ARRL EMC Committee Semi-Annual Report

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For The
American Radio
Relay League

Board of Directors Meeting
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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 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. 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. 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. James Roop, K9SE, past FCC District Director
- Mr. Mark Steffka, WW8MS, Automotive EMC engineer
- Dr. Steve Strauss, NY3B, Home Phone Networking Alliance Technical Committee
- Dr. Richard E. Dubroff, W9XW, Professor Emeritus at Missouri University of Science & Technology

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 2016, 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.
- 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:

    1) Large grow lighting devices used for indoor gardening. Unfortunately complaints from these devices seem to be on the rise. As previously reported, Mr. Gruber tested a grow light in the Lab was labeled as a Part 18 non-consumer device. It generally met the limits. As such, these grow lights are not intended to be marketed or sold for residential purposes. While this continues to be an obvious marketing violation, the interference potential is much less than grow lights in previous FCC complaints. Mr. Gruber also tested a grow light that did meet the limits.

       Also as previously reported, earlier grow lights grossly exceeded the FCC limits. The Lab has purchased and tested four separate ballast units and each

exceeds the applicable Part 18 consumer limits by a significant margin – nearly 60 dB in one case. The first of these cases was submitted as a complaint to the FCC March 12, 2014. The remaining three cases were submitted to the FCC by General Counsel Chris Imlay on June 30, 2015.

Although these devices exceeded the limits by an incredible margin, and were reported to the FCC, so far there has been no visible enforcement action taken by the Commission. Furthermore, given the amount of time that has lapsed since these filing, enforcement action now seem unlikely.

It must be emphasized that these devices are being heard at much greater distances than normally expected from an otherwise legal device. In some cases, we have received reports of interference from devices that were found to be over ½ mile away. Hams affected by grow light interference have found this problem to be particularly difficult to solve for several reasons:

1. Because of the abnormal distances over which this interference can propagate, hams often find it difficult to find the source. An otherwise legal device at the FCC limits is typically a few hundred feet or less, thus limiting the scope of the problem to one that can be located by sniffing with a portable shortwave receiver. This is often not practical in the case of a grow light.

2. Once the source residence is located, hams are often not comfortable approaching the homeowner or filing a complaint. He or she may no longer be a neighbor, and given the nature of what they might be growing, hams often fear for their personal safety.

It must be emphasized that these grow lights are not only the worst devices we've ever tested in the Lab for conducted emissions; they often are difficult if not impossible to resolve.

2) Although there has been a slight increase in complaints from LED Part 15 bulbs, they haven't been a significant source of RFI problems in household environments. Nonetheless, Mr. Gruber continues to recommend cautious optimism. These devices still have the potential to become a serious problem without a practical solution. If we consider bulbs that are at or near the FCC limits in a typical suburban environment, the affected ham could easily be within range of 150 or more bulbs from just two neighboring homes. Attempting to find and fix this many sources is obviously not a practical or realistic solution for the ham.

3) Non-consumer Part 18 electronic ballasts being marketed and sold for consumer and residential purposes. Note: Both the consumer and non-consumer limits Part 18 limits were exceeded in the case of all four ballasts tested by the ARRL Lab.

4) 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.

- 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.

EMC Meeting with the Chicago Chapter of the IEEE EMC Society

Planning is underway for a meeting of the Chicago Chapter of the IEEE EMC Society that will invite all interested Amateur Radio operators to attend an evening presentation on Radio Noise. The speakers at the event will be Mr. Ed Hare, W1RFI of the ARRL Laboratory and Vice President of Standards for the IEEE EMC Society; and Dr Greg Lapin, N9GL, the co-chair of the Spectrum and Receiver Performance Working Group of the FCC Technological Advisory Council. The April 19th event will be held at the Fermilab NAL in Batavia, Illinois. The emphasis of the presentation will be on the increasing radio noise environment and the impact on the radio communications environment.

Summary of Recent and Ongoing Lab Activities

Working Group for Recommended Practice of Locating Power Line Noise

Mr. Gruber now serves as Chairman of a Working Group to develop a Recommended Practice for Location of Power Line Gap Noise. See **Committees** section for additional details. EMC Committee member Jerry Ramie, also serves as the Working Group's secretary.

Grow Lights

As previously reported in this document, Mr. Gruber tested four sample grow lights for conducted emissions. They were purchased from both local retailers and on-line sources. Three different manufacturers were included in this survey – Lumatek, Quantum and Galaxy. They were selected on the basis of complaints that from the field. Not surprisingly, each was also considerably over the FCC limits. The worst case measured 58 dB over the applicable Part 18 consumer limits.

ARRL General Counsel Chris Imlay used the resulting Lab report as the basis for an FCC complaint on March 12, 2014, which was covered in the ARRL News. See Appendix 1 in the July 2015 EMC Committee report for this article and Mr. Imlay's complaint. The three remaining FCC complaints were filed on June 30, 2015. See Appendices 2 and 3 of this report for copies of two of these filings.

Although the first complaint was submitted to the FCC over two years ago, and these devices measured way over the applicable FCC limit, there does not yet appear to have been any enforcement action taken by the FCC. Mr. Gruber believes that this lack of enforcement is simply unacceptable. He further advises that enforcement issues such as this be treated with a higher level of urgency within the ARRL.

