ARRL EMC Committee Semi-Annual Report

Doc. # 20

For The
American Radio
Relay League

Board of Directors Meeting
January 17-18, 2014

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. Phil Barsky, K3EW, Engineering/Management Consultant, retired
- 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

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®, 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 2nd half of 2013, 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 that no previously reported case has been successfully resolved.
- 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. Fortunately, so far, the bulbs that we've tested have substantially met the applicable FCC limits.
    - 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. The Lab has now purchased a common and popular 1kW grow light and tested it for conducted emissions. Although this was only a sample of one, the results showed this ballast to be approximately 60 dB over the FCC Part 18 consumer limit. For comparison, it was still about 38 dB over the non-consumer limit. This is the worst device we've ever tested in the Lab for conducted emissions.
- Working with AT&T engineering staff to help resolve RFI issues with U-Verse and other broad band systems.
- Reviewing proposed EMC related material for ARRL publications.

Summary of Recent and Ongoing Lab Activities

<u>Lighting Devices</u>

As previously reported, Mr. Gruber tested a number of energy saving Part 15 & Part 18 Lighting Devices for conducted emissions. It should be noted 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 help provide us with a better understanding of interference potential from LED and CFL bulbs as they currently exist. It was also used by Mr. Gruber to write an upcoming QST article. This article appeared in the October issue of QST, page 42.

The analysis suggests that they substantially meet the applicable Part 15 or Part 18 limits in the Amateur spectrum. Those that failed primarily did so below 500 kHz. The measured emissions in most cases, however, were within our measurement tolerance. Although this might suggest a greater potential for interference to the two new proposed Amateur bands below 500 kHz, it is important to note that in all cases the 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 in the United States. If and when interference occurs, the burden then 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.

Arc Fault Current Interrupter AFCI Breaker Immunity Issues

As previously reported, Mr. Gruber began receiving a few reports of "tripping breakers" from hams in early 2013. Specifically, these complaints concerned AFCI breakers, or Arc Fault Circuit Interrupter type breakers. These breakers are designed to trip if they sense an arc, and are now required by the electrical code in some specified rooms for residential wiring.

In response to these complaints, Mr. Gruber with invaluable help from W1AW Station Manager Joe Carcia built a "universal" circuit breaker test fixture. Mr. Gruber purchased every AFCI breaker that he could find at local electrical supply centers and big box home supply stores. Most of the complaints that he received seem to have involved breakers made by Eaton, which is a Cutler Hammer company, a well known manufacturer of electrical equipment. As a result, he purchased both a 15 and 20 Amp Eaton AFCI breakers for these tests.

Joe Carcia, NJ1Q & Circuit Breaker Test Fixture at W1AW

The initial results of this testing indicated that the AFCI breakers were surprisingly robust. They were operated them in the basement of W1AW during code practice sessions. They were simply not tripping, even with multiple transmitters all operating simultaneously at 1,000+ watts. Even the suspect Eaton breakers, which he purchased at Home Depot, were not tripping.

Puzzled, Mr. Gruber then asked a complainant if he could send a sample or two of the problematic breakers. Shortly thereafter, he received two samples and tested them at W1AW. The initial tests indicated that there was indeed a problem. At somewhere between 25 and 50 watts, they would trip. Interestingly enough, these breakers were smaller than the ones that he had purchased and had a yellow (as opposed to a white) reset button. The part numbers were also very similar and the breakers were clearly meant to be interchangeable.

Mr. Gruber's understanding of the problem was that Eaton had redesigned their AFCI breaker, possible adding some new microprocessing circuitry. The older breakers were still on the shelf at Home Depot, and the newer model was used at the complainant's residence and neighborhood. Based on his testing, the AFCI problem was primarily linked to one manufacturer (Eaton), and more specifically, only the latest model of Eaton breaker at the time. It was not quite the universal problem that some had feared. However, with today's cookie-cutter sub developments, this was particularly problematic for some hams. These cases featured high density housing where every service entrance panel is filled with Eaton breakers. It was an obvious recipe for disaster.

Once the scope and magnitude of this problem was understood, Mr. Gruber contacted the Eaton Company. As a result, two engineering representatives visited the Lab in August. They were particularly interested in resolving the problem. Within a couple months, they sent new prototypes, which did not trip, even during W1AW broadcast transmissions. At present, the new breakers are awaiting UL approval. Mr. Gruber wishes to emphasize that Eaton couldn't have been more cooperative or helpful in resolving this matter to everyone's satisfaction.

