

ARRL EMC Committee Semi-Annual Report

Doc. # 16

**For The
American Radio
Relay League**

**2020 Annual Board of Directors Meeting
July 17-18, 2020**

**Submitted By
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Chairman, ARRL EMC Committee**

EXECUTIVE SUMMARY:

Two significant issues EMC issues have arisen as major challenges to continuation of interference-free access to the amateur radio spectrum. Both are sources of potential harmful interference which has been measured, researched, and documented by EMC Committees of the ARRL and the EMC Committees of other national amateur organizations. The emissions of these systems are subject to regulation in most countries. One of these types of potential interference sources is being currently deployed under existing regulations while the other source is in an experimental status with its governing regulations currently under development.

The issue of WPT-EV, Wireless Power Transfer – Electric Vehicles, presents the potential for harmful interference from what could become a ubiquitous presence of wireless vehicle charging systems. WPT-EV is notable because the Rule Making process has just begun. The incipient process of gathering comments regarding the regulation of the transportation's industry deployment of WPT-EV is a portion of FCC Docket 19-226. The ARRL has filed Comments and Reply Comments in the Docket 19-226 proceedings which are now part of the record. Two main concerns are that first, no amateur bands be used for the fundamental frequency for power transfer and that second, that any impact to amateur operations by spurious and harmonic emissions cause less than a 1-dB increase to the background noise floor within the amateur bands.

The second issue, that of harmful interference to amateur operations regarding the installation of residential solar power systems, is the other main potential source of great concern. For installation into a residential setting such devices are regulated under FCC Part-15. There are rules for the standards that these devices must meet in order to protect licensed users of the spectrum within this residential setting. However, the only standards that apply in FCC Part-15 below 30 MHz are for conducted emissions into the AC Mains. There are no applicable limits that apply for radiated emissions below 30

MHZ, and there is no regulation of conducted RF between the solar panels, power optimizers and the power converter. The only applicable regulatory limit regulates that conducted RF from the power converter back into the AC Mains.

The ARRL Laboratory and the EMC Committee has been working with industry both directly with manufacturers and standards committees for both issues. In the case of the solar panel industry the work by the ARRL Laboratory with the manufacturers has proven quite effective. One good example of this cooperation has been with Solar Edge in the design improvements of that manufacturer's roof-top mounted optimizers.

With regards to the potential for harmful interference arising from WPT-EV charging systems for transportation, the ARRL has been working with our sister EMC organizations, within industry standards groups and directly with manufacturers at some of the first deployments of WPT-EV systems in test range environments. While to many ARRL members the most visible involvement of the ARRL are the FCC filings placed in public record. On the other hand, this almost invisible and highly technical involvement in the establishment and refinement of standards produces a great impact on reducing the potential for harmful interference. The standard being proposed presently is for a field strength that combined with a typical reduction of un-necessary emission still creates a signal far above the noise background found at most amateur stations. In the case of what was seen at one test of a WPT-EV the charging system covered the 40-meter band with noise that registered S7 at a distance of 32 feet to typical mobile amateur radio installation.

Each of the various issues addressed in this report could at minimum present the possibility for a 20-page synopsis for the Board. My suggestion is that at a future time that the Board be invited to meet with the members of the Committee in an electronic forum to discuss in more detail each of the issues regarding the known potential sources of harmful interference to amateur radio.

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 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, Eversource, retired
- Mr. Brian Cramer, PE, W9RFI, Electrical Interference Solutions, Inc.
- Mr. Ed Hare, W1RFI, ARRL Laboratory Manager
- Mr. Paul A. Cianciolo W1VLF, ARRL Lab RFI Engineer, HQ Staff Liaison
- Mr. Ron Hranac, N0IVN, Technical Leader, Cisco Systems; past member of the Board of Directors, Society of Cable Telecommunications Engineers
- Dr. Gregory Lapin, N9GL, Chair ARRL RF Safety Committee
- Mr. Jerry Ramie, KI6LGY, ARC Technical Resources, Inc.
- Mr. James Roop, K9SE, past FCC District Director
- Dr. Steve Strauss, NY3B, Home Phone Networking Alliance Technical Committee
- Dr. Richard E. Dubroff, W9XW, Professor Emeritus at Missouri University of Science & Technology
- Mr. Bob Allison, WB1GCM, Assistant ARRL Laboratory Manager
- Mr. Ed B. Hudgens, WB4RHQ, ARRL Delta Division Vice Director
- Mr. Carl Luetzelschwab, K9LA, ARRL Central Division Vice Director
- Mr. Riley Hollingsworth, K4ZDH, ARRL Volunteer Monitor Program Coordinator

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, review and publish articles about RFI
- Write and publish the ARRL RFI Book
- Design and update ARRL's RFI web pages
- Produce video content pertaining to RFI
- 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
- Work with the FCC Enforcement Bureau on RFI cases that require FCC intervention.