At this point, Mr. Gruber recommends that some official response or statement from the ARRL be issued in this matter. Members often ask what the ARRL is doing about this lack of FCC enforcement and he is not quite sure what to tell them.

Other Lighting Devices

As previously reported, Mr. Gruber tested a number of energy saving Part 15 & Part 18 Lighting Devices for conducted emissions. It should be emphasized 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 are considerably lower than applicable Part 15 limits*. As a consequence, the ARRL Board has previously asked us to consider a proposal to reduce Part 15 limits to Part 18 levels for lighting devices. This concern was included in FCC comments filed by ARRL on October 8 on a *Notice of Proposed Rule Making* (NPRM) in ET Docket 15-170 and RM-11673. The ARRL News covered the story on October 13, 2015. Here is the URL:

www.arrl.org/news/arrl-asks-fcc-to-clarify-that-hams-may-modify-non-amateur-gear-for-amateur-use

Mr. Gruber is happy to report that there continues to be relatively few complaints of RFI from these bulbs. However, these bulbs could still be legally marketed and sold if their emissions were close to the FCC limits. The emissions in this case would 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 wide spread problem. This concern was also included in the previously mentioned NPRM comments filed by ARRL on October 8, 2015.

An additional problem involves the sale and marketing of non-consumer rated ballasts to consumers in hardware and big box stores. These ballasts are being sold to unsuspecting consumers and have been the subject of interference complaints to the ARRL Lab. ARRL General Counsel Chris Imlay first filed a complaint concerning Home Depot on

July 14, 2015. This complaint concerned the improper marketing of such devices. See Appendix 4 for this report.

Two additional filings by Mr. Imlay occurred on December 28, 2015 against Lowes and Walmart. These complaints noted similar marketing issues as the one filed against Home Depot. The resulting news story and complaints are included as Appendices 5 and 6 in this report.

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 worked with Eaton to identify the problem and find a solution. As a result, Eaton began to provide replacement breakers at no cost to homeowners affected by this problem. Since that time, Eaton has developed several version of the "ham friendly" breaker. Unfortunately, not all the new breakers fixed the problem, at least up until early this year. The latest version, released around January, seems to have fixed these issues, at least to the extent that they are reported to ARRL.

Also as previously reported, a new Square D breaker is now being reported as problematic, at least in one case. Mr. Gruber, along with assistance from W1AW Station Manager Joe Carcia, tested two samples at W1AW. They did not appear to be trip during W1AW broadcast bulletins.

Status on FCC Enforcement and Outstanding EMC Cases

Mr. Gruber reports that the FCC has been sending letters to utilities (and consumers) with some regularity. Meaningful enforcement beyond that, however, continues to be very disappointing. To the best of his knowledge, no previously reported longstanding power line noise case has been resolved during the second half of 2016 due to enforcement. 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.

As previously reported, the FCC is not pursuing amateur related EMC enforcement issues in a meaningful way. At the present time, two non-power line examples of particular concern include:

1. On March 14, 2014, the following story appeared in the ARRL News: ARRL to FCC: "Grow Light" Ballast Causes HF Interference, Violates Rules.[1] This story reported a formal complaint made by the ARRL to the FCC concerning grow light ballasts that were considerably over the applicable FCC Part 18 limits. Since these devices are being marketed and sold in shops across America, and given the incredible margin by which they exceed the limits, this was a slam dunk case for FCC enforcement. Yet, at the time of this report, no enforcement has taken place. In fact, to the best of Mr. Gruber's knowledge, the FCC has yet to even respond to the ARRL's complaint.

   While it may be understandable for the Commission not to comment on an ongoing investigation, it is clear that timely FCC enforcement is not happening. It has now been nearly three years since the ARRL's news story on this matter. It would appear that the FCC is either unable or unwilling to provide timely and meaningful enforcement, even in a clear and egregious case such as this. Mr. Gruber now fears that situation has already compromised the FCC's credibility as an enforcement body. Meaningful FCC enforcement when warranted is essential toward protection of all spectrum, not just the ham bands.

   It has also been reported by EMC Committee members who are professionally employed electrical engineers in the cable-TV/cable-modem area that grow light ballast have been found to cause serious harmful interference to the operation of cable systems; Electro-Magnetic Interference from grow-light ballasts enters the cable system in the downstream end and causes interference to subscribers in a relatively large areas. As previously noted in the Summer-2014 EMC Committee report, emissions from some grow-light ballasts have measured 58 dB above the FCC limits. In other words, these devices are presenting problems to cable distribution systems often with coupling to the ground and power of residences with the conducted levels far in excess of what is encountered in typical amateur installations.

   Mr. Gruber now indicates that some ARRL response or follow-up take place at the Board level. At this point he has done all he can do and grow light complaints continue.

2. On April 24, 2014, the following story appeared in the ARRL News: ARRL FCC Cites Washington Resident for Causing Interference on Amateur Frequencies.[2] This article describes a case in Woodinville, Washington in which the FCC conducted a field investigation. Although this investigation resulted in a finding of harmful interference from a nearby property, possibly caused by a lighting device, the property owner subsequently failed to respond to the Commission. As a result, the Commission released a Citation & Order on the 24th of April, the

[1] The URL is www.arrl.org/news/arrl-to-fcc-grow-light-ballast-causes-hf-interference-violates-rules. Included at the end of this report as Appendix XXA.

