

# ARRL EMC Committee Semi-Annual Report

Doc. # 20

**For The  
American Radio  
Relay League**

**Board of Directors Meeting  
July 20-21, 2012**

**Submitted By  
Kermit Carlson, W9XA  
Chairman, ARRL EMC Committee**

## **Mission Statement:**

The EMC Committee monitors developments in the Electromagnetic Compatibility (EMC) field and assesses their impact on the Amateur Radio Service. The Committee informs the ARRL Board of Directors about these activities and makes policy recommendations for further action, if appropriate.

The overall goals of the committee are:

- Advise the ARRL Board about issues related to radio-frequency interference
- Advise the ARRL HQ staff on the content of its publications
- Make recommendations to the ARRL Board and HQ staff
- Maintain contact with other organizations involved in EMC matters through established liaison individuals

## **Members of the Committee:**

- Mr. Kermit Carlson, W9XA, ARRL Central Division Vice Director, EMC Committee Chairman
- Mr. Gordon Beattie, W2TTT, Principal Technical Architect, AT&T Enterprise IT Service Assurance
- Mr. Jody Boucher, WA1ZBL, RFI troubleshooter, Northeast Utilities
- Mr. Brian Cramer, PE, W9RFI, Electrical Interference Solutions, Inc.
- Mr. Mike Gruber, W1MG, ARRL Lab RFI Engineer, HQ Staff Liaison
- Mr. Ed Hare, W1RFI, ARRL Laboratory Manager
- Mr. Ron Hranac, N0IVN, Technical Leader, Cisco Systems; past member of the Board of Directors, Society of Cable Telecommunications Engineers
- Mr. Richard D. Illman, AH6EZ Senior Engineer, Motorola Solutions
- Mr. Steve Jackson, KZ1X, VDSL and wireless communications
- Mr. John M. Krumenacker, KB3PJO Design Engineer
- Dr. Ron McConnell, W2IOL, T1E1.4 VDSL Standards Committee

- Mr. Jerry Ramie, KI6LGY, ARC Technical Resources, Inc.
- Mr. Cortland Richmond, KA5S, EMC Engineer
- Mr. Mark Steffka, WW8MS, Automotive EMC engineer
- Dr. Steve Strauss, NY3B, Home Phone Networking Alliance Technical Committee

### **Recent EMC Committee Activity and Discussion:**

The EMC Committee held three Webinar and Telephone Conferences during the first half of this year. The latest one was on June 28, 2012. Topics of discussion included:

- Mr. Gruber reported on FCC enforcement, particularly with regard to inadequate enforcement of cases involving power line noise. He also provided some background information on the rules and ongoing testing of LED bulbs. Additional details on these topics are included later in this report.
- In July 2012, the FCC released a Public Notice about ARRL's petition for reconsideration of the BPL rules. ARRL had asked that spectral notching for Amateur Radio be made part of the rules, as well as the use of a scientifically justifiable distance extrapolation method. The date for the filing of Oppositions to the petition is July 17 and the date for reply comments is July 27.

### **HQ Staff:**

The role of the ARRL HQ staff consists of the following:

- Answer individual inquiries from hams (and sometimes their neighbors) about RFI problems
- Write and publish articles about RFI
- Write and publish the ARRL RFI Book
- Design and update ARRL's RFI web pages
- Maintain a database at ARRL to facilitate EMC case tracking and reporting
- Work with ARRL's D.C. office on various spectrum and RFI-related filings
- Maintain contact with industry
- Participate in standards and industry groups, as a voting member or as a liaison. This includes ANSI accredited C63<sup>®</sup>, Society of Automotive Engineers EMC and EMR committees, Home Phone Networking Alliance, VDSL, HomePlug, FCC and individual companies.

Mr. Gruber handles the majority of the staff work on EMC matters. In the 1st half of 2012, he also continued with work in a number of key areas:

- Adding updates and revisions to the ARRL RFI Web pages.
- Facilitating and providing assistance on resolving long standing power line noise cases with the FCC.
  - Of particular note is a case near Pittsburgh, PA. Although this case was first reported to the ARRL in 2003, and the FCC has written the utility five letters concerning the matter, it is clear the utility still lacks the proper

equipment and expertise to correct the problem. Mr. Gruber, with assistance from Mike Martin of RFI Services, helped the FCC investigate the noise in May of 2011. Several sources were found and reportedly fixed by the utility. The utility however is unable to find the remaining sources. They point to a sign as the culprit, which is a tactic they had used previously. This case remains ongoing, and the complainant reports he was never contacted by the utility after the FCC's letter one year ago. This case was also the subject of an ARRL News article when the utility told the complainant that they wanted to charge him for locating the noise several years ago.

- Testing the conducted emissions of suspect consumer electronic and electrical devices. Devices that exceed FCC specified absolute limits can be identified and reported to the FCC. Of particular concern are:
  - LED Part 15 Bulbs, which may meet Part 15 limits, but if at or near the limits, could present an RFI problem without a practical solution, especially if there are many bulbs that are contributing to the problem. As an example, a device at FCC limits could be in the range of several homes in a typical suburban environment. When considering bulbs, a conservative estimate might be 50 bulbs per household, thus putting 150 or more bulbs within range of an Amateur station with just two neighboring homes.
  - Non-consumer Part 18 electronic ballasts being marketed and sold for consumer and residential purposes.
  - Variable speed pulsed DC motors now appearing in such things as washing machines, HVAC systems and pool pumps. Furnaces and air conditioners seem to be particularly problematic.
  - Large grow lighting devices used for indoor gardening are particularly problematic in some parts of the country, especially California and Colorado. These devices can be heard at much greater distances than would normally be expected from a device that meets the FCC Part 15 or 18 limits. One light that we looked at, for example, was considerably over the limit.
- Working with AT&T engineering staff to help resolve RFI issues with U-Verse systems.
- Reviewing proposed EMC related material for ARRL publications.

