorization Process

- *Would the new high speed Access and In-House BPL equipment pose a higher risk of interference to licensed radio services than the traditional carrier current systems?*

Yes. Ultimately, the risk of harmful interference from any Part 15 device comes down to the proximity of the unintended radiator to the antenna of an authorized spectrum user. A traditional carrier current system has a limited geographical range, be it a single building or a campus, over which interference could be expected. The ubiquitous nature of Access BPL represents something fundamentally different. The risk of harmful interference increases significantly with an Access BPL system that is deployed across an entire community or electric-utility service area.

¹⁹ See 47 U.S.C. § 15.15(c) (emphasis added).

²⁰ See 47 U.S.C. § 15.5(a).

²¹ See 47 U.S.C. §§ 15.5(b) & (c).

- *Should the new Access and In-House BPL equipment be required to comply with either the Certification procedure or the Declaration of Conformity under our equipment authorization program, which warrants additional oversight, or should they be covered under our Verification procedure like the traditional carrier current systems?*

Because of the ubiquitous nature of Access BPL within its service area, I suggest that highest degree of oversight is necessary and ask the Commission to consider requiring Certification for Access BPL equipment.

Concluding Remarks

The crucial *unsubstantiated* claim in the matter before the Commission is the assertion that widespread deployment of Access BPL can readily be accomplished on a non-interference basis. To date the evidence from engineering demonstrations and field trials in Europe and Japan have shown just the opposite to be the case.

Far from being a cause for celebration, the “irrational exuberance” demonstrated for the immature and still unproven technology touted in this *NOI* is a very legitimate cause for concern and trepidation by each and every authorized user of the HF spectrum.

Despite all the fanfare, carrier current systems that are at the focus of this *Inquiry* are simply *not* new technology. This is made obvious by the existence of rules in Part 15 that deal with carrier current systems. Even the *NOI* itself plainly states:

“The idea of using... power lines to carry information...*is not new*”²².”

Thus, the invocation of Section 7 of the Communications Act of 1934 as amended²³ in regards to what in reality are nothing more than elaborate carrier current systems is somewhat misguided at best.

Furthermore, the objections raised in response to this *NOI* are not whether carrier current systems in general and BPL systems specifically are in the public interest. Rather my concerns relate to a wholly separate issue. That issue is what changes to the rules are necessary to reconcile Access BPL’s propensity for causing widespread interference with *sustainable* Access BPL operations on an unlicensed, non-interference basis under Part 15 of the rules.

In regards to the latter question, the burden of proof rightly rests with proponents of Access BPL to make the case that they have the technical capability of offering a service that will not in practice be compromised by its inability to *operate* without causing harmful interference.

The Commission need not be supplied with proof of the negative (“no interference shall result”) prior to commencement of Access BPL operations as that is a logical impossibility. Conversely, commencement of Access BPL operations using fully compliant equipment does not provide any assurance that such operations will not be disrupted in the event that harmful interference were

²² See the *NOI* at ¶ 4 (emphasis added).

²³ See 47 U.S.C. § 157.

to occur. The Commission cannot authorize continued *operation* of a Part 15 compliant device if that operation results in harmful interference to licensed radio communications services. The Commission's remedy, suspending operation of the offending device until cause of the interference is eliminated, is not tempered by the device owner's investment in infrastructure, contractual service obligations or use of compliant equipment. In light of this risk and its consequences, statistically meaningful evidence on the occurrence rate of harmful interference from Access BPL under normal circumstances, *not* simply a lack of interference reports²⁴ from limited field trials, will help in convincing a skeptical marketplace.

The Commission's decision must be based upon the facts at hand and an evaluation of the potential changes to the spectral environment that would result from its decisions. In evaluating whether "ubiquitous" unlicensed operations across the spectrum from 1.7 MHz to 80 MHz require changes to Part 15 rules, the Commission must consider the potential for interference conflicts between those operations and incumbent, authorized radio services.

I have no objections to BPL technology *per se*. I would readily support its rapid deployment if BPL truly functioned as a "closed-circuit," wireline communications system that did not cause harmful interference to the Amateur Service and other licensed services. I do join with the Commission in encouraging the further development of this technology.

To be even-handed and not distort the decision of the marketplace, BPL must be required to operate on exactly the same non-interference basis under Part 15 of rules as the competing technologies of DSL and cable. (Of course, the cable plant must also meet the more stringent leakage requirements of Part 76). To do otherwise provides an unfair regulatory subsidy to one of the competitors, something that goes beyond cheerleading to picking winners and losers.

I would urge the Commission to delay any decision on new rules for BPL until comprehensive field tests are completed and an objective evaluation of BPL's interference potential to licensed users of the HF spectrum is available.