[2] The URL is www.arrl.org/news/fcc-cites-washington-resident-for-causing-interference-on-amateur-frequencies.

same day as the ARRL News article[3]. However, as of early July, the interference was confirmed to be ongoing.

The noise in this matter is consistent with a grow light. At this point, the property owner has simply ignored the FCC's Citation and Order and no further FCC enforcement has taken place after almost three years. Instead of meaningful enforcement, the FCC has simply dropped the case. Given the FCC's own determination that harmful interference is occurring, and that a Citation & Order was issued, in the matter, Mr. Gruber believes that this is the best case for an NAL that he has seen in a decade.

Mr. Gruber now recommends some ARRL response or follow-up take place at the Board level. At this point he has done all he can do. The complainant is asking for an update on his case and Mr. Gruber is at a loss as to tell him.

Historically, meaningful FCC enforcement beyond an advisory letter has been and continues to be disappointing. So far, most cases involving Amateur radio have been argued 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.

In a typical case, one or more letters will be sent by the FCC in Gettysburg to an offending device operator. Beyond that, a typical case will be referred to the local FCC field office for an investigation. From what we've seen, most field investigations result in a conclusion of convenience. As a typical example, the agent may conclude that the noise is insufficient to meet the criteria for harmful interference, thus ending the case. Other complainants have reported a lack of follow-up after an investigation, especially if the source was not active during the initial field investigation

Also from what we've seen, FCC field agents often do not have the proper training or equipment to correctly identify and locate power line noise. 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 issued an NAL or forfeiture. Some cases like this have dragged on for a considerable period of time with no resolution.

Furthermore, from what we've seen so far, the FCC Field Office reduction has had 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. Gruber'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.

[3] The URL is http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0424/DA-14-536A1.pdf.

Perhaps most alarming of all, Mr. Gruber now reports that he is not aware of any field investigations involving Amateur radio since the field offices were gutted in 2016. One non-Amateur example was also reported in the July 2016 EMC Committee report. In this case, a police officer from Evanston, Illinois requested ARRL help in a case involving cell phones, key FOBs and similar devices.

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 two examples described in the previous section plus a third appear to demonstrate an alarming trend.

In summary:

1. The first involves grow light manufacturers. The ARRL has so far filed four complaints of devices that were grossly over the applicable FCC limits. Although the first complaint was filed on March 14, 2014, so far there has been no apparent enforcement action by the Commission. **In fact, the Commission has yet to even acknowledge or respond to any of these complaints.**
2. The second is an apparent lack of response to an FCC Citation & Order that was issued on April 24, 2014. The Citation and Order was ignored by the recipient and he interference continues unabated. **The FCC has yet to take any meaningful action in the matter after nearly three years.**
3. The third example concerns the three illegal marketing of Part 18 non-consumer lighting devices. The first Home Depot complaint was filed by the ARRL on July 14, 2015. The Lowe's and Walmart complaints were filed on December 28 and 29, respectively. Although the first complaint was filed one year ago, the FCC has failed to take any action problem continues. **In fact, the Commission has yet to even acknowledge or respond to any of these complaints. At the time of this report, the only response has been from Walmart seeking to rectify the problem.**

It must be emphasized that even if there is an ongoing FCC effort in any of these matters, they have now been ongoing for a considerable period of time 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 lighting devices, including grow lights, not to mention such things as switching mode power supplies, battery chargers, pulsed dc motors in appliances, etc., meaningful enforcement is badly needed. A lack of it 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 a grow light, 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 t meaningful enforcement could be expected in other interference matters as well.

Mr. Gruber now recommends some sort of visible Board level follow-up in these matters.

Second Half 2016 Year Total RFI-Case Statistics:

New RFI Cases – 133
New electrical power-line cases – 29

- ARRL Letters sent – 12
- FCC 1st Letters submitted – 8 (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 – 0

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; and there has been no change to the process of processing cases presented through the Agreement. Although none of the previously reported cases have been successfully resolved as a result of FCC enforcement, the Committee is continuing in the process of addressing this issue.

<u>KI6IBS Power Line Noise Investigation</u>

In an effort to develop a power line noise case for ARRL consideration as a higher level FCC complaint, Messer's Gruber and Ramie investigated the case of Eric Schreiber, KI6IBS, in March and April of 2015. This case is located in Pleasant Hill, CA and first reported to ARRL on April 24, 2012. The utility in this matter is PG&E.

Since first reported to us, PG&E has responded to numerous FCC and ARRL communications. PG&E also claims to have made significant effort toward resolving it. Although the noise at KI6IBS is intermittent and primarily active at higher temperatures, it was severe and not particularly difficult to find when using proper modern methods and equipment. The people that PG&E were sending out did not have the right equipment, or if they did, they didn't know how to use it.

Complete details on this investigation appear as Appendix 7 of this report. Although Mr. Gruber has forwarded this report to PG&E's attorney Jonathan Pendleton on June 12, 2015, the problem remains ongoing. Laura Smith at the FCC was also a CC recipient of this report. While there was a subsequent attempt to fix this problem, it was

unsuccessful. PG&E failed to conduct a technically competent RFI investigation in response to Mr. Gruber's report.