### **Summary of Recent and Ongoing Lab Activities**

Pertaining to Part 18 & Lighting Devices, Mr. Gruber reports that he is in the process of testing 33 lights for conducted emissions. The selection of bulbs includes:

- 30 LED bulbs from a variety of retail outlets, Dayton and eBay sources.  
Note: One LED bulb marked Part 18.
- 2 red LED (used) traffic lights purchased at Dayton.
- 1 CFL bulb in a floodlight configuration, similar to a number of the LED bulbs.

Mr. Gruber adds that LED bulbs operate under are Part 15, while CFL's and electronic fluorescent light ballasts typically Part 18. In this case, there is an important distinction between these two rules - *Part 18 limits for consumer RF lighting device lower than applicable Part 15 limits*. As a consequence, the ARRL Board has previously asked us to look at proposal to reduce Part 15 limits to Part 18 levels for lighting devices.

The results and data from this testing will provide us with a better understanding of interference potential from LED bulbs as they currently exist. Initial analysis suggests they substantially meet Part 15 limits. It is important to note, however, that these limits high enough to create interference issues. Mr. Gruber emphasizes that even if an LED bulb is near the Part 15 limit, it can still be legally be sold and marketed. If and when interference occurs, the burden falls on operator to correct problem. While this rule may work on a case-by-case basis for a small or limited number of sources, it is not practical should many bulbs in several houses be contributing to a wide spread problem.

### **Status On FCC Enforcement and Outstanding EMC Cases**

Mr. Gruber reports that the FCC has been sending letters to utilities (and consumers) with some regularity. Meaningful enforcement beyond that, however, has been very disappointing. No previously reported longstanding case has been resolved during the first half of 2012. Looking at total picture, less than 20% of the known FCC power line cases have been resolved since the beginning of 2009.

Here are some approximate statistics after ten years:

- 3,500 total RFI cases.
- 1,000 Power Line Noise cases. Note: There are likely to be more since approximately 1/3 unknown sources are power line noise.
- 180 cases involved one or more FCC letters.
- 52 cases involved 2 or more FCC letters.

Here are some FCC Statistics from January 2009 to December 2011:

- 73 letters sent involving Power Line Noise.
- 50 cases remain ongoing. Note: It is possible that some of these cases have been corrected but not reported as such to ARRL.
- 13 and possibly 14 cases known to be fixed.
- 2 complainants moved.
- 3 cases involve an unknown status.
- 1 case on hold.
- 3 cases disregarded. Note: Reasons might include inappropriate behavior or lack of complaint credibility.

In summary, Mr. Gruber reports the following comments concerning FCC enforcement:

- Less than 20% of the PLN cases involving the FCC from 2009 to 2011 are now fixed.
- Some cases have lingered for many years without satisfactory resolution.
- Cases are often caught in an endless loop or letter writing campaign.
- Of the approximately 1,000 ARRL power line noise cases, the FCC
  - Has never issued even one NAL.
  - Issued only about 4 citations. Note: Remarkably, the same noise level that prompted the Lakeland citation was later deemed not to meet FCC's criteria to be harmful interference.
- Present protracted power line noise case examples include cases in Pittsburgh, Lakeland and Colorado. It is important to note that Mr. Gruber was personally able to find noise at each of these locations in less than one hour of looking.
- Bottom Line: The FCC is clearly not doing its job!

### **First Half 2012 Year Total RFI-Case Statistics:**

New RFI Cases – 115

New electrical power-line cases – 32

- ARRL Letters sent – 10
- FCC 1st Letters submitted – 4 (Note: Laura Smith may have issued FCC letters based on need and input from the ARRL. These letters were not formally submitted by ARRL and therefore not included in this total. Many of these letters were follow-up in nature and therefore required custom legal language. The effectiveness of these letters has yet to be determined.)
- FCC 2nd Letters submitted – 2 (Note: One letter involves four complainants.)

### **Electric Utilities:**

Power-line interference has continued to be the single number one known interference problem reported to ARRL HQ. It can also be one of the most difficult to solve. Fortunately, Laura Smith clearly remains interested in RFI matters and continuing with the Cooperative Agreement. In addition, the Committee is continuing in the process of forming a working group to address this issue of power line noise.

The following power line noise cases are of particular interest. Some have been previously discussed in semi-annual reports.

- W4FGC in Lakeland, Florida: This previously reported case also remains ongoing. Although the FCC investigated the matter, it was at a time of unusually low noise activity. It should be noted that the noise is typically present at slightly varying levels most of the time.

Over the years, the utility's RFI investigator has claimed that the complainant's equipment and antenna are responsible for the noise. He also claimed that the complainant's expectations are unrealistic. It should be noted that none of these claims have been validated by Mike Martin or Mike Gruber during their

investigations into this noise. In addition, the complainant's daughter obtained the services of a 3<sup>rd</sup> party independent RFI investigator from a nearby city in Florida in May of 2011. This investigator was able to locate four sources of noise in the complainant's neighborhood in a relatively short period of time.

At the time of this report, the complainant is 90 years old. Although this case has been partially resolved, it remains on-going. It was first reported to the ARRL in January 2003. Mr. Gruber reports that he has spent probably more time on this case than any other. Despite his effort, little or no improvement occurred as a result of sources located by the utility.

- W2PM in Ramsey, NJ: This case involved a 69 kV transmission line with a tower in the complainant's backyard. The utility's RFI investigator initially concluded that there was a composite of noises that were being generated all along the line. The problem was not fixable. Based on a recording of the noise, Mr. Gruber concluded that there were only two noises affecting the complainant's station. Mr. Gruber found the two sources in November of 2009. Based on his reports, the utility's RFI investigator took a second look. He concluded there were hardware issues with approximately four towers that needed replacement. These towers were somewhat unique as a result of hardware incompatibility when the voltage was increased on the line several years ago to 69 kV.