Mr. Cianciolo handles the majority of the staff work on EMC matters. In the 1st half of 2020, he will continue working in several key areas:

- Responding to member inquiries about RFI issues and problems
- Adding updates and revisions to the ARRL RFI Web pages.
- Facilitating and providing assistance on resolving long standing power line noise and other RFI cases with the FCC.
- 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 lighting devices, including LED and grow lights. Issues concerning grow lights have been discussed in previous EMC Committee reports.
- Working with SolarEdge to resolve RFI from both PV panel optimizers and line tie inverters
- Reviewing proposed EMC related material for ARRL publications.

SUMMARY OF RECENT AND ONGOING ARRL LAB EMC ACTIVITIES:

Power-Line Noise:

Power line noise remains a significant problem facing hams today. Cases can drag on for years without meaningful FCC enforcement, often leading to frustration on the part of the ham. Much of the time ARRL spends on a case involves helping the Amateur understand the issues and how to best work with his or her local power company and, most important, how the Amateur can correctly identify noise as being caused by electric-utility equipment and how to correctly identify the source. Although in theory, if power-company equipment causes interference, it is the responsibility of the power company to fix it, they can generally do so much faster if the complainant is able to identify the pole from which the noise is coming.

P1897 Recommended Practice for handling Sparking Gap Noise complaints:

This IEEE Working Group continues developing an IEEE standard on the best practices for electric utilities to use to resolve power-line radio and television noise complaints. The group, chaired by Mr. Gruber, formerly an ARRL staffer, now an ARRL consultant, has been working cooperatively for over four years on this document. It is very close to being finished without any requirements to take votes or force members to take sides. Any contentious issues were resolved in a collaborative way and the group is very friendly. The EMC Committee recognizes the staff and volunteer efforts of Mr. Gruber, who is primarily responsible for the successful creation of this important industry standard.

The Vice Chair, Brian Cramer, W9RFI, formerly of Exelon, is also a member of the EMC Committee. Additional EMC Committee members in the Group also include Mr. Ramie, KI6LGY, who serves as its secretary, Mr. Hare, W1RFI, Mr. Beattie, W2TTT,

Mr. Boucher, WA1ZBL, Mr. Hranac, N0IVN, and Mr. Carlson, W9XA. Although not a member of the EMC Committee, it should be noted that former Atlantic Division Vice Director Riley Hollingsworth, K4ZDH, is also a Working Group member.

An important goal in developing this standard is to achieve the consensus with the utility industry, to ensure adoption and use of the standard. Text should be complete and the standard ready for IEEE ballot in the last quarter of 2020

Ron Hranac N0IVN Reports on the status of cable television industry:

As a whole, the cable industry continues to do a good job adhering to the FCC's regulations about signal leakage and interference. During the past six months, ARRL received one report of a cable-related interference problem that was resolved with assistance from ARRL's Paul Cianciolo, W1VLF. This was the first cable-related complaint in the last two years. Our cable industry liaison, Mr. Ron Hranac, N0IVN, noted that he received no reports or complaints directly, indicating that most cable systems are either clean or are addressing complaints effectively. Mr. Hranac also noted that the cable industry has been deploying new-generation signal leakage detection equipment over the past few years. That new-generation detection equipment – available from several manufacturers – is digital-compatible and operates on multiple frequencies (in contrast to older single-frequency detectors), further improving cable operators' abilities to manage signal leakage.

Photo-Voltaic Systems (Solar Panels):

Complaints involving solar PV systems continue to be on the rise and are, in fact, the dominant RFI issue ARRL has dealt with in recent months. ARRL has identified that the vast majority of the systems causing interference are manufactured by Solar Edge. In 2019, ARRL established contact with Solar Edge. Its engineers have been exceptionally cooperative, and they are field-retrofitting Solar Edge in the field in response to complaints. The vast majority of these cases, 207 as of June 30th, to ARRL's knowledge, have been resolved to the satisfaction of the involved Amateur Radio operator. The resolution consists of replacing the AC inverter, the optimizers, rewiring the panels using twisted-pair wiring and adding ferrite common-mode chokes. These solar systems appear to meet the FCC's emissions limits, which apply only to conducted emissions onto the AC mains below 30 MHz and radiated emissions limits above 30 MHz. Many of these systems have been installed by Solar City. Solar City was recently purchased by Tesla. Tesla is new to the arena and after some initial reluctance, Solar Edge is now working with Tesla to continue to resolve interference problems. This will be closely watched and encouraged by ARRL.