Mr. Gruber reports that this case is solid. The only potential issue might be the intermittent nature of the noise in cooler weather. Given the extraordinary effort it requires to groom and develop a case to this level, Mr. Gruber recommends to the Board that it be used for a timely and higher level complaint at the FCC. He also notes that Mr. Schreiber continues to periodically ask about the status of his case with the ARRL. Since his case is being handled at a higher level within the ARRL, he has been unable to advise Mr. Schreiber in this regard**.**

Since it has now been almost two years since his investigation, Mr. Gruber now recommends some ARRL response or follow-up take place at the Board level. At this point he has done all he can do. The complainant has periodically asked for an update on his case and Mr. Gruber is at a loss as to tell him.

<u>K7GMF Power Line Noise Complaint</u>

Tom Lopez of Cochise Arizona first reported his power line noise problem to ARRL over ten years ago. Despite numerous FCC letters and an investigation by Mike Martin, the problem continues. A brief timeline is as follows:

- 02-18-04 – Complainant first reports interference problem to ARRL
- 03-20-06 – ARRL sends letter to Sulphur Springs Valley Electric Cooperative (SSVEC), the utility in this matter.
- 03-16-09 – FCC sends 1st FCC letter to utility.
- 08-17-09 – FCC sends 2nd FCC letter to utility.
- 05-10-10 – RFI investigator Mike Martin, whose services were obtained by the Utility, reports that he investigated the problem. There were numerous staples in a desert environment contributing to the problem. The primary source was found to be associated with 69 kV transmission lines about six miles away. This problem could not be fixed at the time of Mr. Martin's investigation.
- 03-01-11 – FCC sends 3rd FCC letter to utility.
- 07-08-14 – Mr. Carlson contacts Mr. Lopez to ascertain the current state of harmful interference to K7GMF from power line noise.
- 08-18-14 – Mr. Gruber requests 4th FCC letter.
- 12-05-14 – Laura Smith reports that she had sent the utility a letter in August but did not receive a reply. She indicated that she would send to the field if nothing after the Holidays.
- Present – Mr. Lopez reports the problem continues and he has not heard from the field. He asks Mr. Gruber for help and provides him with a package of recent documents related to his case.

Mr. Gruber reports that he did have contact with FCC staff about this particular case at the beginning of July, 2015. Later that month, Laura Smith responded that she had asked the Field Office to put it on their schedule. She also added that they can only make the site visit when they can bundle it with other Arizona matters. She noted that they are coming from CA and the FCC front office will only approve travel for a case like this if they can kill multiple birds with that one stone. She will let Mr. Gruber know once they have a trip planned. At this point, however, it has been almost two years and the field offices have been severely cut back.

Although Mr. Gruber has concerns about the complexity of the case with over five years since the professional investigation began, Mr. Gruber is now grooming this as one of the cases that the Committee still believes should be used as a higher level complaint with the FCC.

Additional ARRL RFI Investigations by Kermit Carlson

ARRL Central Division Director and EMC Committee Chairman Kermit Carlson continues to perform follow-up on the status of the 74 open cases of power line noise that had been previously referred to the FCC. The purpose of this inquiry was to determine the status of harmful interference from Power Line Noise for cases that had been reported in the past 6 years but for which the League had an unknown remediation status.

Out of the 41 unresolved cases identified by the follow-up several cases have been selected for further preparation for presentation to the Commission as long-term unresolved problems; KI6IBS, Pleasant Hills, California and the K7GMF, Cochise, New Mexico have been identified as long outstanding cases of detrimental harmful interference from power line gap noise. Similar cases do exist in every Division of the ARRL.

Mr. Carlson continues to work on several new cases of gap noise and noise sources of unknown origin which are causing harmful interference to amateurs. Presently these cases are trying to be resolved by working directly with the owners of the noise generating sources. The purpose of his investigations is to gain insight into the practical efficacy of industry practices on remediation of harmful gap noise interference that impacts amateur radio installations and to discover practical methods that are effective in helping amateur operators eliminate EMC problems.

Ladd, Illinois

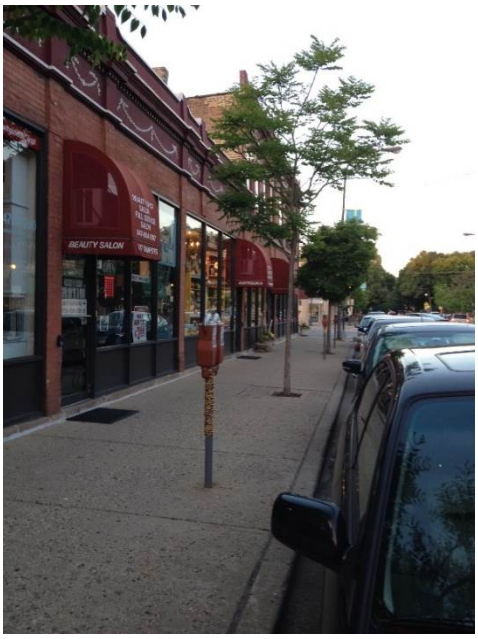
Mr. Carlson visited the site of an amateur station in Ladd, Illinois where several points of powerline gap-noise interference were producing signal levels well above S9 on the victim receiver. With the help of the station operator and with the help of the local lineman for the Municipal power utility, a survey of 4 locations was conducted ranging in distances of 700 feet to 2500 feet from the amateur's station. Problems were located to the offending device on the powerline system over a period of 4 hours. The issues that

were discovered included a lightning arrestor that had completely opened and was arcing, two bad support insulators that were arcing and line dead-end support that was arcing. Over a period of two months the local utility has completed repairs on their equipment. The root problem remains that in many utilities that, although there is an interested to remediate problems, there is no budget for proper noise detection equipment.