In 2010, the utility's RFI investigator informed Mr. Gruber that they would need to shut down the line in order to make the repairs. The repairs were expected to be completed before the start of the air conditioning season. The repairs were never started, and the utility never contacted the ARRL or complainant to advise of the schedule change. The case then went to the FCC and Laura Smith issued an advisory notice.

At the time of the last Committee report, the utility's RFI investigator reported that the noise was fixed and the case closed. The complainant in this matter appears to have dropped his complaint. This case is now considered closed unless there is anything further from the complainant.

It case was first reported the ARRL in May of 2009. Mr. Gruber believes this would make a great example case for stations near high voltage transmission lines. A power line noise case in the vicinity of transmission lines has always been problematic with the FCC, even if the lines were not the source.

- K3GT in Allison Park, Pennsylvania: As previously reported, Mr. Gruber, with the assistance of Mike Martin of RFI Services helped the FCC investigate this case in May. Matthew Urick of the FCC Field Office in Philadelphia conducted the investigation, which is located near Pittsburgh. Also present was the complainant, Bob Thacker, K3GT. The utility in this matter, Duquesne Light & Power, had wanted to charge the complainant for RFI investigations.

Although this problem had been going for over a decade, Mr. Gruber reports that they were able to demonstrate to the FCC that the noise was coming from a number of poles that they identified. By the end of the day, they had identified noise sources in all directions but one.

As a result of this investigation the FCC had issued a letter to the utility. Despite the ARRL's exceptional effort to hand this case for enforcement to the FCC, the FCC gave them another 60 days to fix the problem. Remarkably, this was the same requirement afforded by the Commission in their first letter to the utility dated December 17, 2002.

Although the utility appears to have fixed the sources that were identified during the investigation, they were unable to find the remaining sources. They have claimed by letter to the Commission that the remaining sources are being caused by signage. They previously made similar claims before the investigation. Mr Gruber reports however, that the noise signatures were consistent with power line noise sources – not signage. Furthermore, both Mr. Martin and the FCC's Matt Urick agreed at the time that this was power line noise – not a sign.

At the moment, this case remains ongoing. It is, however, one of the best cases we've ever seen for FCC enforcement. The FCC's enforcement in this case has been disappointing to say the least.

AA9VI in Northbrook, Illinois: As previously reported, this case was investigated by EMC Committee member Brian Cramer, W9RFI. Also present was Committee Chairman Kermit Carlson. It had also been previously investigated by the FCC and first reported to the ARRL on December 10, 2007. At the time of Mr. Cramer's investigation, the FCC field agents had been unable to locate the source of the problem.

Mr. Cramer reports that in many ways the RFI problems at AA9VI highlight the frustration that electric utility trouble-shooters can have resolving issues. There are individuals within the utility who are committed to resolving the problem, but their actions are sometimes mis-directed and very expensive.

In this case, the utility had identified "noisy" insulators on a 345kV transmission tower just outside the substation. The insulators were replaced, but there was no improvement for the ham. Mr. Cramer was sent on behalf of the ARRL to locate the source. From outside the substation he was able to trace the time-domain signature to a portion of the substation. The utility then located a "noisy" 354kV bus insulator, and requested an outage to replace it.

Mr. Cramer then returned to the substation with utility personnel and checked inside the substation. The signature from AA9VI did not match the noisy insulator they had identified, but it did match a 345kV bus insulator on the opposite bus.

The fact is that the utility has expended a great deal of time and money in an effort to fix the problem. But, the situation has not improved because the utility personnel lack the training and experience to identify the correct noise source. Although this noise was not particularly difficult to locate with the right training and equipment, neither the FCC nor the utility had been able to find it prior to Mr. Cramer's investigation.

At present, ComEd reports that they replaced the identified insulator. However, they did not provide the complainant with advance notice before the repairs were made. The complainant was therefore unable to monitor the effect on his issues of de-energizing, repairing, and re-energizing the bus. He is still having problems. Mr. Cramer has informed ComEd that they would need to financially participate in further investigation. So far, ComEd has not responded to that offer. The case remains unresolved after almost five years.

## **PAVE PAWS**

Mr. Hare reports that requests for Longley-Rice modeling of potential repeater systems has slowed down, but that ARRL will continue to help on request.

## **Broadband over Power Line (BPL):**

Broadband over power line (BPL) is the use of electrical wiring or power-distribution lines to carry high-speed digital signals. There are two types of BPL of concern to amateurs. Both *in-building* and *access* BPL have signals that occupy most or all of the HF range, extending into VHF. The power-line or electrical wiring can act as an antenna and radiate these signals. In-building BPL can be used to network computers within a building. It uses the building wiring to carry digital signals from one computer to another. Most in-building BPL operates under the [HomePlug](#) industry specification, which does not use the Amateur bands and thus poses no significant threat to Amateur operation.

Access BPL provides broadband Internet access to homes and businesses, using a combination of techniques and wiring. In late December 2011, the last large Access BPL company and provider, IBEC, announced that it was shutting down in January 2012. At this point, most of the IBEC systems are shut down, although a few still have equipment on the poles, making radio noise although unused. Although there are a handful of tiny BPL systems still in operation in the US, at this point, Ed reports that most remaining systems do not use the ham bands. The BPL system operated by the French Broad EMC in North Carolina, however, does use the Amateur bands. In late 2011 testing, ARRL staff found that this system also does not notch the NTIA bands and it was operating well above the FCC limits. Because the system uses IBEC equipment, ARRL held off on filing a complaint on this until it could learn how IBEC's bankruptcy would affect the operation of the system, but since it appears that the system will continue in operation, ARRL will prepare and file a complaint with the FCC.