There is at least one case that appears to be difficult to resolve, though, with some residual noise present even after the retrofit has been completed. This system is located on Long Island in New York, so ARRL is planning a field trip to investigate the noise, verify the source and determine what can be done to resolve this persistent case.

Resolving these RFI cases becomes challenging when several homes in a given area have implemented solar power near and Amateur operator. In many areas, homes are closely-spaced and Amateur antennas may be only 15 to 30 feet away from a neighbor's solar array. These retrofits are very time consuming and expensive. ARRL has reports from Solar Edge that indicate that as many as 9 systems needed to be retrofitted for a single Amateur operator. An Appendix to this report shows photographs from a retrofit done locally in Connecticut to the Amateur station of W1VLF.

It worth noting here that ARRL RFI desk has several complaints concerning several other manufacturers. Enphase and Generac to name two. It is expected that solar power issue will be on the rise in the state of California. Building code will require new homes built after Jan 1 2020 incorporate solar power.

Grow Lights:

Grow light continue to be an issue. At the present time, Mr. Cianciolo refers a suspected grow light case to Ms. Laura Smith in the FCC Enforcement Bureau for follow-up. Ms. Smith then sends a suspect grower a letter without mentioning the ham or Amateur Radio. In cases where the FCC letter is ignored, however, specific FCC enforcement action has not been occurring. Grow-light interference cases are becoming more prevalent as more states legalize the growing of marijuana.

Other Lighting Devices:

Mr. Cianciolo reports that interference from lighting devices seems to be on the rise. Much of the problem to be caused by switching mode power supplies in low voltage lighting products. Some states mandate efficient lighting in new construction. Leading to wholesale installation of LED bulbs Another issue has been dimmers for LED bulbs. The solid-state drivers/ballast are the chief causes. Commercial establishments wishing to lower energy costs are moving toward utility subsidized LED lighting fixtures. Some of which are causing RFI. These are being handled by ARRL staff, but the EMC Committee is continuing to monitor this as a potential threat to Amateur Radio.

Several readily available LED recessed lighting fixtures were tested in the ARRL lab and were found to meet FCC 15B when operated in a stand-alone condition. However, these same fixtures failed to meet FCC part 15B when operated as intended, IE mounted in a grounded recessed lighting housing. The failure mode was from the internal LED driver power supply transformer field, coupling to the ground lead. Radiating from there. Other model of LED fixture that used a small spacer to provide some distance between the transformer and the ground lead did not suffer from this problem.

It should also be noted that LED bulbs can be legally marketed and sold if their emissions are close to the FCC limits. The emissions in this case could be high enough to create interference issues even from nearby residences in a typical suburban neighborhood. If and when such interference occurs, the burden then falls on the device *operator* to correct problem. While this rule may work on a case-by-case basis involving a small or limited number of sources, it is not practical should many bulbs in several houses be contributing to a widespread problem. This issue has been demonstrated in an actual case in California.

An additional problem involves the sale and marketing of non-consumer rated ballasts to consumers in hardware and big box stores. These ballasts are still being sold to unsuspecting consumers and have been the subject of interference complaints to the ARRL Lab.

Leviton GFI nightlight receptacles:

Leviton and other manufactures are marketing a GFI receptacle to replace outlets where this type of protection maybe needed. Incorporated into the receptacle is a night light consisting of 2 LEDs that turn on when the ambient light level approaches an internally set value. Fundamentally this seems like a good idea in that the amount of light needed to navigate a home at night is very little and will always be automatically available.

However, the implementation is an issue. The LEDs are driven pulse width modulator power supply with no RFI filtering to AC line. When tested in the EMC lab a single unit showed between 30dB decreasing to 5 dB over FCC part 15 B conducted emissions limits over a frequency range of 150 KHz to 5 MHz. Remembering that this was for a single unit, the impact of many of these devices located in a single home was devastating for the Ham who installed these. The ARRL has purchased several similar devices for testing at the EMC lab. More testing to be done.

Class D Audio Amplifiers:

Class D audio amplifiers with Bluetooth input capabilities are beginning to be a problem for some amateur radio operators. The Class D/Bluetooth devices are being installed in new homes as an enticement to purchase. The device/s(several in some homes) fit into a standard duplex outlet and takes power from either a wall wart or a common DC power supply in the basement. The ARRL lab tested several of these devices and they were found to meet FCC 15B, until an actual speaker with leads is connected. The conducted emissions then rise in excess of 20 dB above FCC part 15B conducted emission. Lack of

the appropriate LC filter on the speaker leads is the cause. One case concerned an amateur operator living 1800 feet from a new housing development. The housing development used 3 of devices in each of the new homes. This amateur operator was experiencing RFI from these devices 40 dB above his ambient noise.