Complete details appeared in the November 19, 2013 ARRL news story, *ARRL Helps Manufacturer to Resolve Arc Fault Circuit Interrupter RFI Problems*. The URL is:

www.arrl.org/news/arrl-helps-manufacturer-to-resolve-arc-fault-circuit-interrupter-rfi-problems

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 has historically been very disappointing. With regard to power line noise, no previously reported longstanding power line noise case has been resolved during the second half of 2013. While some cases have been closed, many cases can drag on indefinitely. . Protracted cases are often caught in an endless loop or letter writing campaign. As a result, new cases develop faster than old cases are resolved. There has been little or no change from the previously reported statics in this regard. The FCC has yet to issue even one NAL in an RFI case involving Amateur Radio. As previously reported, the FCC is clearly not doing its job!

Second Half 2013 Year Total RFI-Case Statistics:

New RFI Cases – 116
New electrical power-line cases – 26

- ARRL Letters sent – 19 (Note: One letter involved four complainants.)
- FCC 1st Letters submitted – 9 (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 – 3

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. Although none of the previously reported cases have been successfully resolved, the Committee is continuing in the process of addressing this issue.

Vice director and EMC Committee Chairman Kermit Carlson has been performing field survey work for power line noise interference. Six different cases were chosen in the Chicago Metropolitan/Northern Illinois area for local investigation using Radar Engineers noise signature equipment provided by the ARRL Laboratory.

Of the seven cases chosen, all have elements of ongoing detection and remediation.

- Two of the affected amateur stations have had intermittent interference that has not been located due to the sporadic nature of the interference. In both cases the affected operator has reported noise levels in excess of S9 on HF. Both of these stations had reported the issue to the local power utility through normal customer trouble reporting methods resulting in some remediation work.

    - One of these two cases was in Streamwood, Illinois. It was found that a tree was touching "low-voltage" 13.8 kV distribution conductors at the entrance to his property, after this was remediated by the Utility the noise problem seemed to be solved.

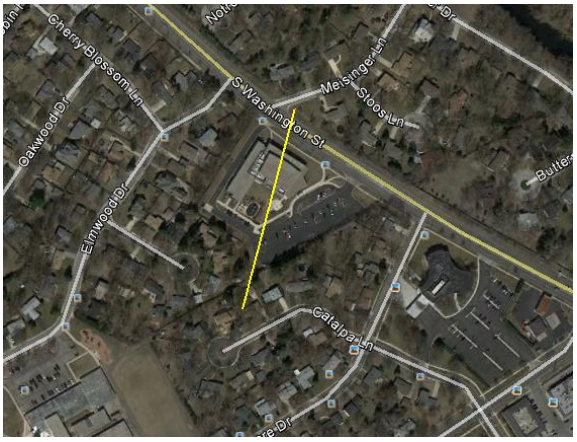
    - The second case was an amateur in Davis Junction, Illinois (20 miles south of Rockford, Illinois) who had reported harmful interference from power line noise the source of which was determined to be a 75-kiloVolt transmission line located along an Illinois State highway located in the front of the amateur's residence. This interference case had been issued an FCC letter from the ARRL Lab. The Utility has replaced 40 insulators on this power line and according to the amateur no further interference has been noted.

- A third case in Oswego, Illinois involves an amateur who has had ongoing interference with reports of various field investigations by Mr. Brian Cramer W9RFI and most currently by Mr. Kermit Carlson W9XA. The Utility has not been forthcoming with details of any remediation, but a complicating issue is the location of amateur and the intermittent nature of the interference. Locating efforts will continue. Please note in the photograph that power line right-of-way, with three separate sets of distribution power lines, is directly behind the victim site. The line drawn on the aerial photograph indicates the last detected source of intermittent noise. This particular noise source, at a distance of 1,600 feet, provided interference of S9 at 28 MHz, which is much lower than the intermittent source of greater than 20 dB over S9 on 28 MHz to a vertical. At this site, the

severity of the noise varies greatly with weather conditions and there is a significant volume of potential sources; as a result the search for additional sources continues.