BPL is also one of several options for the developing smart-grid technologies, although it is far from being the front runner in current smart-grid deployments. The reliability of using BPL on overhead and underground distribution lines is not sufficient to make BPL the first choice of smart-grid backbone technology.

### **Smart-Grid and Related Standardization**

Mr. Ramie reported on the EMC issues for Amateurs with regards to the Smart-Grid and Related Standardization issue as part of the 3<sup>rd</sup> ARRL-EMC Committee webinar meeting this year. His detailed written report can be found in full in Appendix B of this document.

### **Automotive EMC:**

The Headquarters staff continues to send all reports of automotive EMC problems to interested people in the automotive industry. While these reports are advisory, they are helpful to the industry in planning for future designs. Mr. Steffka is also planning an evaluation of hybrid and electric vehicles' HF band RFI characteristics. He continues to help prepare automotive related responses to Technical Information Services (TIS) questions for ARRL members.

### **Cable Television:**

As a whole, the cable industry continues to do a good job at adhering to the FCC's regulations about signal leakage and interference. ARRL has received only a few reports of problems, indicating that most systems are either clean or are addressing complaints effectively. Only a handful of these cases have required Mr. Hranac's involvement and ARRL follow up.

### **DSL, U-Verse & Home Phone Networking Alliance**

Mr. Beatty continues to assist with broadband service complaints to the ARRL. Only a handful of complaints were received since January.

Dr. Strauss indicates he has nothing new to report relative to the Committee.

### **RFI-Case Database:**

The ARRL HQ staff maintains a database of RFI reports and cases. This is used primarily as a case-management tool for the several hundred RFI cases ARRL handles every year, but the information the Lab staff are gathering about types of interference cases, involved equipment and frequencies will provide a wide range of reporting capability. Here are some statistics from the database for the 1<sup>st</sup> half of 2012 and compared to the four previous years:

<b>Category of Case Reported to</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012-1</b>
-------------------------------------	-------------	-------------	-------------	-------------	---------------

**ARRL Lab/EMC Engineer**

<b>BPL</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>0</b>
<b>Unknown Unintentional Radiators</b>	<b>49</b>	<b>65</b>	<b>57</b>	<b>78</b>	<b>23</b>
<b>CABLE TV</b>	<b>11</b>	<b>26</b>	<b>8</b>	<b>7</b>	<b>2</b>
<b>Computing Devices and Modems</b>	<b>15</b>	<b>21</b>	<b>4</b>	<b>7</b>	<b>1</b>
<b>Power Line Noise</b>	<b>81</b>	<b>113</b>	<b>90</b>	<b>65</b>	<b>32</b>
<b>Plasma TV Receivers</b>	<b>8</b>	<b>12</b>	<b>10</b>	<b>14</b>	<b>4</b>
<b>Other Broadcast Receivers</b>	<b>3</b>	<b>2</b>	<b>7</b>	<b>0</b>	<b>2</b>
<b>Other Receivers</b>	<b>1</b>	<b>4</b>	<b>8</b>	<b>3</b>	<b>1</b>
<b>Other Transmitters</b>	<b>11</b>	<b>1</b>	<b>2</b>	<b>9</b>	<b>2</b>
<b>Broadcast Transmitters</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>6</b>
<b>Lighting Devices</b>	<b>12</b>	<b>12</b>	<b>15</b>	<b>13</b>	<b>2</b>
<b>Fence Systems</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>0</b>
<b>Battery Chargers</b>	<b>6</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>3</b>
<b>Wheelchair</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>
<b>Water Pump Systems</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>
<b>HVAC Systems</b>	<b>5</b>	<b>4</b>	<b>11</b>	<b>6</b>	<b>2</b>
<b>Alarm Systems including detectors</b>	<b>3</b>	<b>4</b>	<b>6</b>	<b>0</b>	<b>2</b>
<b>Other Appliances</b>	<b>12</b>	<b>7</b>	<b>3</b>	<b>8</b>	<b>6</b>
<b>GFIC</b>	<b>5</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>AUTOMOBILE Systems</b>	<b>12</b>	<b>8</b>	<b>4</b>	<b>3</b>	<b>1</b>
<b>Manufacturing and Retail</b>				<b>0</b>	<b>0</b>
<b>Generated Noise</b>	<b>1</b>	<b>2</b>	<b>1</b>		
<b>AT&amp;T U-Verse Systems</b>	<b>3</b>	<b>10</b>	<b>10</b>	<b>8</b>	<b>3</b>
<b>Other</b>					<b>21</b>

It is important to note that power line noise has consistently been the most reported and problematic RFI problem reported to the ARRL Lab. As Committee member Ed Hare indicted, *more hams suffer from power line noise right now than will ever suffer from BPL.*

## **ARRL RFI Forums:**

The two RFI forums remain ongoing in the ARRL forums pages. These forums provide self help and discussion for members. They are monitored and moderated by HQ Lab staff and other volunteers. The pages are:

- RFI - Questions and Answers
  - RFI questions and are answered by other members and RFI experts. Members can post questions and read answers about solutions to an RFI problem they are having. The link is:  
[www.arrl.org/forum/categories/view/20](http://www.arrl.org/forum/categories/view/20)
  
- RFI - General Discussion
  - This forum is a place to discuss technical issues associated with RFI and Amateur Radio. The link is:  
[www.arrl.org/forum/categories/view/21ssion](http://www.arrl.org/forum/categories/view/21ssion)