Variable Speed Pulse-Width-Controlled Electric Motors:

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 and difficult to resolve. Based on ARRL case records, these appliances can either be the source of noise or victims of interference. Many such devices are hard-wired to the AC mains, making it difficult to affix external common-mode chokes or other filters.

HVAC Equipment:

ARRL has received complaints involving several different types of HVAC equipment. One of these companies is Mitsubishi, the manufacturer of the HVAC system used at ARRL HQ. Mr. Cianciolo has established a contact within Mitsubishi technical resources. Our engineering contact at Mitsubishi is bringing the issue of ECM RFI up at the Mitsubishi HVAC technical staff meetings for review. No engineering takes place in the USA, so the issues will be forwarded to the engineering in Japan. Specific model numbers of Mitsubishi equipment generating RFI have been provided to Mitsubishi. Resolution of these problems is still in progress. ARRL is pleased that Mitsubishi is looking into the problems, but as of the date of this report, no remedy has been implemented.

Other Appliances:

Residential devices are experiencing RFI from amateur radio operators as well. One such case involved a Samsung gas oven/stove which would mysteriously turn on the oven in the middle of the night. The cause was found to be a local amateur operator working 20 meters CW getting into the microprocessor control circuitry. Samsung replaced the oven with another unit and returned the problem unit to the factory for study.

Update on Samsung gas range. Since the January 2020 EMC report 5 more cases have been reported. RF immunity in these appliances appear to be severely lacking. Reported faults with these appliances range from erratic displays to stove turning on without input by the owner. Contact has been made with the Samsung engineering and several emails have been passed. The Samsung engineering team reports that the RF immunity testing will be done again but claim the likely cause of the defect is high humidity or liquid spilled onto the range. I explained that the lab testing is not necessarily indicative of “as installed” performance. There is great difficulty in email correspondence due to the language barrier. Correspondence is ongoing.

Wireless Power Transfer Systems:

Wireless Power Transfer (WPT) systems. While there haven't been any reported cases of interference so far, this emerging technology in the use of WPT for high-powered chargers for electric vehicles (WPT-EV) could have the potential to cause significant interference problems. This may be particularly true in cases involving high power, such as in a system used to charge an electric vehicle. We continue to monitor WPT development through the use of industry contacts.

The most recent challenge to Amateur Radio spectrum is from potential interference from WPT-EV (Wireless Power Transmission – Electric Vehicles) systems. Appendix #1 shows the block diagram of one such system under development. This rapidly developing threat has been understood to be a large potential issue for the 2019 World Radiocommunications Conference (“WRC-19”). Planning within the IARU Committees had started work on gathering background information about WPT-EV and the potential for harmful interference to the Amateur Radio Service starting approximately at the beginning of 2018.

On September 2, 2018 the FCC released a Public Notice, Report Number 3103 which contained a call for comments on a Petition for Rulemaking that had been filed jointly by BMW of North America LLC, Ford Motor Company, Nissan North America Inc. and Toyota Motor North America Inc.

The ARRL has filed Comments about the proposed field strength limits that would allow high-power wireless charging technologies for electric vehicles which would operate in the 79-90 kHz band. A copy of the ARRL Comment Filing appears as Appendix #2 to this report.

While the subject band of frequencies (79-90 kHz) is not used by the Amateur Radio Service, the potential for harmful interference remains significant. The ARRL Laboratory and the ARRL EMC Committee has not been able to gain access to any prototype or experimental WPT-EV system for actual field strength measurements.

The limit for emissions on the fundamental frequency as stated in the manufacturer's Petition is 74.4 dBuA (dB microAmp) per meter at a distance of 10 meters. An equivalent term for this level of field strength (disregarding the near-field effects) for such a system could be stated as 2 Volts per meter. For a complete discussion of how this proposal compares with existing FCC Part-15 and Part-18 field strength limits please refer to Appendix #3 of this report.

The largest concern is that of harmonics and noise related to a high-power system where those emissions fall onto Amateur Radio spectrum. There is no doubt that there will be harmonics and noise arising from the use of such devices but the ARRL Lab has not been able to make field strength measurements. Of great concern is the fact that WPT-EV has a great potential for harm given that coupling between the charging power source primary

and the vehicle's receiving secondary will form an imperfect coupling system, and that mis-alignment between the two could provide for the potential for saturated inductors and power coupling to material other than the target of intended coil on the vehicle. One of the systems that has been described to Mr. Carlson performs an interface between the charging base and vehicle by a separate wireless communications link but that the frequency of the power transmission is swept within the power transfer frequency band to identify the frequency of best power transfer. The potential is strong that each of these systems might continue to sweep the 79 to 90 kHz band along with the attendant harmonic and vestigial switching noise on MF, HF and higher. The estimated power transfer of a typical unit is expected to be in range of 10 kW.