Oswego, IL Photo

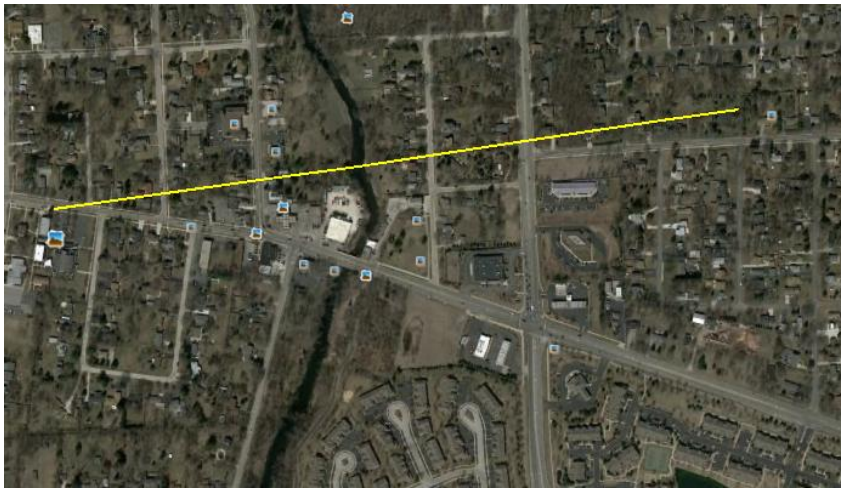
- A fourth case in Naperville, Illinois was determined to be primarily due to a single power line insulator located 700 feet from the victim site. This particular source could only be located using Direction Finding with Interference Signature methods available with the Radar Engineers equipment. When normal DF was used by the amateur, following an HF beam heading from the amateur's station the path to the source crossed several intervening properties, each with interference emitters. Each of these emitters was of a radiated level not sufficient to reach the victim site, but was strong enough to be detected by portable HF and VHF receivers when following the path. The result was the several smaller sources were identified as possible emitters which actually were not responsible for the interference presented to the victim site. It was only after the Signature Detection capability of the Radar Engineers equipment was used was the actual source located beyond the intervening smaller sources. The location of this insulator has been reported to the responsible Municipal Utility for remediation and further interference work is on hold pending work on the offending source. It should be noted that this source provided an interfering signal of S9+20 on 28 MHz to a vertical antenna.



Naperville, IL aerial Photo

- A fifth case involves an active VHF/UHF operator in Palatine, Illinois who has experienced significant harmful interference levels of power line noise on 50 MHz and 144 MHz. For this investigation the Signature Detection capability of the Radar Engineers equipment was used to determine that the two beam headings to the sources separated by 40 degrees azimuth, resulted from problems on the same power line, but were sourced by separate insulators on separate phases of the "low-voltage" distribution lines. The Noise Signature capability allowed the two sources to be DF'ed separately by differences in signature as well as the difference in timing. The time of the interference is important in cases such as this since the signature of voltage breakdown occurs at the peak of the power line sine wave, and the two insulators on different phases provided signatures separated by different times as well as different patterns of the breakdown. This case has been referred to the Utility for repair.

- A sixth case involves an amateur in Warrenville, Illinois, who had varying degrees of success dealing directly with the Utilities technical experts. In this case, the local Utility supervisor was aware of the nature of early detection of evolving problems and that radio interference can be used to detect issues prior to failure of the power distribution system. This particular amateur has been fighting interference for over 6 years at his station and has developed a good rapport with his local Utility. This amateur has also obtained a Radar Engineers UHF noise locator but one that does not have Noise Signature detection capability. Over the fall months of 2013 Mr. Carlson helped this amateur detect several separate issues, all of which required Noise Signature techniques during the Direction Finding search. Each of these searches lead to issues that were verified by Ultrasonic methods at the source, photographically documented and then reported to the Utility for repair. The aerial photograph shows the location of one power line noise source located 3,300 feet from the victim site. This source provided a level of >20db over S9 as received on a 14 MHz 4 element beam.



Warrenville, IL Photo

The efforts of the amateur in this sixth (Warrenville) case is most remarkable because of the great amount of effort that this amateur has expended in making productive and cooperative contacts within the Utility; the same Utility in all of the cases mentioned above with the sole exception of the Naperville case. This Utility now has a reporting capability that is available to "Supervisors" on the toll-free trouble reporting line which is called an "EMI Ticket". Since the "EMI Ticket' reporting is new, it is unknown how productive this new procedure will be, but it is anticipated that it will help this Utility properly address the problem of power line noise within their distribution system.

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.

Access BPL provides broadband Internet access to homes and businesses, using a combination of techniques and wiring. As of July 2013, there are only a handful of BPL systems still in operation in the US and none are being expanded in any way as the major US BPL manufacturers have all shut down any production of access BPL equipment.