Mundlelein, Illinois

Mr. Carlson investigated an HF noise complaint at the station of W9/ZL1TNC in the town of Mundelein, Illinois. Three devices were found to be producing powerline gap noise. The precise locating of the three items took just over one hour of time. The amateur filed a complaint with the Commonwealth Edison service desk and within one month a field survey had arrived and located two of the noise producing devices. These were then remedied in short order. The third item which continues to produce noise was not identified by the utility's surveyor. The newly installed pole-mounted capacitor continues to cause interference and is the subject of a re-filed work ticket with the utility. A complaint with the Illinois Commerce Commission is anticipated and will produce a repair of this final issue.

Evanston, Illinois



A very interesting case of Electromagnetic Compatibility arose in Evanston, Illinois as the result of an inquiry from Officer Henderson of the Evanston, Illinois Police Department to Mr. Mike Gruber, the ARRL EMC Engineer in Newington. Although not directly an Amateur radio problem, the request for help in Evanston presented a very unusual fact pattern.

In this particular case, the six-hundred block of Dempster Avenue in the commercial down-town area of the North Chicago suburb was plagued with the strange problem. Wireless motor vehicle key-fob's wouldn't allow owners to open their vehicles, or in the case of some very expensive cars, some owners were unable to start their cars until it was towed to a point a block away. It was further reported that when this occurred, the affected drivers were unable to use their cellphones in order to summon for help. The location of this problem favored one set of eight on-street parallel parking spots in this Chicago suburb.

In response to this unusual request, Mr. Carlson, W9XA, acting as the ARRL-EMC Chair made the short trip to Evanston for a look at the EMC implications of the situation. Mr. Carlson met with two officers of the Evanston PD, an affected business owner and the owner of the building nearest the problem area in late June.

It was learned during the visit that the Evanston PD had requested help from the FCC but had been told that this was a car maker's problem and that this was not something that the Commission would investigate. Of some concern to the PD was possibility that this was a potential beginning or indication of some nefarious or illegal activity. But even more disconcerting was the increasingly common need to have the local gendarme's present for a police tow or assistance to the public for what seemed to have become a common occurrence.

During his visit, Mr. Carlson employed a Radar Engineers-240A Noise Signature Receiver and UHF Yagi antenna to survey the affected block of Dempster Avenue. Since Key-fob operation is typically around 315 MHz and 433 MHz, both sets of frequencies were used in the survey along the sidewalks of the block. Although several sources of noise generation were identified in the survey of the block, a particularly strong source was noted at either end of the block, and the directional antenna indicated the same central point in the middle of the block.

The source at the center of the block was identified as a neon sign transformer replacement power supply that provided a very significant radiated signal to the area of the on-street parking just across the sidewalk - a distance from eight to 40 feet to the affected parking spot locations.

Although the actual neon tube portion of the sign was over 40 years old, the power supply was relatively new. The building owner and the police officers were advised to have the business owner who owns the sign to turn-off the sign should this problem arise. The owner of the sign was made aware of the issue that his neon lighting device is causing a problem.

Since that visit, several other instances have been reported in other Chicagoland areas of unexplained key-fob problems that are resolved once the car has been towed from a location.

This situation demonstrates the electromagnetic compatibility problems that are evolving in an atmosphere of non-compliant imported unintentional RF emitting devices. The Ventex neon power supply did cause Mr. Carlson's Verizon cellphone to not work when closer than a few feet from the device, so it is anticipated that further investigation will show that this device given the extremely close proximity to a public way does cause harmful interference and disruption to licensed radio services As a note the owner of the sign power supply was not the business owner who had met with Mr. Carlson during this visit.

An update of the story developed shortly after the publication of this story in the summer of 2016. Engineers from the Federal Communications Commission did visit the site and they conducted a search for a source of radio noise. That search was conducted after the Ventrex neon sign supply had been removed, and an additional source of excessive radio noise was reportedly identified as lighting fixtures within one of the businesses located along the affected parking area. The lighting had been installed as part of program by the local power utility, Commonwealth Edison as part of an energy conservation program. The manufacturer of the subject lighting fixtures did contact Mr. Carlson at his office. However, since the identification of the other fixtures was a result of a noise search by others, the manufacturer was referred to the FCC personnel who were involved with the Commission's noise survey of the block.

Another inquiry arose as news of the Evanston case spread through the internet media. An inquiry from a Chicago Television station's news operation was referred to Mr. Carlson by the Newington staff. The request was for an interview and comment about a similar problem at a location on Sheffield Avenue in the City of Chicago. A similar fact pattern of inoperable Car Key-fobs and dropped cellphone calls has plagued a certain intersection. Mr. Carlson conducted a preliminary noise survey of the area and found two significant sources of radio noise. Both sources were recently installed lighting in area business. The television news organization has not contacted Mr. Carlson since the original contact in December.

