Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Parts 1, 2, 15, 25, 27, 74, 78, 80, 87,	)	**ET Docket No. 12-338**
90, 97 and 101 of the Commission's Rules Regarding	)	**(Proceeding Terminated)**
Implementation of the Final Acts of the World	)	
Radiocommunication Conference (Geneva, 2007)	)	
(WRC-07), Other Allocation Issues, and Related Rule	)	
Updates	)	
	)	
Amendment of Parts 2, 15, 80, 90, 97 and 101 of	)	**ET Docket No. 15-99**
the Commission's Rules Regarding Implementation	)	
of the Final Acts of the World Radiocommunication	)	
Conference (Geneva, 2012) (WRC-12), Other	)	
Allocation Issues, and Related Rule Updates	)	
	)	
Petition for Rulemaking of ARRL to Amend Parts 2	)	
and 97 of the Commission's Rules to Create a New	)	
Medium Frequency Allocation for the Amateur Radio	)	
Service	)	

To: The Commission

COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, the national association for Amateur Radio, formally known as the American Radio Relay League, Incorporated (ARRL), by counsel and pursuant to Section 1.415 of the Commission's Rules (47 C.F.R. § 1.415), hereby respectfully submits its comments in response to the *Notice of Proposed Rule Making* portion of the *Report and Order, Order, and Notice of*

Proposed Rulemaking, FCC 15-50, 30 FCC Rcd. 41835, released April 27, 2015.[1] The *Notice of Proposed Rulemaking* portion of that document (the "*Notice*") proposes, among other things, to amend Parts 2 and 97 of the Commission's rules to implement allocation decisions from the World Radiocommunication Conference (Geneva, 2007) (WRC-07) and the 2012 World Radiocommunication Conference (Geneva, 2012) (WRC-12) concerning portions of the radio frequency (RF) spectrum in the Low Frequency (LF) [2] and Medium Frequency (MF) [3] bands. The *Notice* also addresses a *Petition for Rule Making* filed by ARRL on November 29, 2012 requesting the allocation of the 472-479 kHz band (the 630-meter band) to the Amateur Service on a secondary basis. In the interest of the more than 730,000 Amateur Radio Service licensees of the Commission in licensed access to the LF and MF portions of the radio spectrum for purposes of experimentation and technical self-training, ARRL states as follows:

I. Introduction.

1. In the *Report and Order* portion of the *Report and Order, Order, and Notice of Proposed Rulemaking* relative to the Amateur Radio Service, the Commission implemented allocation decisions from the *WRC-07 Final Acts* and made necessary conforming updates to the Part 97 service rules. The *Report and Order*, first, allocated the 135.7-137.8 kHz (the 2200-meter) band to the Amateur Service on a secondary basis, creating the first LF Amateur Radio allocation. It also elevated the secondary amateur service allocation in the 1900-2000 kHz band (the 160-meter band) to primary status[4], but temporarily allowed use of that band by commercial

[1] The *Notice* was published in the Federal Register on July 2, 2015; 80 Fed. Reg. 38316 *et seq*. That publication of the *Notice* specified a comment date of August 31, 2015. Therefore, these comments are timely filed.
[2] The LF frequency range is commonly defined internationally and domestically as the spectrum between 30 kilohertz and 300 kilohertz.
[3] The MF frequency range is commonly defined internationally and domestically as the spectrum between 300 kilohertz and 3 megahertz.
[4] The decision to elevate the Amateur Radio allocation from secondary to primary in the 1900-2000 kHz band partially unwound an action taken in 1983 which allocated the 1800-1900 kHz band to the Amateur Service on an exclusive basis; allocated the 1900-2000 kHz band to radiolocation on a primary basis for Federal and non-Federal

fishing vessels for radio buoys on the "open sea" premised upon operators of those buoys obtaining or holding a Part 80 ship station license. This last action effectively legitimizes the operation of these radio buoys which have been deployed and operated illegally for years and which have regularly caused interference to radio Amateurs in the 160-meter band.

2. In the *Notice* portion of the document, the Commission proposes to amend, among other rule parts, Parts 2 and 97 to implement allocation decisions from the *WRC-12 Final Acts* by: (1) allocating the 472-479 kHz (630-meter) band to the Amateur Service on a secondary basis; (2) amending the Amateur Service rules to provide for use of the 2200-meter and 630-meter bands while protecting incumbent uses[5] from interference; and (3) amending Part 80 of the Commission's rules to permanently authorize radio buoy operations in the 1900-2000 kHz band under a ship station license on essentially a "blanket" basis without modification of the ship station license.