Under the terms of a non-disclosure agreement, Mr. Hare and Don Beattie, G3BJ, representing IARU, were invited to witness EMC testing of a prototype WPT-EV charger in early 2020. This testing, conducted at a certified and calibrated EMC-laboratory open-area test site by a manufacturer of WPT-EV equipment, was intended to demonstrate the likelihood of interference from WPT-EV systems to licensed amateur operation. The testing was done of a prototype WPT-EV charger being used to charge a passenger motor electric vehicle with an installed charging loop and associated electronics. Messrs. Hare and Beattie were invited by the manufacturer and the Society of Automotive engineers to witness the testing of the emissions from the system for compliance with the applicable FCC rules, using the calibrated OATS and EMC test equipment of the test facility. An amateur receiving antenna and HF transceiver was also set up 10 meters distant from the EV being tested, to offer an opportunity to do qualitative analysis of the interference potential to amateur radio operations on the LF, MF and HF bands.

The ambient noise levels at this commercial OATS, although low enough to permit measurements to be made of EMC-compliance levels, was much higher than would be present at typical amateur stations. On 40 meters, for example, S7 noise, consisting of broadband noise and/or discrete noise signals, was observed across most of the band. Especially during the daytime hours, this is an exceptionally high noise level. Both Mr. Hare and Mr. Beattie concluded that this noise level was exceptionally high – too high, in fact, to permit reasonable assessments of the interference potential of WPT-EV systems to amateur radio. This observation was provided verbally on several occasions to the WPT-EV manufacturer present at the testing. Even at this high level, spurious emissions, both harmonics and inverter noise, were easily heard on all amateur bands. At a station with more typical noise levels, this noise would have been tens of dB greater than the ambient and discrete levels present at most amateur stations. Although the noise levels were lower than the FCC emissions limits, they clearly would have caused interference to amateur operations. (The emissions limits are much higher than the levels needed to protect against local interference from Part 15 and Part 18 systems.)

This report was ultimately compiled by the WPT-EV manufacturer into a report intended to be used in various international regulatory and standardization efforts. The WPT-EV manufacturer also did testing at a presumably quiet rural location in Utah. ARRL had serious objections to the paper, seeing major discrepancies of tens of dB in self consistency. The paper as first drafted also showed the noise levels at the “quiet site”

purportedly greater than the noise levels that were seen at the OATS system being used for the testing. Mr. Hare worked with the report author to remove the obvious errors, to the point where formal objection was no longer appropriate, but the report clearly had a WPT-EV bias. The end result concluded that the “quiet” noise levels were only a few dB lower than the noise levels observed at the first site.

This report was subsequently provided by the WPT-EV manufacturer to various parts of the ITU-R processes and to standards organizations such as CEPT, presented in a way that implies that these two tests of ambient noise demonstrate that noise levels are much higher than the levels described in the ITU-R Recommendation, P372.14, Radio Noise. The inappropriateness of this conclusion is pretty obvious. P372.14 has been developed based on many hundreds of measurements, made across a wide range of locations, at various times of day, in various seasons and across entire solar cycles. Two measurements made at two locations simply cannot replace that body of data. P372.14 represents noise levels in absolute terms, indicating the number of dB greater than thermal noise was present in various environments. The testing done by the WPT manufacturer was done using peak-hold, in various bandwidths, showing both intentional signals and noise levels, and, simply put, two measurements showing atypical results is not a reliable indication of anything. Mr. Hare, working with Mr. Beattie, has provided conclusions to the IARU to be used to refute this study at every opportunity. This is ongoing, as is a project to locate and analyze the various noise studies done over recent years, to counter the claims that noise in residential areas is only slightly lower than noise in industrial area and to counter claims that noise levels are significantly greater than the median values described in ITU-R P372.14.

1st Half of 2020 RFI cases reported to the ARRL Lab:

- New RFI Cases – 84
- New electrical power-line cases – 16
- ARRL Letters sent – 3
- FCC 1st Letters submitted – 2 (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 could possibly be follow-up in nature and therefore require custom legal language. The effectiveness of these letters has yet to be determined.)
- FCC 2nd Letters submitted – 1

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. In addition, over 150 phone calls were taken from members concerning RFI issues, that do not rise to the level of cases to be added to the data base.