Marketing of Drone TV transmitters that operate on Amateur, Aeronautical Radio-Navigation and FAA radar frequencies.

As previously reported, the ARRL EMC Engineer Mike Gruber and Mr. Carlson were sent information which revealed there is a serious potential problem with the marketing of video transmitters for installation on airborne drones that operate on amateur and aeronautical radio-navigation radio frequencies. The marketing of radio equipment which has obviously not been tested for FCC rules compliance is nothing new, but in addition to being a nuisance for the operators on the 23 cm band the operation of these transmitters does carry the distinct possibility of causing harmful interference which would result in a serious safety of flight issue for aircraft operations.

Messer's Gruber and Ramie wrote a report detailing numerous concerns regarding this matter September. It was subsequently submitted to General Counsel Chris Imlay on September 22, 2016 in an effort to facilitate an official FCC complaint. Although this report is included as Appendix 8 in this report, here are several highlights:

- These devices are highly illegal on a number of levels. **Most importantly, they represent a serious hazard to air traffic and the public safety.**
- Some of these devices are being marketed and sold as Amateur equipment but some of its channels conflict with air navigation equipment.

- The channels chosen for operation of these airborne transmitters demonstrate a complete disregard by the manufacturer of the established and legal assignments of frequency allocations.
- The specified output power can be several times legal Part 15 and Part 97 power output for such devices. Furthermore, given the fact that they operate from drones, can operate at relatively high altitudes, interference to aircraft navigation systems could potentially occur at greater than normal expected distances.
- These transmitters and amplifiers are being offered online by a number of internet vendors. A quick online perusal of vendors indicates that there is no shortage of suppliers of these devices.
- It is only a matter of time until amateur operations will be affected by these transmitters, but if such a device ever does interfere with the integrity of the FAA's ATC transponder radar system it would be beneficial to be able to show that we had warned the Commission of the nature and dangerous potential that these transmitters represent.

Marketing of various units continued unabated at the time of the ARRL Lab's report. Sampling of the offerings at that time could be found using any internet search engine with the search terms "1.2GHz, transmitter". A recent search of Amazon also provided hundreds of offerings of transmitters capable of power levels between one-quarter and six watts. The FCC has in the past addressed the marketing of similar unauthorized radio frequency devices but there have been no recent Commission actions against the marketing or operation of these unauthorized devices.

Although recent complaints concerning improper marketing of non-compliant devices have been ignored by the Commission, it remains the consensus of the ARRL-EMC Committee that the potential for serious problems does warrant consideration for filing a formal complaint. At the time of this report, Mr. Imlay is preparing a filing with the Federal Communications Commission that will outline the legal and technical basis for a complaint. It will also include a request for action to prevent the improper marketing of the non-compliant devices. Please note that not all drone television transmitters are at variance with the Commission's Rules and Regulations. The remediation of this situation could be easily remedied by a simple action by the Commission. Just over a decade ago, the Commission was able to stop the marketing of very similar illegal devices with a short letter to the offending marketers (Please see Appendix #8 to this report). It is hoped that the Commission will abate this problem with a similar action.

Common sense alone would dictate that swift and meaningful FCC enforcement would result in this matter, including the vendors of these devices which can be easily found. It is only a matter of time until amateur operations will be affected by these transmitters, but if such a device ever does interfere with the integrity of the FAA's ATC transponder radar system it would be beneficial to be able to show that we had warned the Commission of the nature and dangerous potential that these transmitters represent.

Noise Monitoring Suggestion and Action Item

Dr. Greg Lapin, N9GL, the Chair of the ARRL RF Safety Committee contacted Mr. Hare and Mr. Carlson prior to the November EMC Committee meeting to suggest that the EMC Committee consider undertaking a the creation of a program to measure and monitor trends for background noise in the HF spectrum. Ed Hare has been working on the details of the formation of a crowd-sourced method of collecting background noise measurements.

This is very timely issue given the recent work by the FCC Technological Advisory Council which is an advisory group to the FCC which is investigating changes and trends to the radio spectrum noise floor to determine if there is an increasing noise problem, and, if so, its extent. The FCC Office of Engineering and Technology (OET) announced the TAC study in a *Public Notice* in mid-July which **invited comments** and answers to questions that the TAC has posed in the notice. The ARRL filed comment prior to the August 11th deadline. Please see Mr. Imlay's report for the January 2017 ARRL Board meeting for a copy of that filing. The TAC said it is trying to determine the scope of any noise issues and has invited "quantitative evidence" of noise problems, as well as recommendations on how to perform a noise study.

"The TAC is requesting input to help answer questions about the study of changes to the spectrum noise floor over the past 20 years," the announcement said. "Noise in this context denotes unwanted radio frequency (RF) energy from manmade sources. Like many spectrum users, TAC members expect that the noise floor in the radio spectrum is rising as the number of devices in use that emit radio energy grows."