3. ARRL is appreciative of the Commission's actions and proposals in this proceeding to date which overall are responsive to the needs of the Amateur Service. The restoration of the primary allocation for the Amateur Service at 1900-2000 kHz allows reasonable flexibility in ongoing experimentation and research in the 1800-2000 kHz band once again. The allocation of the 2200-meter band, together with the proposal to adopt flexible rules for the use of that first LF allocation, and the proposal to allocate the 630-meter band for Amateur use, when implemented will complete at least a basic complement of Amateur Radio allocations in all portions of the radio spectrum domestically. It also addresses a need for allocations in this frequency range first

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use; and, pursuant to Footnote US290, allocated the 1900-2000 kHz band to the Amateur Service on a secondary basis. The 1983 action was for the purpose of providing relocation spectrum for radiolocation stations that would be displaced from the 1605-1705 kHz band when expanded-band AM broadcasting would be implemented in that band. However, there were no such displacements as it turned out, inasmuch as that older radiolocation technology became, and remains largely obsolete.

[5] Specifically, according to the *Notice* at paragraph 4, "Amateur stations would share the band with power line carrier (PLC) systems operated by electric utilities. Amateur stations would be permitted to operate in these bands at fixed locations when separated from electric transmission lines by a specified distance."

publicly acknowledged in the preparations for the 1979 World Administrative Radio Conference. The *Notice* in this proceeding continues the discussion commenced earlier in Docket 12-338 of the compatibility between Part 97 Amateur Radio operation at 2200 and 630 meters and Power Line Carrier (PLC) systems operating under Part 15 of the Commission's Rules, for the purpose of determining appropriate operating parameters and procedures going forward. It is readily apparent from the record established in Docket 12-338 (as is further elaborated on hereinbelow) that there can most assuredly be compatible operation by Amateur stations in both the 2200 and 630-meter bands without adverse interaction with PLCs. This can be facilitated by normal, well-established notification procedures conducted entirely in the private sector, and available database information sharing by utilities and the public contact information for licensees in the Amateur Radio Service. Notification procedures will be necessary only in those predictably few instances in which geographic proximity and co-channel or overlapping channel operation occurs.

II. Radio Buoys in the 1900-2000 kHz Band.

4. Fishing boats have been illegally using unlicensed radio buoys[6] for years. On information and belief, no Commission enforcement action has ever been taken against any of them. The Commission has nevertheless granted a temporary waiver allowing for radio buoy operation in the 1900-2000 kHz band by commercial fishing vessels under authority of a ship station license, thus rewarding the illegal operation that caused, and continues now to cause interference to Amateur Radio operation in that band. In the *Report and Order* in this proceeding, the Commission noted the ongoing illegal use of these buoys by the U.S.

[6] These buoys have been granted equipment authorization (certification) for Part 90 licensed use, presumably because they are radiolocation devices. They have not, however, been legally operated by fishing boats pursuant to Part 90 service rules or otherwise heretofore and there apparently have not been any equipment authorization grants relative to Part 80 operation of the devices.

commercial fishing fleet "under the faulty assumption[7] that such use is permitted by their Part 80 ship station licenses."[8] The Commission noted that this was in fact illegal, but nevertheless, on a blanket basis, has temporarily granted a waiver for unlicensed radio buoy operations in the 1900-2000 kHz band by commercial fishing vessels which have a ship station license. In the instant *Notice*, the Commission now proposes to amend Part 80 of the Commission's rules to authorize radio buoy operations in the 1900-2000 kHz band permanently, under a ship station license.[9] The proposal is to make the entire 1900-2000 kHz band available to commercial fishing vessels for radio buoys on the "open sea" and to include them in the equipment authorized "as part of a ship station license." It asks for comment on this proposal.[10] There are proposed technical requirements in the rules for the radio buoys based on the existing Part 80 rules and on the operating parameters of radio buoys that are currently imported and marketed pursuant to the Part 90 rules. Specifically, the Commission proposes to authorize buoys to transmit on any frequency in the 1900-2000 kHz band, provided that the output power does not exceed 10 Watts and that the antenna height of the buoy station does not exceed 4.6 meters (15 feet) above sea level. The *Notice* also proposes rules for the use of "sel-call buoys"[11] . Based on the characteristics of sel-call equipment, the *Notice* proposes to authorize ship stations to transmit selective calling signals on all frequencies in the 1900-2000 kHz band, provided that the output power does not exceed 10 Watts, and that the station's antenna height does not exceed