Here are some statistics from the database for the first half of 2019 and compared to the previous six years:

Case Type	2013	2014	2015	2016	2017	2018	2019	2020
Unknown Unintentional Radiators	68	81	49	70	73	56	47	31
CABLE TV	4	4	4	2	2	3	2	1
Satellite TV	2	3	1	0	2	0	1	0
Computing Devices and Modems	5	6	8	3	12	5	0	2
Power Line Noise	52	51	43	47	44	47	28	16
Plasma TV Receivers	3	5	1	3	1	1	1	1
Other Broadcast Receivers	4	4	0	1	1	1	0	0
Other Receivers	1	4	1	6	5	0	0	1
Other Transmitters	2	4	3	3	2	13	5	3
Broadcast Transmitters	6	2	5	1	3	3	1	0
Lighting Devices	10	15	7	19	6	8	6	3
Confirmed & Suspect Grow Lights	2	16	6	12	11	10	6	2
Fence Systems	3	3	0	2	0	2	0	0
Battery Chargers / Power Supplies	4	5	7	9	6	1	3	2
Water Pump Systems	2	2	0	0	1	1	3	2
HVAC Systems	10	6	5	12	6	3	4	
Alarm Systems including detectors	2	4	2	3	4	2	0	0
Other Appliances	7	4	3	10	7	5	3	3
GFCI / AFCI	7	25	6	5	6	6	7	3
Automobile Systems	7	1	1	3	5	1	1	0
Manufacturing Generated Noise	1	2	0	0	0	0	1	1
AT&T U-Verse Systems	3	4	6	1	2	0	0	0
PV Systems	2	1	3	10	24	10	12	10
Doorbell Transformers	2	3	0	2	2	1	1	1
Other	16	16	15	30	16	12	10	3

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

STATUS ON FCC ENFORCEMENT AND OUTSTANDING EMC CASES:

Mr. Cianciolo reports that the FCC continues sending letters to utilities (and consumers) with some regularity. Specific enforcement beyond that, however, continues to be lacking. To the best of his knowledge, no previously reported longstanding power line noise case has been resolved during the 2nd half of 2019 due to specific enforcement action such as an FCC Citation or forfeiture. 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 can 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 a case of interference to Amateur Radio from a Part 15 or Part 18 device. Yet – some cases have dragged on for over a decade without resolution.**

So far, most cases involving Amateur radio have been addressed on the basis of harmful interference as opposed to exceeding the FCC emissions limits. The FCC rules place the burden to correct harmful interference on the *operator* of the offending device – not the distributor or manufacturer. Device operators in a typical RFI case include a power company or neighbor.

It appears that FCC field agents do not always have the proper training or equipment to correctly identify and locate power line and other noise sources. Their equipment seems better suited for locating such things as transmitters. Even if the source is known, or if the source is a consumer device in a nearby home, we've yet to see one in which the FCC

Finally, from what we've seen so far, the FCC Field Office reduction continues to have a significant and negative impact on FCC field resources. Despite the Commission's enthusiastic claims for a centralized "Tiger Team" approach, it has only made matters worse. To the best of Mr. Cianciolo's knowledge, it has yet to be even one Amateur case investigated by a Tiger Team. It also appears that FCC enforcement issues have become problematic for other radio services as well.

FCC Enforcement Concerns:

While a lack of meaningful enforcement in cases involving device operators has been the norm for a considerable period of time, the issues described in the previous EMC Committee reports remain ongoing. A brief summary includes but not limited to:

- Grow lights and other devices being marketed and sold that exceed the FCC limits, in some cases by a considerable margin.
- Illegal marketing of Part 18 non-consumer lighting devices. Non-consumer devices are being marketed to consumers for residential environments. These devices are only intended for commercial and industrial environments.
- Field investigations are almost non-existent with abnormally long waiting times.
- Field investigations being conducted in such a way that the outcome will not be favorable to the Amateur. Examples include cases in which the investigation took place at times when the source was known to be off, checking for noise at random (unaffected) frequencies, etc.

It must be emphasized that any FCC enforcement effort in any of these matters will have the maximum impact if it takes place in a timely fashion. Some cases have been ongoing for a considerable period with no known formal FCC action. Even if there was to be an FCC action at this point, it would not be timely enough to achieve maximum impact as a future deterrent.

With the proliferation of new types of electronic devices and technology, some of which have the potential to cause a considerable interference problem, some meaningful FCC enforcement is badly needed. A lack of enforcement in RFI matters would no doubt be disastrous for both hams and other services as well. If the FCC does nothing about something as egregious as grow lights, or proper follow-up it to a Citation & Order, or illegal marketing of industrial devices, it would fundamentally call into question the FCC's credibility as an enforcement body. It would also seem unlikely that meaningful enforcement could be expected in other interference matters as well.