The ARRL representative on the TAC, Greg Lapin, N9GL, co-chairs the TAC Spectrum and Receiver Performance Working Group with Lynn Claudy of the National Association of Broadcasters. Lapin also serves as chairman of the ARRL RF Safety Committee.

The TAC said that its search for "concrete evidence of increased noise floors" has turned up only "limited available quantitative data" to support its presumption of a rising noise floor. The TAC said it wants to find ways to add to the available data so it can "answer important questions" on the topic for the FCC.

The TAC noted that many types of devices generate radio spectrum noise. In the case of *incidental radiators* — devices not designed to emit RF but do so anyway — there is little regulation governing such noise. "Most electric motors, light dimmers, switching power supplies, utility transformers, and power lines are included in this category," the TAC announcement explained.

Devices designed to generate RF for internal use, or send RF signals to associated equipment via connected wiring, but which are not intended to emit RF energy, are called *unintentional radiators.* This category includes computers and many portable electronic devices, as well as many new high-efficiency lamps. FCC regulations limit the levels of emitted RF energy from these devices.

A third group of devices categorized as *intentional radiators* (unlicensed and licensed) and *industrial, scientific, and medical (ISM) radiators* — are designed to generate and emit RF energy by radiation or induction. Intentional radiators include cellular phones and base stations, unlicensed wireless routers, Bluetooth devices, broadcast TV and radio stations, and radar systems. Amateur Radio transmitters also fall into this category. Microwave ovens, arc welders, and fluorescent lighting are examples of ISM equipment.

"Such emitters contribute to the noise floor with emissions outside of their assigned frequencies," the TAC said. "These are sometimes generated as spurious emissions, including, but not limited to, harmonics of desired frequencies and intermodulation products." FCC regulations permitting the operation of these devices specify emission limits outside of the device's licensed or permitted operating frequencies.

The TAC said that responses to the questions it has posed in the *Public Notice* will help it to "identify aspects of a study to determine trends in the radio spectrum noise floor. The ARRL is planning to comment. Please refer to Mr. Imlay's July report to the ARRL Board for details on the response by the ARRL.

Smart Grid & EMC Standardization Efforts

Mr. Ramie (KI6LGY) updates our efforts in these areas:

1) **IEEE-P1613 development**
Drafting of this document was completed in December and it has been submitted to the three sponsoring Committees within the Power & Energy Society for review. (Substations, T&D and Power Systems Relaying Committee) They will have a meeting in the next few weeks and it is expected that this document will be elevated to a "Consensus" ballot to move it to the IEEE for a formal Standards ballot. We're expecting a successful Consensus ballot.

Immunity testing will be run with the doors removed entirely, as it is assumed they will often be open when in use for servicing. My feeling is that this document will become IEEE-1613(2017) sometime during the upcoming year. When progress is more assured, I will begin updating a previous Presentation on the old IEEE-1613.2(2013) into a new Presentation to be given at EMC Society and Power/Energy Society meetings. I have speaking commitments from Tucson, Phoenix, Las Vegas, Reno, San Diego and Santa Clara already. I expect to speak in Seattle, Portland, Chicago, Minneapolis, Detroit, Indianapolis and possibly RTP and Austin as well. This will take over a year to complete the circuit.

2) **SGIP-EMI Issues Working Group**
Another area the League is supporting is continuing EMC work with the Smart Grid Interoperability Panel (SGIP) formerly under NIST (now a private non-profit). The EMI Issues Working Group did the original work defining the missing tests for utility

equipment that became IEEE-1613.1(2013). It was the vehicle that brought the American utilities into harmonization with the Europeans on specifying reliable equipment that could resist interference by demonstrating "immunity" to simulated interference during required type-testing.

Our next product will be a webinar presentation for the rest of the SGIP to be given January 17 at their upcoming meeting. The webinar is the visual presentation of our recent white paper on interference, geomagnetic storms and HEMP attacks.

3) **IEEE-P1897 Recommended Practice for Powerline Noise Mitigation**
Mike Gruber is the Chair of this Working Group that's discussing the best practices for utilities to employ for resolving powerline noise complaints. The Vice Chair, Brian Cramer of Exelon, is also a member of the EMC Committee. Mr. Ramie, also with the EMC Committee, is the Secretary. Several other EMC Committee members are members of this working group as well. Our views are well represented. We want consensus with the utility industry and I feel it is attainable. I am assuming we can have text ready to ballot by the middle of 2017.

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. During the past six months, ARRL received no reports of problems. Our cable liaison, Mr. Ron Hranac (N0IVN), also noted that he received no reports or complaints directly, indicating that most cable systems are either clean or are addressing complaints effectively.

DSL, U-Verse & Home Phone Networking Alliance

Mr. Beattie continues to assist with broadband service complaints to the ARRL. In addition, Mr. Beattie has been working toward formalizing the process that AT&T uses to address these issues with ARRL.

Based on a previously reported complaint from Arizona, Mr. Beattie also reported that CenturyLink is doing something different than other xDSL carriers. Specifically, they are increasing their DSLAM signal level in the specific spectrum where the interference

is occurring. If the source is an Amateur station in the transmit mode, the DSLAM can create interference to that same station when in the receive mode.