In-premise BPL is continuing to be sold, but at this point, none of the several industry standards on BPL protocols permit the use of the Amateur bands.

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 Efforts

Mr. Ramie reports on Smart-Grid EMI and standardization issues as follows:

EMI Issues White Paper

The NIST-SGIP-EMI Issues working group published[1][1] their "*Electromagnetic Compatibility and Smart Grid Interoperability Issues*" white paper in December of 2012[2][2]. Although it does not describe all utility environments, IEC 61850-3 was one of

[1][1] https://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPDocumentRegistry/EMII_WG_EMC_White_Paper_SGIP_2012_005.pdf
[2][2] http://members.sgip.org/apps/group_public/document.php?document_id=1732&wg_abbrev=sgip-emiiwg

the Best Practice guides used by the working group for determining which EMC immunity tests to recommend for inclusion in the extension to IEEE – 1613. Also, these two Standards were already widely used in Industry. (As shown in their advertising) IEC 61850-3 requires these immunity tests for substation communications networking equipment:

- IEC 61000-4-6 Conducted RF Immunity
- IEC 61000-4-3 Radiated RF Fields (C37.90.2 is cited in IEEE-1613)
- IEC 61000-4-8 Power-frequency magnetic fields
- IEC 61000-4-10 Damped Oscillatory Magnetic Fields
- IEC 61000-4-16 Conducted Common-Mode Disturbances
- IEC 61000-4-4 Electrical Fast Transient (C37.90.1 is cited in IEEE-1613)
- IEC 61000-4-5 Surge
- IEC 61000-4-12 Ring & Damped Oscillatory Waves (C37.90.1 is cited in IEEE-1613)

The five "gap" immunity tests missing from substation communications networking equipment tested under IEEE-1613 vs. what is required under IEC-61850-3 are shown in red above. (No IEEE equivalent) A "gap" is a missing test or one that is run improperly.

IEEE-P1613.1

In December of 2012, the NIST-SGIP-EMI Issues Working Group asked the IEEE Power and Energy Society Substations C2 Subcommittee, chaired by John Tengdin, to include these five (red) "gap" immunity tests in their ongoing work on the extension of IEEE-1613, called IEEE-P1613.1 The IEEE tests shown in black above already existed within IEEE-1613 for substation communications networking equipment, so additional (lower) test levels were called out in the IEEE-P1613.1 extension for communications networking equipment installed outside substation boundaries (both in transmission and distribution environments).

Gaps in American Utility EMC Standards

These five "gap" immunity tests were referenced in the IEEE-P1613.1 draft as of January, 2013. IEC-61850-3 included immunity tests and levels for substation communications networking devices that were incorporated into the IEEE-P1613.1 draft and called out for products used in Zone A (inside the substation fence) as shown in the middle column below.

"Gap" Immunity Tests and Levels in IEEE-P1613.1

"Gap" Standards	Zone A (Substations) (from IEC-61850-3)	Zone B (T&D) (from IEC-61000-2-5)

IEC 61000-4-5 (Surge)	**Installation Class 4**	**Installation Class 3**
IEC 61000-4-6 (Conducted RF)	**Level 3: 10Vemf**	**Level 2: 3Vemf**
IEC 61000-4-8 (60Hz magnetic)	**Level 5: 100A/m + 1,000A/m**	**Level 4: 30A/m + 300A/m**
IEC 61000-4-10 (Oscillatory Magnetic)	**Level 5: 100A/m (peak)**	**Level 4: 30A/m (peak)**
IEC 61000-4-16 (Common Mode Disturb.)	**Level 4: 30V + 300Vrms**	**Level 3: 10V + 100Vrms**

Zone B is defined in the IEEE-P1613.1 draft as outside the substation fence in the transmission and distribution (T&D) networks and allows a lower test level in each case. (Per IEC 61000-2-5 as cited in the EMI Issues White Paper) The author gratefully acknowledges the contribution of Don Heirman in establishing these two zones.