## **Committees:**

ARRL continues to be represented on professional EMC committees. Messrs. Hare and Carlson continue to represent the interests of Amateur Radio on the ANSI ASC C63<sup>®</sup> EMC committee. Mr. Hare is the Primary ARRL C63<sup>®</sup> representative; Mr. Carlson is the Alternate. Mr. Hare serves as the Vice Chair of Subcommittee 5, Immunity. Mr. Hare also leads the C63<sup>®</sup> committee's Task Force on testing below 30 MHz, which has completed a first draft of an intentional emitter measurement standard that correctly and scientifically extrapolates field strength measurements below 30 MHz. This draft is now in ballot and is expected to become part of the ANSI C63.10 standard on the measurement of unlicensed intentional emitters (transmitters). Mr. Ramie serves as the C63<sup>®</sup> Secretary and as a member of the Below 30 MHz Task Group. The C63<sup>®</sup> committee is working on developing industry standards for immunity, emissions and testing of electronic devices. ARRL serves as a resource to the committee to protect the interests of Amateur Radio. Subcommittee 1 continues to work on a variety of EMC projects, primarily related to test site standardization. Subcommittee 5 deals with immunity and immunity measurement issues. Subcommittee 8 deals with various types of medical equipment. The multiple ARRL EMC-Committee representation on C63 watches immunity and testing developments.

Mr. Hare also serves on the IEEE EMC Society Standards Development Committee (SDCom) as its Secretary. SDCom serves as the EMC Society standards board, overseeing the development of all IEEE EMC Standards.

Related to committee work, Mr. Hare also maintains informal contact with a number of industry groups, including HomePlug and the HomeGrid Forum (in-premise BPL industry groups), Society of Cable Telecommunications Engineers, Society of Automotive Engineers and the Electric Power Research Institute, as a few examples.

## **FCC Rules**

As previously reported in the July 2011 EMC Committee report, Messers. Gruber and Hare have proposed five suggestions for changes in the FCC rules. These proposals remain under review and are included as Appendix A in this document. Also, in support of that effort, here is a summary of planned, recent and ongoing Lab activities:

- Radiated emissions limits below 30 MHz in FCC Part 15 rules for unintentional emitters such as plasma TVs.
  - Test and document an actual TV in Annapolis, MD.
  - Document cases from database.
- Lower limits in Part 15 for non-CFL lighting to possibly harmonize with the lower limits for fluorescent bulbs in Part 18 rules.
  - Document cases from database. Obtain and test bulbs.
- Better external labeling on packaging for Part 18 fluorescent bulbs and ballasts.
  - Document items sold in major stores.
  - Testing as required.
- Specific radiated and/or conducted emissions limits for certain incidental emitters such as motors or power lines.
  - Document large number of power-line cases.
- Pulse-width motor controllers used in appliances.
  - Test a number of devices that belong to staff and/or local hams.

## **The Future of EMC and Amateur Radio:**

Interference to hams appears to be the present major work of the committee. Although immunity problems still do occur, this is being addressed at the national and international standards level. RFI from unlicensed devices poses a major real threat to Amateur Radio at this time. This will continue to require significant Committee and ARRL staff attention. To the extent possible with existing staff, or with additional resources, the ARRL should increase its contact with standards organization, industry groups and individual companies, and continue to work on all aspects of RFI problems and solutions.

ARRL's information about RFI can be read at:

[www.arrl.org/radio-frequency-interference-rfi](http://www.arrl.org/radio-frequency-interference-rfi).

I would like to express my sincere gratitude to Mr Mike Gruber and the entire ARRL-EMC Committee for their time and effort in the preparation of this report. I would like to

especially thank Mr. Jerry Ramie, KI6LGY, of ARC Technical Resources, Inc. for his detailed information on the emerging area of Smart Grid and related EMC standards presented in Appendix B.

**Respectfully Submitted,**

**Kermit A Carlson W9XA  
EMC Committee Chairman  
ViceDirector Central Division**

## Appendix A

### FCC Rules

As previously reported in the July 2011 EMC Committee report, Messers. Gruber and Hare have proposed the following five suggestions for changes in the FCC rules. These proposals remain under review.

1. Presently there are no Part 15 radiated emissions limits for unintentional emitters below 30 MHz. This had been a relative non-issue until the proliferation of plasma TVs. Our experience has shown that direct radiation at HF from a plasma display can be problematic and difficult to fix. One suggestion therefore would be to add absolute radiated emissions limits in this case to the HF spectrum. (Note: In the cases looked at by the Lab, the interference was relatively short range. While reducing the frequency of the limits may not completely solve the problem, it should help in some cases.)
2. Fluorescent lights with electronic ballasts, electronic ballasts and CFLs typically operate under Part 18. Part 18 has a separate set of absolute limits for “RF Lighting Devices.” These limits are then broken down into consumer and non-consumer devices. Note: The limits are higher for non-consumer devices, similar to Part 15A and 15B for digital devices.

Quasi-Peak Part 18 limits from 3 to 30 MHz for consumer and non-consumer RF lighting devices are 48 dB<sub>μV</sub> and 70 dB<sub>μV</sub>, respectively. For consumer devices, these are the lowest of any specified limits in Parts 15 and 18 of the rules. It is also important to note that, in the case of Part 18 lighting devices, the FCC created a special set of lower limits just for them. Apparently, the difficulty in eliminating interference from a widespread proliferation of Part 18 bulbs in homes and neighborhoods is something that concerned the FCC when they wrote these rules.

Unlike fluorescent bulbs however, the new LED bulbs operate under Part 15. The limits for these bulbs are 56 dB<sub>μV</sub> from 0.5 to 5 MHz, and 60 dB<sub>μV</sub> from 5 to 30 MHz. These newer LED bulbs are becoming increasingly ubiquitous in many stores and homes. Unlike their Part 18 equivalent however, they have also become a source of interference. The suggestion would be to reduce the Part 15 limits for lighting devices to Part 18 lighting device limits from 3 to 30 MHz. Essentially, make the limits for Part 15 and 18 bulbs the same, thus reducing the RFI potential from newer LED bulbs before they become a major problem.