SMART GRID AND EMC STANDARDIZATION MONITORING:

The EMC Committee is also closely monitoring the development and proliferation of the Smart Grid. Mr. Ramie is involved in developing and promoting EMC Standards for the Smart Grid as the liaison between the IEEE-EMC Society and the Power/Energy Society of the IEEE. In that role, Mr. Ramie reports to Mr. Hare, the VP of Standards for the EMC Society. Here's a summary of recent activity:

Smart Electric Power Alliance (SEPA) - EMI Issues Working Group - this group, Chaired by Don Heirman formerly of AT&T, develops educational materials like seminars and white papers for their members. Those members include utilities, regulators, trade associations and equipment makers, along with a smattering of consultants working for them. We have produced and delivered a recent white paper/seminar called "Smart Grid Strategic EMC Recommendations for the Future" that discusses how a utility can specify meaningful EMC immunity testing to validate their equipment resistance to interference.

P1613 - EMC Immunity testing of Communicating Devices - This is becoming the controlling EMC immunity document for any smart grid device in a substation blockhouse or out on a pole that has a communications port, including an antenna. Almost all smart grid controllers will communicate, so the COM port was used as a hook to attach immunity requirements to these products. (if you regulate the COM port, you regulate the device) It calls out the three C37.90.x Standards below, all of which are under revision. The scope and purpose of the four documents is being aligned at the next meeting in Jacksonville, FL in January.

PC37.90.1 - SWC & EFT Testing of Protective Devices (controllers for protective relays) – The Surge Withstand Capability (tolerance of switching transients) in this document already is harmonized with Europe under IEC 61850-3 and IEC 60255-26 draft. The Electrical Fast Transients (EFT) section will have the 100kHz rep rate added to address this frequency region that is filled with switch-mode power supply noise. Mr. Ramie reports that he is not expecting problems with moving this document forward.

PC37.90.2 - Radiated RF Immunity testing of Protective Devices – Mr. Ramie's presentation to this working group used Mr. Hare's ARRL modeling software to develop four Use Cases to justify the highest test level in the industry, at 35V/m peak (20V/m before modulation is applied). This is a realistic level that was widely supported and not any higher than the previous version of this document. The Use Cases just solidify the logic of adding these higher test levels and additional dwell frequencies, all with realistic modulations applied. The document is almost finished, and it is anticipated that the draft will be reviewed in January.

PC37.90.3 - Electrostatic Discharge (ESD) testing of Protective Devices – This document had three profound problems that must be addressed:

- Fig. 1 in the document allowed test personnel to make a subjective decision during the test sequence to delete one of the three forms of ESD coupling required under the basic Standard IEC 61000-4-2 (Direct-air, Direct-contact, Indirect coupling planes) This was an invitation to cheat. (not acceptable)
- Table 2 of the document forced users to skip one mandated test level without justification. The table even disagreed with the correct recommendations in Annex B, which called out four test levels, not three. (this is cheating, which is not acceptable)

- Over-use of IEC figures - The original document copied four International Electrotechnical Commission IEC figures, which is not acceptable with the IEC. The committee should be able to obtain permission to use one figure, but not four. Mr. Ramie has recommended removing the four derivative figures, insert the table-top figure from the IEC and simply call out IEC 61000-4-2 as Normative, with IEEE-C63.16 as Informative for selection of test points, application of testing to those points, test levels, test report contents, & pin-testing of front-panel serial connectors)

It is expected to take 2-4 years to complete this work. Mr. Ramie reports an improvement in cooperation is much improved now that TVA supports our efforts.

INDUSTRY CONTACT AND 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. 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.

Mr. Hare is the Primary ARRL C63® representative; Mr. Carlson is the Alternate. Mr. Hare serves as the Chair of Subcommittee 5, Immunity. Mr. Hare also serves on Working Groups developing standards for the measurement of LF and HF wireless power-transfer devices, lighting devices and a Working Group writing recommended procedures to test various forms of Industrial, Scientific and Medical devices.

Mr. Ramie serves as the C63® Secretary and as a member of Subcommittee 5. 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.

The C63® committee has cancelled its in-person meetings due to various travel and quarantine restrictions. Subcommittee, Steering Committee and the Main Committee meetings have been and will be held using WebEx. Although this does eliminate staff travel time and allows a more targeted selection of the portions of a meeting that will actually be attended, the logistics of scheduling and/or attending multiple meetings has certainly proven to be a challenge.