Acceptance Criteria

The final draft of IEEE-P1613.1 uses the existing Acceptance Criteria from IEEE-1613 (2009), which also has been adopted in the latest version of IEC-61850-3 as well. These criteria apply for Class 1 devices (where recovered disruptions are allowed) and Class 2 devices (where no disruptions are allowed, implying an optical connection). The Acceptance Criteria in P1613.1 also requires that both transmit and receive functions are exercised during the application of each test stimulus and that the device remains energized until post-testing evaluations are completed. They are summarized as:

a) No hardware damage occurs.
b) No loss or corruption of stored memory or data, including active or stored settings, occurs.
c) Device resets do not occur, and manual resetting is not required.
d) No changes in the states of the electrical, mechanical, or communication status outputs occur. This includes alarms, status outputs, or targets.
e) No erroneous, permanent change of state of the visual, audio, or message outputs results. Momentary changes of these outputs during the tests are permitted.
f) During the tests, SCADA analog values shall not change by more than 2% of full-scale values. After the test, accuracy must revert to the manufacturer-claimed accuracy.
g) No “re-booting” of the device after the test is allowed

Harmonization

The original impetus from the NIST-SGIP-EMI Issues Working Group was to encourage the harmonization of the testing requirements in the US with those in other parts of the World. IEC-61850-3 was already in the NIST Catalog of Standards for harmonization

when the work began. The parallel effort to extend IEEE-1613 for utility communications networking equipment using IEEE-P1613.1 was a natural fit for these ambitions. Immunity testing to IEC 61850-3 (substation environments) and IEC 61000-2-5 (commercial/industrial environments) is now equivalent to that required in IEEE-1613 and its extension, IEEE-P1613.1. These two pairs of Standards have nearly identical immunity tests, test methods, test levels and Acceptance Criteria. Market barriers have therefore been removed and the interoperability of communicating utility products is further enhanced. Manufacturers of utility communications networking equipment now only have to meet one "harmonized" set of immunity tests for their products in most of the World. Utilities that purchase communications networking equipment can now choose from more manufacturers of equivalently-tested products and compare them easily.

Impact for Amateur Radio

This new IEEE-1613.1(2013) Standard requires conducted immunity testing on utility communications products (and almost anything used in smart grid must communicate) covering 150kHz - 80MHz, which covers all of the HF spectrum. Now, resistance (immunity) testing to interference from AM emanations in the HF frequency range will be required for utility communications equipment going forward. The chances of hams causing interference to utility-owned smart grid equipment, most of which will communicate, is now greatly reduced while the reliability of the smart grid is enhanced. This important work could not have continued to a successful conclusion without the support of the ARRL.

SGIP 2.0, Inc.

The NIST-SGIP ceased to exist on January 1, 2013 and the SGIP-2.0, Inc. took its place. It is an industry-sponsored forum to assure that the components in a modern electric grid can interoperate and communicate reliably with each other. The members of SGIP-2.0 resolve standards coordination issues and identify Standards gaps which might otherwise impact seamless connectivity and reliable operation in the harsh electric utility electromagnetic environment.

ANSI-C12.1 testing of Revenue Meters

Problems with the EMC tests and figures in the ANSI-C12.1 (2008) Standard for revenue meters were uncovered during the IEEE-P1613.1 writing work in January, 2013. (ANSI-ASC-C12® operates under the National Electrical Manufacturers Association or NEMA) A preliminary report[3[1]] from the IEEE-P1613.1 writing group was given to the SGIP2-EMI Issues Working Group on 2/25/13, with ANSI-C12.1 working group members in attendance. A copy of the report was given to the IEEE-EMC Society SDECom on 3/6/1. The problems with this Standard are summarized below.

EMC Testing Problems in ANSI-C12.1 (2008)