3. Part 18 rules specify labeling for RF lighting devices are as follows:

***§ 18.213 Information to the user.***

*Information on the following matters shall be provided to the user in the instruction manual or on the packaging if an instruction manual is not provided for any type of ISM equipment:*

- (a) The interference potential of the device or system*
- (b) Maintenance of the system*
- (c) Simple measures that can be taken by the user to correct interference.*
- (d) Manufacturers of RF lighting devices must provide an advisory statement, either on the product packaging or with other user documentation, similar to the following: This product may cause interference to radio equipment and should not be installed near maritime safety communications equipment or other critical navigation or communication equipment operating between 0.45–30 MHz. Variations of this language are permitted provided all the points of the statement are addressed and may be presented in any legible font or text style.*

As the above indicates, including (d), the RFI potential is not required to appear on the outside of the package. One could easily buy a fluorescent light or ballast and not know there are issues until he opens the box. The suggestion would be to require an obvious warning on the outside of the package, similar to what appears on the box of a Part 15 unintentional emitter. The suggested wording would be similar to its Part 15 equivalent. In addition, part c of the above rules should be referenced and give the location of this information.

4. Part 18 specifies two sets of limits for RF Lighting Devices – consumer and non consumer. (Note: Some manufactures specify Part 18A and 18B on their products, similar to Part 15. This is not spelled out in Part 18 however.) A quick look at a local “big box” store will show that many ballasts are non-consumer rated. The label is not on the box but rather in very small print in the device or on a sheet inside the box. The suggestion would be to require consumer and non consumer labeling on the outside of the box. The labeling must also be large enough to be obvious to the consumer at the time of purchase.

In addition, some fluorescent light fixtures with electronic ballasts do not specify the type of ballast inside. The suggestion would be to also add labeling to the outside of the box in the case of a light fixture. It should be clear to the consumer that the device is or is not suitable for residential use.

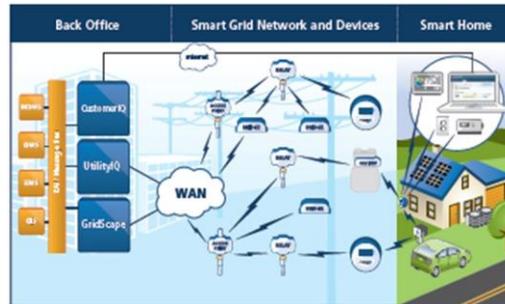
5. Add intentional emitter radiated emissions limits for Part 15 incidental emitters in the case of power lines, associated hardware and electric motors. Although power line noise is the most reported source of known interference to the ARRL, and often the most difficult to solve, there are presently no specified limits for power lines (or any other) incidental emitters.

## Appendix B

The following report was prepared and presented by Mr. Jerry Ramie, KI6LGY, of ARC Technical Resources, Inc. for the ARRL-EMC Committee meeting.

### Smart-Grid and Related Standardization

1) Smart Metering using 902-928MHz band. This diagram shows the residential smart meter connecting to the utility smart grid network and devices. (local repeaters and access points) Note that the metering backhaul system commonly used in California is meshed frequency-hopping spread-spectrum (FHSS).



In Northern California, GE or L+G meters are outfitted with SilverSpring Networks 310 radio cards. (shown below)



These produce 2-20mS duration packets, adding up to 45 seconds/day of transmission. (That's a very low duty cycle) The consumer-side radio is a 2.4GHz narrow-band ZigBee device running SEP1.0 firmware. Here are the specifications for the NIC300 family of meter cards:

**NIC 300 product family**

NAN communications      Data rates: 100 kbps  
 Spread spectrum: FHSS  
 Transmitter output: 27 to 30 dBm (500 mW to 1 W)  
 Receiver sensitivity: -97 dBm for 1% PER  
 HAN communications      Protocols: IEEE  
 802.15.4,  
 ZigBee Smart Energy Profile 1.0  
 Frequency: 2.4 GHz ISM Band  
 Transmitter output: 20 to 23 dBm (100 to 200 mW)  
 Receiver sensitivity: -97 dBm for 1% PER

2) Access Points (neighborhood concentrators) also use this band. (specifications below)

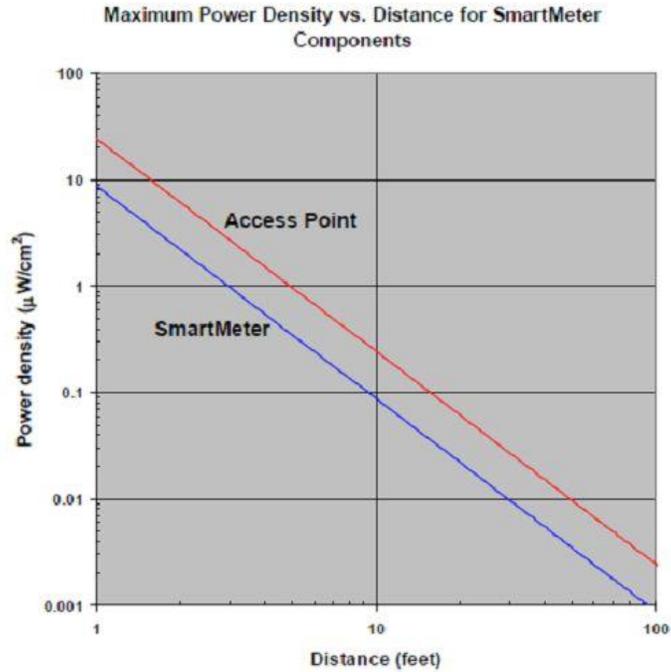


**Specifications:**

<b>Communications</b>	Data rate: 100 Kbps Frequencies: 902-928 MHz (North America) 915-928 MHz (Australia) 902-907.5, 915-928 MHz (Brazil) Spread spectrum technology: FHSS Transmitter output: 30 dBm Output impedance: 50 ohms Receiver sensitivity: -97 dBm for 1% PER WAN: Cellular, Ethernet, and Satellite
<b>Protocols/Security</b>	Addressing: Internet Protocol version 6 (IPv6) Security: Secure Hash Algorithm 256 bit (SHA-256) RSA-1024 and/or ECC-256 Encryption: Advanced Encryption Standard (AES-128 or AES-256)
<b>Physical Interfaces</b>	Antenna connector: N Type, Female Antenna: J-Pole or High-Gain Directional

Access points like this (or repeaters) have much higher duty cycles as they handle as many as 5,000 meters each. They also have better antennas, like the 0dBi J-pole shown above. If there was going to be an interference problem on 900MHz, it would most likely be with one of these. RF field strengths for smart meters and access points is shown below from a PG&E-commissioned report.