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 continues to serve as the IEEE EMC Society Vice President for Standards, with a term running until the end of 2020. He anticipates seeking another two-year term when elections are held near the end of the year. The IEEE EMC Symposium that had been scheduled to take place in Reno, NV in late July has been cancelled. It has been converted to being a virtual event, spread out over a 1-month period. As a member of the EMC Society Board of Directors, Mr. Hare was part of the planning process to create a virtual event, literally from scratch over about a month's time.

As the Vice President for Standards, he will be using an IEEE WebEx account to host the virtual meetings of about a dozen of the Working Groups.

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

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

- Continue to identify and test devices that operate above the FCC limits, including lighting devices.
- Develop standardized methods of locating RFI sources of harmful interference to Amateur Radio stations. Work with other Industry Groups to develop methods of best practices for location sources such as lighting controls, motor controls and power line noise.
- Test a number of devices that belong to staff and/or local hams that have caused instances of harmful interference.

HF NOISE FLOOR MEASUREMENT

During the World Radio Conference in the fall of 2019, there were several comments made by participants from other delegations that opined that the noise floor in rural areas was the same as that found in suburban and urban areas. This has immediate implications should this inference be accepted as fact, absent any quantitative measurements since it has the possibility of allowing regulators to provide lower level of protection to sources from EMI sources in low-noise areas. Should the level of protection afforded to spectrum users be established at the level of the higher urban noise level environment, it would be at the detriment to the noise floor in suburban and rural areas. With the future now presenting the possibility of many high-power potential noise sources being introduced into common usage, there is a very real need to protect users of the amateur spectrum from a detrimental increase in “background noise”.

Sources of the man-made portion of the radio background noise have been made as far back as the 1920’s when there was noted to be a significantly higher background in urban and suburban areas attendant with the-then new modern use of electrical devices. There have been few measurements in the modern era since the mid-1970’s. While most amateur stations have experienced some increase in the noise background experienced during normal operation, the evidence is extremely anecdotal. There is a serious need to replicate as best as possible the methodology used in the mid-70’s to benchmark the noise background with qualified and calibrated receivers and antennas in an effort to determine the amount of increase over the past 50 years. Further, the methodology of any noise measurement effort should be established for an on-going long-term gathering and analysis of collected data.

In the past year a sub-group of EMC Committee has been studying the various methods and technical issues that arise when making qualified noise measurements with calibrated antennas. The immediate goal has been to measure the noise floor of one remote site with defensible and technically correct methods of analysis, and to use the results of that analysis to refute the assertion that noise in rural areas is at the same level as urban locations. It is the hope to be able to eventually establish a network of noise measurement sites to measure long-term changes to the radio noise floor.

Members of the EMC Committee Noise-Measurement group are participating in the efforts of other similar monitoring and research system such as HAMSci and the TangerineSDR initiative. While the TangerineSDR/DASI does have a system parallel to the technical needs of the Noise-Measurement group, the TangerineSDR system is still at the board design level of development. The Noise Study group decided to proceed with the establishment of a noise measurement effort at an existing location in order to gain experience with the technical challenges of establishing a noise measurement effort. While the TangerineSDR receiver would be a great tool, there are countless issues that need to be accomplished before the EMC Committee's Noise-Measurement group could ever consider adding a large base of monitoring receiver locations, not to mention the yet-to-be-accomplished final of the design for the TangerineSDR device.

The Noise Measurement group is comprised of Ned Stearns, AA7A, Lee Finkel KY7M, Ed Hare W1RFI, Kristen McIntyre K6WX, Paul Cianciolo W1VLF, and Kermit Carlson W9XA.

The decision was made to establish a receiving test location at a very remote rural site to undertake the various technical challenges. The site selected has a large, established antenna farm that has a large number of antennas, an operating network connection, electrical power and dedicated shelter. The site has been available online for remote monitoring since October.

A great amount of effort this past October by Ned Stearns AA7A, and Lee Finkel, KY7M, has resulted in demonstrated and technically valid method of calibrating the antennas on the site.

One of the challenges of gathering the data is since the bandwidth of the "internet pipe" from the site is limited it has been decided to data-log the original I-Q data from the receiver and then download and store short periods of received I-Q data so that analysis can be performed at any time off-line. This method also has the benefit that the original data is available for re-analysis at any future date.

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 Mr. Hare, W1RFI; Mr. Ramie, KI6LGY; Mr. Gruber, W1MG, Mr. Cianciolo, W1VLF, Mr. Lee Finkle KY7M and Mr Ned Stearns, AA7A, for their contribution of material for this report. I would also like to thank all of the EMC Committee members for their ongoing service to the ARRL and the Amateur Radio community.

Respectfully Submitted,

**Kermit A Carlson W9XA
ARRL EMC Committee Chairman
Director, ARRL Central Division**