4.7.3 Accuracy Tests	**4.7.3.12 Test No. 26 – Radiated RF Immunity**
Accuracy table should be the Acceptance Criteria	Re-draw Figs. 6, 7, 8 & 9 to show typical installations
Before/after evaluation only used for surge testing	Reference IEEE-1613 and IEEE-P1613.1 (no references now)
Assessment of "relative error shift" required during all other tests	Break frequency range at 80MHz into Radiated & Conducted tests
EUT should be connected and running as normally used	Specify field strength as 10V/m (-0 to +6dB)
	Delete reference to "most sensitive side" (does not exist)
Test No. 17 - Surge Tests	Use linearly polarized antennas, not circular
No performance requirements	EUT should be connected and running as normally installed
No test setups, test levels or phase angles	Exercise & assess critical functions during the tests
Cites incorrect SPD Standard; delete ring wave tests	Delete GTEM references, cite IEC 61000-4-3 Annex D as normative
Use IEC 61000-4-5 tests & methods (levels from IEEE-P1613.1)	Harmonize modulation requirements (80% AM)
4.7.3.4 Test No. 18 – Power-freq. Magnetic Field	**Figures 6, 7, 8 & 9**
Proximity method is unique, not harmonized	Re-draw to show typical installations (not opened or shorted)
Unit of measurement is unique, not harmonized	Critical functions & COM exercised during tests (not disconnected)
Use immersion method to IEC 61000-4-8 (levels from IEEE-P1613.1)	Acceptance is assessed during all tests (except surge)
4.7.3.11 Test No. 25 – Electrical Fast Transient	**4.7.3.13 Test No. 27 – Cond. & Radiated Emissions**
Use both 5kHz and 100kHz repetition rates	LISN is mounted on the floor, which is not an option
EUT should be connected and running as normally used	Re-draw figs. 6, 7, 8 & 9 to show typical installations
Correct Fig. 4 to show 0.5m connection	Load meter normally (not disconnected or shorted to ground)
Specify reference ground strap (1.5m)	Exercise & assess all functions & COM during the tests
Delete "power return cable" and comment #4	Use worst-case emissions for measurement case
Correct Fig. 5 to show proper power connections	
Communications & all functions must be evaluated during tests	
Use tests & levels from IEEE-1613 and IEEE-P1613.1	
	4.7.3.14 Test No. 28 - ESD
4.7.3.11a Test No. 25a – Oscillatory SWC	EUT should be connected and running as normally used
EUT should be connected and running as normally used	I/O or communications hardware should be installed and running
I/O or com. hardware should be installed and running	"Relative error shift" should be assessed during the test
"Relative error shift" should be assessed during the test	All lower test levels must be satisfied (not top level only)
Use tests & levels from IEEE-1613 and IEEE-P1613.1	Use tests & levels from IEEE-1613 and IEEE-P1613.1

The final (unanimous) SGIP2-EMI Issues *C12.1 (2008) Recommendations* report[4][2] about these flawed EMC tests was finished in March and posted to the SGIP2 public website. The Conclusions from this report:

SGIP2-EMI Issues C12.1 (2008) Recommendations report Conclusions

1) Before/after assessment of EUT Acceptance (accuracy) is called out in clause 4.7.3

2) But, before/after assessment is not used in other "disturbance" tests (inconsistent, not harmonized)

3) Before/after assessment assumes the EUT was changed or damaged by the stimulus

4) Before/after assessment is incorrect (redundant) for an un-changed, un-damaged EUT

5) EUT Assessment during the testing is suitable for non-destructive tests that may only disrupt critical functions (like EFT, SWC, Radiated & Conducted RF immunity and ESD)

EUT Assessment during testing harmonizes with other International Standards identified as appropriate by the EMI Issues working group. In April, the working group expanded the IEEE-P1613.1 report they had received on 2/25 into their *Recommendations* to address the EMC testing problems in the ANSI-C12.1 Standard. Mr. Koepke, the EMII working group Chair, delivered these Recommendations (above) in-person at the ANSI-ASC-C12® meeting in Chicago on May 1, 2013. The EMI Issues working group agreed to work with the ANSI-C12.1 writing group to correct (or delete) the flawed EMC tests identified in ANSI-C12.1.

ANSI-ASC-C63® assigned a joint task force at their May 8, 2013 meeting to review the EMC testing problems discovered in ANSI-C12.1 (2008) and report their findings[5[3]] to the Subcommittee 1 & Subcommittee 5 Chairs and to the SGIP2-EMI Issues Working Group within sixty days.

ANSI-ASC-C63® Joint Task Force Conclusions about ANSI-C12.1 (2008)

1) Follow the recommendations of the EMI Issues Working Group in amending ANSI-C12.1

2) Harmonize with IEEE-1613 and its extension, IEEE-1613.1, for a list of tests to run

3) Add two tests from IEEE-1613.1 (IEC-61000-4-10 & IEC-61000-4-16)

4) Use IEEE-P1613.1 test levels for Zones A & B (with the substation boundary being the divider)

5) Use a relative "error shift" between perturbed and un-perturbed meters to assess acceptance to established criteria during tests, similar to OIML-R46 (2012)[6[4]]. (With the exception of destructive surge testing, which may require the "before/after" or "survivability" test method)

6) Use the setups and methods cited in ANSI-IEEE-C63.4 for emissions testing (Figure 7, for example)
No other ANSI-ASC-C63® activity is expected in this regard.

[5[3]] http://c63.org/documents/misc/minutes/May2013/C63R_C12_1_Joint_task_force_report.pdf
[6[4]] http://www.oiml.org/en/publications/final-drafts/pdf/fdr_r46-1-2.pdf

Recent Events

The IEEE-P1613.1 ballot closed on 6/6/13 with 97% affirmation. The document will be published in December, 2013. The ANSI-ASC-C63® task force findings about ANSI-C12.1 (2008) were delivered to the SGIP2-EMI Issues Working Group on 7/15/13, with ANSI-C12.1 committee members in attendance.