Mr. Gruber also reports that there has been a reduction in interference reports from CenturyLink DSL systems. As previously reported, the interference appears to be caused by radiation from the phone lines due to a fault or imbalance on the lines. The problem occurs in the upper portion of the 75 meter band above 3.8 MHz. One such complaint in Idaho was detailed in the last EMC Committee Report. Although CenturyLink to not directly respond to Mr. Gruber's letter, there was a significant and mostly successful effort to fix the problem. The complainant seemed happy with the results and Mr. Gruber may close the case. At the time of this report there are no other open cases involving CenturyLink.

In another case, Mr. Beattie and other AT&T personnel provided valuable troubleshooting support to a Tucson-area couple who had engaged Tucson Electric Power regarding power line noise interference to their 40m operation. Mr. Beattie and other AT&T personnel investigated TEP's suggestion that power supplies at an AT&T's cell site were causing interference to the couple's HF operation. While no relevant noise was found at the site, AT&T isolated the issue to one or more TEP transmission poles. The Amateur Radio operators are now waiting for a response from TEP. The FCC, ARRL and AT&T were copied on this latest communication and are standing by pending TEP's response. See Appendix 9.

Radio Frequency LED Lighting Products

As previously reported, the FCC's Office of Engineering and Technology (OET) FCC issued a clarification concerning LED lighting products on June 17, 2016.

Previous to this notice, LED lighting devices with circuitry operating from 9 kHz to 1705 only needed to meet conducted emissions testing up to 30 MHz. While it also refers to radiated emission testing below 30 MHz, Mr. Gruber notes that there are no specified FCC limits for this. (He also suggests that radiated emissions testing below 30 MHz would be particularly difficult to implement.)

The FCC's notice reaffirms previous testing requirements but also adds a new requirement – radiated emissions testing from 30 to 1,000 MHz. While this requirement only applies to RF lighting devices with internal circuitry operating between 9 kHz to 1705 kHz, Mr. Gruber is pleased to see the FCC take this step. He's been generally hearing of more RFI issues from LED lighting in the 2 meter band, apparently caused by radiated emissions. See Appendix 10 for the ARRL News story and the FCC's notice.

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 2016 and compared to the previous four years:

Category of Case Reported to ARRL Lab/EMC Engineer	2011	2012	2013	2014	2015	2016
BPL	0	0	0	0	0	0
Unknown Unintentional Radiators	78	66	68	81	49	70
CABLE TV	7	3	4	4	4	2
Satellite TV			2	3	1	0
Computing Devices and Modems	7	3	5	6	8	3
Power Line Noise	65	53	52	51	43	47
Plasma TV Receivers	14	5	3	5	1	3
Other Broadcast Receivers	0	4	4	4	0	1
Other Receivers	3	1	1	4	1	6
Other Transmitters	9	2	2	4	3	3
Broadcast Transmitters	4	6	6	2	5	1
Lighting Devices	13	4	10	15	7	19
Confirmed & Suspect Grow Lights[4]	---	---	2	16	6	12
Fence Systems	2	0	3	3	0	2
Battery Chargers / Power Supplies	1	3	4	5	7	9
Wheelchair	1	0	0	0	0	0
Water Pump Systems	2	1	2	2	0	0
HVAC Systems	6	3	10	6	5	12
Alarm Systems including detectors	0	4	2	4	2	3
Other Appliances	8	7	7	4	3	10
GFIC / AFCI	1	5	7	25	6	5
AUTOMOBILE Systems	3	2	7	1	1	3
Manufacturing and Retail Generated Noise	0	0	1	2	0	0
AT&T U-Verse Systems	8	8	3	4	6	1
PV Systems	---	---	2	1	3	10
Doorbell Transformers	---	---	2	3	0	2
Other	---	36	16	16	15	30

[4] 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. 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.

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, 2017, as the IEEE EMC Society Vice President of Standards.

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.

Mr. Gruber continues as Chairman of a Working Group to develop a Recommended Practice for Location of Power Line Gap Noise. Additional EMC Committee members in this group include Messrs. Cramer as Co-chairman, Ramie, Carlson, Hare and Boucher. This P1897 Working Group is sponsored by the EMC Society. The first formal meeting was held on December 10, 2015 and development on a set of best practices continues with monthly meetings.

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.

I am pleased to report to the ARRL Board that ARRL EMC Committee Member Mr. Ed Hare, W1RFI, the ARRL Laboratory Manager, has been elected to the position of Vice-President of Standards for the IEEE EMC Society. Congratulations to Ed for his election to the important industry position.

As a note of personal thanks, I would like to recognize Mr. Hare, W1RFI, Mr. Ramie, KI6LGY; Mr. Gruber, W1MG; Mr. Roop, K9SE; Mr. Hranac N0IVN; Mr. Beattie W2TTT, for their authorship 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
EMC Committee Chairman
Vice Director Central Division

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1. Appendix 1 Lumatek Dial-a-Watt ballast complaint
2. Appendix 2 Quantum Horticulture HPS/MH-600W ballast complaint
3. Appendix 3 Galaxy 1000 Watt Dimmable ballast complaint
4. Appendix 4 Home Depot marketing complaint.
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7. Appendix 7 KI6IBS RFI investigation report
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9. Appendix 9 AT&T RFI Investigation report
10. Appendix 10A and 10B – Radio Frequency LED Lighting Products