Examples of RF Fields Commonly Found in the Everyday Environment in Relation to SmartMeter™ System Operation	
RF Source	Power Density (µW/cm <sup>2</sup> )
Immediately adjacent to a SmartMeter™ device (1 foot)	8.8
Immediately adjacent (1 foot) to a SmartMeter™ access point if elevated to height of transmitter	24
Adjacent to 25 foot high SmartMeter™ access point at ground level	0.03
Installed microwave oven- FDA allowable at 5 cm from door [FDA, 2009]	5,000
Typical RF field in kitchen with operating microwave oven [1 meter] [Mantiply, et al. (1997)]	10
Cell phones (at head) [Mantiply, et al. (1997)]	30 – 10,000
Cell phone base stations at ground level (maximum) [WHO (2006)]	1-12
Walkie-Talkies (at head) [Mantiply, et al. (1997)]	500 – 42,000
Wi-Fi wireless routers, laptop computers, cyber cafes, etc., maximum (~1 meter for laptops, 2-5 meters for access points) [Foster (2007)]	10-20
Median exposure to FM radio and TV broadcast station signals [Tell and Mantiply (1980)]	0.005



3) Ken Leisten (K6DND) complained about a PG&E access point back in October, 2011. I went out with my 2M/440 Elk log-periodic antenna but could not positively identify the offender. The following photo shows my setup.



He felt that his interference was coming from this unit, but I thought it was too far away from his home and the interfering signal faded and recovered before we got to this location. He asked PG&E to replace it, they did, and that made no difference.



A new investigation is needed here, and Ed Hare has ordered an appropriate antenna for the work. We may want to capture a spectrum plot of this case if it is still on-going. No formal complaint has occurred, although Mr. Leisten said he wanted to pursue one.

### **In-Premises BPL & HF interference**

HomePlug modems notch the ham bands by 25dB. HomeGrid Forum notches them to 35dB. Hams may still experience HF interference from these modems if they're nearby or sharing the same transformer secondary. (it's conducted interference which can re-radiate from unshielded power wiring) Shut-down is the only mitigation. (these two modems can be replaced by a piece of CAT-5 cable for a few dollars)



### **Distribution Automation Equipment**

This kind of equipment will soon be widely deployed to enable smart grid functions. They're Class A Industrial products with conducted emissions levels from their switching

power supplies 10dB higher than consumer products. These devices will be installed on poles out in the neighborhoods at HF antenna heights. (see photo)



Will there be interference? How will any interference be mitigated? Are smart grid EMC Standards complete? (**NO**)

### **Trying to get EMC noticed...**

September, 2009: The IEEE-EMC Society asks me to address P2030 at their Plenary session AND all three working group sessions at IBM-Watson Research Center. The Presentation was accepted. Brian Cramer from our committee got one paragraph accepted into P2030n about the need for EMC.



January, 2010: IEEE-EMC/SD-COM White paper was given at the P2030 meetings in Santa Clara, CA.



All three working groups declare that no EMC will be in P2030.

### **Finally got noticed...**

September, 2010: Dave Wollman of NIST proposed the charter for the EMII working group under the Smart Grid Interoperability Panel (SGIP). Eight months are allocated for generating recommendations to the Governing Board. (the report will be done in 3Q/2012)

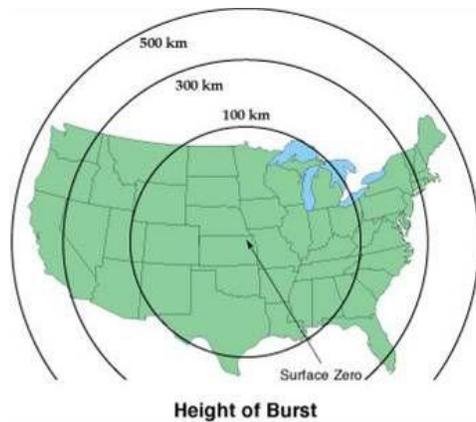


### **SGIP Mandates:**

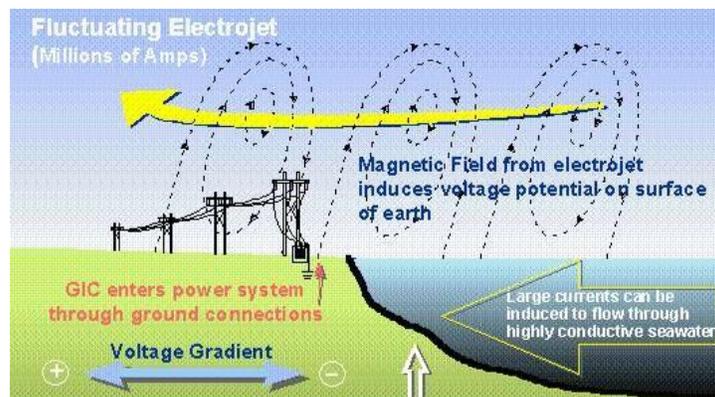
- Identify standards for “Smart Grid”
- Identify missing standards and “gaps”
- Develop “priority action plans” (PAPs) to close gaps
- Provide deep technical reviews in key areas
- Coordinate these plans with Standards Organizations