Finally, I endorse the position that *all* authorized services on HF must be protected from broadband, geographically widespread, harmful interference. It would be a national disgrace if the HF region of the electromagnetic spectrum, a unique national resource, were turned into yet another "vast wasteland," the result of pollution by *unintentional* emissions creating an impenetrable haze of electronic smog.

Respectively submitted,

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²⁴ The absence of evidence not being evidence of absence.

Appendix A Part 15 Field Strength Limits

- 47 U.S.C. §15.209 field strength limits²⁵
 - 30 $\mu\text{V/m}$ (+29.5 dB $\mu\text{V/m}$) @ 30m; $f = 1.705 \text{ MHz} - 30.0 \text{ MHz}$
 - Peak signal level in a 9kHz bandwidth
- Typical suburban residence
 - A ½ acre lot, nominally 45m × 45m
 - 30 m is representative of the separation between power distribution lines and a licensee’s antenna
- ITU-R PI.372-6²⁶ man-made noise levels (9 kHz bandwidth), quiet rural location²⁷.

Frequency	Field Strength
2.0 MHz	-4.5 dB $\mu\text{V/m}$
3.5 MHz	-6.5 dB $\mu\text{V/m}$
7.0 MHz	-9.5 dB $\mu\text{V/m}$

- Increase in noise floor over ITU PI.372-6 man-made level due to the presence of a Part 15 compliant incidental radiator

Frequency	Noise Floor Increase
2.0 MHz	+29.3 dB
3.5 MHz	+31.3 dB
7.0 MHz	+34.2 dB

- **Substantially tighter limits than 47 U.S.C. §15.209 are necessary to avoid harmful interference**
 - Limiting increase in the floor to $\square +1$ dB above ambient requires field strengths of
 - < 0.07 $\mu\text{V/m}$ (-22.7 dB $\mu\text{V/m}$) @ 30m; $f = 2 \text{ MHz}$
 - < 0.04 $\mu\text{V/m}$ (-27.7 dB $\mu\text{V/m}$) @ 30m; $f = 7 \text{ MHz}$

²⁵ 47 U.S.C 15.109(e) requires that a carrier current system operating as an unintentional radiator between 9 kHz and 30 MHz must comply with the radiated limits specified in 47 C.F.R. § 15.209.

²⁶ International Telecommunications Union, Geneva. 1994. *Radio Noise*. ITU-R Recommendation PI.372-6.

²⁷ Measurements made by the Radio Society of Great Britain (RSGB) over a number of years indicate that the daytime ambient noise floor for typical suburban residential locations is below +0 dB $\mu\text{V/m}$ (quasi-peak; 9 kHz bandwidth) in the HF region. The curve for the man-made noise level for a “quiet rural” location given in ITU-R PI.372-6 fairly represents the RSGB measurements.

The radiated emission limits in Part 15 are insufficient by
> 50 dB to protect authorized users from harmful interference.

Appendix B

Some Implications for BPL of the Geographic Density of Licensees in the Amateur Radio Service

- Amateur Population
 - 684,637 licenses²⁸.
- Total Number of Households
 - 105,480,101²⁹.
- Rate of Occurrence
 - 1 household with a licensee from the amateur service per 154 households.
 - Assumes either 1 or 0 amateur licensees per household.
 - No second-order correction for multiple-licensee households.
- Typical suburban residence
 - A ½ acre lot, nominally 45m × 45m.
 - 30 m a representative separation between electrical distribution lines and a licensee's antenna.
- Assume an attempt is made to mitigate harmful interference via an increase in separation.
 - Assume that a -50 dB reduction in field strength is necessary³⁰.
 - Extrapolate field strength on a -40 dB per decade basis³¹.
 - Antenna-power line separation needs to be increased from 30 m to 533 m.
- Black-out service in the event of interference
 - Mitigate interference by turning off BPL in surrounding neighborhood.
 - A “brute force” approach that creates a pocket of “no BPL service” around amateur stations.
 - The resulting “exclusion zone” encompasses an area ~300 times larger than original lot size.
 - On average adjacent zones of avoidance will overlap, pockets of “no service” are not isolated.
- Implications
 - Interference can't be dismissed out of hand as rare, negligible or a “nuisance” factor.
 - The “band-aid” solution of blacking-out service is not economically viable.
 - A systematic approach to interference mitigation must be considered.
 - The result presented is “only” an engineering estimate. Ultimately field trials will confirm or refute.

²⁸ FCC ULS data as of 07/01/2003.

²⁹ 2000 U.S. Census.

³⁰ See Appendix A.

³¹ See 47 C.F.R. § 15.31(f)(2).

Operation on a non-interference basis under Part 15 is a challenge to widespread BPL deployment in residential areas.