Public Comments on ANSI-C12.1 Reaffirmation (Mr. Raime continues);

Some work on new EMC tests has begun in ANSI-C12.1, but the work is not complete and there is concern that known flawed EMC tests will still be included in the Standard now being reaffirmed. Critical functions and the communications modules that control or monitor them should also be evaluated during these tests (which is now required for communications networking equipment covered under IEEE-P1613.1). The flawed EMC tests in ANSI-C12.1 should be fixed or deleted rather than re-affirmed for another five years. The author sincerely hopes for such an outcome and encourages readers to publicly comment on the ANSI-C12.1 draft document late this year. ANSI will soon publish the opening and closing dates for public comments on ANSI-ASC-C12.1 in their weekly "Standards Action" newsletter.[7[5]] *It is unlikely that this magazine article will appear in time to elicit any negative comments on this reaffirmation. We'll probably end up with* ***bogus EMC testing of revenue meters for another five years****.*

Mr. Raime Concludes;

Regardless of the outcome of the ANSI-C12.1 reaffirmation this year, when an ANSI-C12.1 type-tested revenue meter has a third-party communications networking card inserted into it, (thus becoming a "smart meter") it becomes just another utility-owned communications networking device in distribution, like a communicating capacitor bank, re-closer or tap-changer that often share the same media. These communicating distribution devices will have their EMC immunity type-testing addressed as Zone B products under the IEEE-1613 and IEEE-1613.1 pair of utility communications networking equipment Standards. Any platform obviously needs to pass the EMC testing required of the communications networking card installed within it, which is why ANSI-C12.1 (type-testing of utility revenue meters) should harmonize with IEEE-P1613.1 (type-testing of utility communications networking devices). Manufacturers of communications networking cards will certainly demand that the platform they reside within be compatible with their EMC requirements.

Mr. Raime's Conclusion; Future Standards Work

Now that IEEE-1613.1 has become a Standard, EMC type testing of utility-owned communicating assets, both inside and outside the substation fence, will be performed (using a meaningful Acceptance Criteria) before future products are offered for sale.

[7[5]] http://publicaa.ansi.org/sites/apdl/Documents/Forms/AllItems.aspx?RootFolder=http%3a%2f%2fpublicaa.ansi.org%2fsites%2fapdl%2fDocuments%2fStandards%20Action%2f2013_PDFs

What about autonomous assets that don't communicate? Not everything in the Smart Grid will communicate. (In fact, in many cases, it's better if they don't. See this recent "Big Data" problems article.) Non-communicating assets are not addressed in either the existing IEEE-1613, the new IEEE-1613.1 nor in the upcoming IEEE-P1613.2. (which will concern communicating telephone circuits connected at substations or out in distribution). Many new utility devices for the Smart Grid will be autonomous and have on-board sensors and control electronics (using sensitive microprocessors) that will not be immunity type-tested at all unless we directly address them.

This is what a new Standards effort under IEEE-1613.3 does. It will add the same five "gap" immunity tests and all the other tests in the IEEE-1613 series to the testing of autonomous (non-communicating) assets such as tap changers, capacitor banks, voltage regulators, switches, etc. that are connected at Medium Voltage or higher. (both inside and outside the substation fence) The IEEE Power & Energy Society Substations C2 and Power Systems Relaying Committee (PSRC) have both expressed a desire for these IEEE-1613 series EMC type-testing immunity Standards to be applied to autonomous products, including critical protective relaying equipment used in substations. There is no industry opposition to this effort, in fact, several large companies (ABB, S&C, GE, SEL, etc.) have already expressed an interest in being involved. The new IEEE-P1613.3 working group would be chaired by John Tengdin, the former Chair of IEEE-1613.1 and a friend of mine and of the amateur service. (His son is a life-member of the League) The Vice-Chairs would come from Industry, as above. John needs an EMC testing expert and recently asked me to join the working group, possibly as their Secretary.