### **Progress in three areas at the EMII Working Group:**

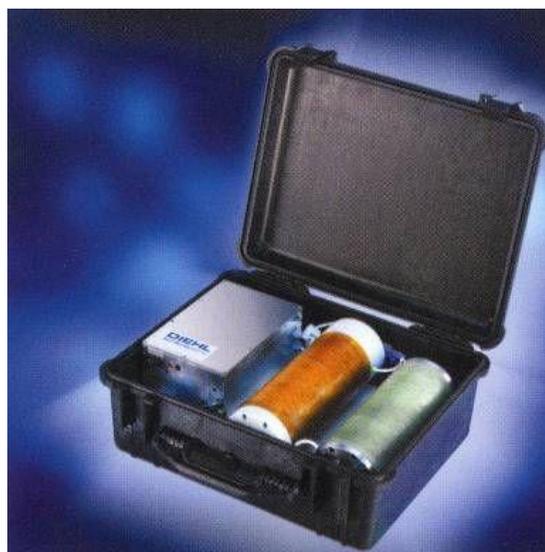
- 1) High-level EM Disturbances
- 2) High-altitude Electromagnetic Pulse (HEMP) created by a nuclear detonation in space



- 3) Geomagnetic Storms created by solar activity have created regional power blackouts in the past due to the creation of severe harmonics in large transformers.



Intentional Electromagnetic Interference (IEMI) caused by electromagnetic weapons used by criminals and terrorists. This unit is commercially available in Europe.



International standards organizations are dealing with protection from these threats for civil equipment and systems. In addition, there are questions being asked by Congress (7/21/09 Dept. of Homeland Security hearing) about whether these high-level EM threats are being considered in the Smart Grid program. In particular, the IEEE EMC Society, with support from its Technical Committee 5 (HPEM), is developing a Standard Practice for protecting publicly-accessible computers from EM weapons (IEMI). Further CIGRE has just begun work on protecting substation control electronics from IEMI. Finally, the International Electrotechnical Commission (IEC) has been working for 20 years developing a body of standards and reports (20 in all) to protect civil electronic equipment and systems from HEMP and IEMI. It's likely that at least some of this work will be recommended for adoption by the EMII Working Group.

## 2) Protective Relay EMC Standards in the US & EU

This chart shows the IEEE or IEC testing for EMC required in the US and EU, respectively:

	<b>Emissions</b>	<b>Immunity</b>
<b>Conducted</b>	<b>IEC 60255-25</b>	<b>IEC 60255-22-6</b>
<b>Radiated</b>		<b>IEC 60255-22-3</b> <b>IEEE C37.90.2</b>
<b>Power-line</b>	<b>IEC 61000-3-2</b> <b>IEC 61000-3-3</b>	<b>IEC 61000-4-8</b> <b>IEC 61000-4-9</b> <b>IEC 60255-11</b> <b>IEC 60255-22-7</b>
<b>ESD</b>		<b>IEC 60255-22-2</b> <b>IEEE C37.90.3</b>
<b>EFT</b>		<b>IEC 60255-22-4</b>
<b>Surge</b>		<b>IEC 60255-22-5</b>
<b>Surge Withstand</b>		<b>IEC 60255-22-1</b> <b>IEEE C37.90.1</b>

I suggested that seven gaps in immunity testing could be identified from this table: (tests that are needed in the EU, but not in the US)

- Surge
- Conducted RF Immunity
- Power-frequency Magnetic Fields
- Pulsed Magnetic Fields
- AC Dips/Interrupts
- DC Dips/Interrupts & AC ripple
- Power-frequency Immunity

These seven gaps, and others, will be identified in our report to the SGIP Governing Board. The Board can:

- Ignore our immunity recommendations
- Authorize a Priority Action Plan (PAP) to directly address these gaps
- Authorize SGTCC action on Certification

### 3) Smart Grid Testing & Certification Committee

"Creates and maintains the necessary framework for compliance, interoperability and cybersecurity testing and certification for recommended smart grid standards."

Recent efforts include preparation of the Interoperability Process Reference Manual (IPRM). It will be used by Interoperability Testing and Certification Authorities (ITCAs) who must be (or must use) ISO-17025 accredited test labs for Certifications.

The EMII Working group will recommend that EMC immunity Standards be required for Smart Grid products Certified by ITCAs. These Authorities will then identify what EMC Standards will need to be met.

### **Progress in the Power & Energy Society**



IEEE-1613 Extension for "Environmental and Testing Requirements for Communications Networking Devices Installed in Transmission and Distribution Facilities." IEEE-1613.1 will add the seven gap immunity tests identified above. Balloting in 3Q/2012

### **More immunity tests coming?**

The IEC 61000-6-5 Generic Immunity Standard for Power Station and Substation Environments is due for revision. New disturbances and associated immunity testing methods have been developed since 2002. SC-77A, chaired by Dr. Bill Radasky, will begin considering them in the new update. Balloting is probably several years away, however.

### **Conclusions**

- 1) We need to understand if utility FHSS emissions on 902-928MHz will have an adverse impact on this band for our members. (new investigation needed in Santa Clara)
- 2) We need to stay vigilant to identify any HF interference from In-Premises BPL modems of any type. (keep in contact with consortia)
- 3) We need to advocate for additional, realistic immunity testing and test levels for Distribution Automation and Substation equipment. (by staying active in SGIP)
- 4) We need to help John Tengdin of IEEE-PES get the seven "gap" immunity Standards included in the 1613.1 extension. (by joining his working group to help draft the text)

- 5) It would be wise for this Country to require mitigations be in place for high-level EM disturbances at major utility nodes. (high-impact low-frequency events) We should advocate for such rules.