The PAR (statement of purpose) for the Standard is being prepared now, and I plan on attending their kick-off meeting in New Orleans (by webinar) in a few weeks. It does not serve the amateur service if autonomous utility equipment is not sufficiently immune to radio emanations, so I hope I can count on the League for support in this effort. I do not expect this to be a difficult, long or expensive project. The participants all seem to agree, they seem to trust John Tengdin and they want the same things. They will need several Acceptance Criteria (rules for judging if a product passes or fails an immunity test) for the various types of equipment being addressed. This is the area that the manufacturers will want to influence and that I will want to police for honesty. I would only ensure that these various Acceptance Criteria made sense from an EMC test engineer's perspective. These Criteria will need to contain enough simply-worded information so that a pass-fail judgment can be made by an independent test engineer. That's how I propose to help the IEEE-P1613.3 working group and help the Smart Grid become more immune from interference and thus safer and more reliable.
- Mr. Jerry Raime

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 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 cable 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. There continues to be a small number of cases involving wideband noise in the MF and HF range that were initially thought to be cable TV-related interference, but after investigation were found to be Part 15 or other devices coupling interference to the cable TV support strand and coaxial cable shield outer surface via National Electrical Code and/or National Electrical Safety Code required neutral bonds. One recent case thought to be cable-related turned out to be power line noise.

DSL, U-Verse & Home Phone Networking Alliance

Mr. Beatty continues to assist with broadband service complaints to the ARRL. Very few complaints were received since July.

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 2nd half of 2013 and compared to the five previous years:

Category of Case Reported to ARRL Lab/EMC Engineer	2008	2009	2010	2011	2012	2013-2
BPL	2	1	3	0	0	0
Unknown Unintentional Radiators	49	65	57	78	66	32
CABLE TV	11	26	8	7	3	2
Satellite TV						1
Computing Devices and Modems	15	21	4	7	3	2
Power Line Noise	81	113	90	65	53	27
Plasma TV Receivers	8	12	10	14	5	2
Other Broadcast Receivers	3	2	7	0	4	3
Other Receivers	1	4	8	3	1	1
Other Transmitters	11	1	2	9	2	1
Broadcast Transmitters	2	2	3	4	6	3
Lighting Devices	12	12	15	13	4	6
Confirmed Grow Lights	---	---	---	---	---	2[8]
Fence Systems	3	4	4	2	0	1
Battery Chargers / Power Supplies	6	2	1	1	3	4
Wheelchair	0	0	1	1	0	0
Water Pump Systems	1	1	3	2	1	1
HVAC Systems	5	4	11	6	3	5
Alarm Systems including detectors	3	4	6	0	4	1
Other Appliances	12	7	3	8	7	3
GFIC / AFCI	5	1	1	1	5	2
AUTOMOBILE Systems	12	8	4	3	2	6
Manufacturing and Retail Generated Noise	1	2	1	0	0	1
AT&T U-Verse Systems	3	10	10	8	8	3
PV Systems	---	---	---	---	---	2
Doorbell Transformers	---	---	---	---	---	2
Other					36	3

[8] It can be difficult to confirm a Grow Light. As a result, a number of other grow lights may appear as Unknown Sources. Based on their signatures, a number of Unknown Sources are most likely Grow Lights but remain unconfirmed.

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

- 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

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® EMC committee. Mr. Hare is the Primary ARRL C63® representative; Mr. Carlson is the Alternate. Mr. Hare serves as the Vice Chair of Subcommittee 5, Immunity. Mr. Hare also leads the C63® committee's Task Force on testing below 30 MHz, which has completed writing a section of an intentional emitter measurement standard that correctly and scientifically extrapolates field strength measurements below 30 MHz. This material was incorporated into the ANSI C63.10 standard on the measurement of unlicensed intentional emitters (transmitters). Mr. Ramie serves as the C63® Secretary and as a member of the Below 30 MHz Task Group. The C63® 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 and Education Committee (SDECom). SDECom serves as the EMC Society standards board, overseeing the development of all IEEE EMC Standards. He was also elected to serve a two-year term, starting January 1, 2014, on the on the IEEE EMC Society Board of Directors.

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

A list of the planned, recent and ongoing EMC activities at the ARRL Laboratory includes;

- 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.
    - Mr. Gruber completed a related article for an upcoming issue of QST
- 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.

As a note of personal thanks, I would like to recognize the contributions of the members of EMC Committee for their ongoing effort to protect the amateur radio service from harmful interference. I especially owe a great debt of gratitude to Mr. Hare, W1RFI; Mr. Raime, KI6LGY and Mr. Gruber, W1MG; for their authorship of material for this report.

Respectfully Submitted,

Kermit A Carlson W9XA
EMC Committee Chairman
ViceDirector Central Division