[7] This presumably was the "faulty assumption" of a single manufacturer of the devices, since that is the sum total of commenters on this issue advocating for these buoys, which hardly explains, much less justifies the illegal, unlicensed use of these devices by hundreds of holders of Commission licenses.
[8] *See* the *Notice* at Paragraph 153.
[9] Vessels that are licensed by rule would have to be individually licensed in order to use radio buoys pursuant to their ship station authorization.
[10] This is an effective waiver of the equipment authorization (i.e. certification) requirements in the rules because there has been no showing whatsoever made for any of these buoys that ensures compliance with in-band or out-of-band emission limits relative to other Part 80 equipment.
[11] These are radio buoys that transmit only after receiving a selective calling signal from their associated ship station.

6 meters (20 feet) above the mast of the ship on which it is installed. There is no non-interference obligation imposed on ship station licensees using these buoys and no obligation to remedy such if reported.

5. There is, moreover a complete dearth of record justification[12] for the proposal to permit licensed radio buoys throughout the 1900-2000 kHz band, whether or not limited to operation in the "open sea."[13] As noted by ARRL in its Reply Comments in Docket 12-338, the only comment in that proceeding addressing the use of these fishing buoys was a "letter" dated February 25, 2013 filed by ITM Marine, of Federal Way, Washington (ITM). That company is an importer and distributor of marine buoys used for "USA based high seas migratory species fishing fleets in the Atlantic and Pacific Oceans." ITM stated that these devices have been used for the past 30 to 40 years (sic), and that there are at least 500 active vessels and a possible 250-500 more in the United States, which are using radio buoys (illegally, until now) to locate fishing

[12] The allocation of this band to the radiolocation service never had anything to do with operating radio buoys for fishing fleets. Until 1983, the 1800-2000 kHz band was allocated to the Amateur Service on a shared basis with the radionavigation service. In 1983, the Commission allocated the 1800-1900 kHz band to the Amateur Service on an exclusive basis, and the 1900-2000 kHz band to radiolocation on a primary basis for Federal and non-Federal use and, pursuant to Footnote US290, to the Amateur Service on a secondary basis. *Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference, Geneva, 1979*, General Docket 80-739, *Second Report and Order*, 49 FR 2358, 2360 paras. 21 and 24 (Jan. 19, 1984). The purpose of allocating 1900-2000 kHz to the radiolocation service was to provide relocation spectrum for radiolocation stations that would be moved out of the 1605-1705 kHz band when expanded-band AM broadcasting would be implemented in that band. Indeed, Section 90.103(c)(28) notes that until July 1, 1988, the band would only be available for licensees of stations which were displaced from 1605-1700 kHz, and that after that date, requests for new station authorizations would be accepted, subject to certain procedures and subject to the geographic separation requirements of Section 90.103(c)(26), since exclusive channel licensing was provided for. Therefore, operation of ocean buoys at 1900-2000 kHz has never been pursuant to an appropriately licensed United States-registered fishing vessel. *There is no indication that these buoys are compatible with other uses in the band, no track record of interference avoidance or resolution, and certainly no indication that the current operators can be relied on for compliance with the Commission's rules.*

[13] The Commission is urged to avoid enacting rules that it has no effective ability or intention to enforce. That fishing vessels have, with impunity, illegally deployed radio buoys in this band on a widespread basis (whether or not due to misrepresentations of the importers and retailers of these devices or due to a disregard of the Commission's rules generally) without even nominal enforcement actions by the Commission, provides no basis for assuming that there will be compliance with any deployment limitations (including geographic deployment restrictions) on these buoys going forward. Nor is there any basis for the assumption that there will be any enforcement action taken with respect to continued illegal operation of the buoys if and when interference is caused. Spectrum planning by the Commission in this context has to be based on *ex ante* determinations of compatibility rather than mere assumptions, especially where the record indicates such a low level of historical compliance.

nets and equipment offshore.[14] ITM claimed initially that these were "licensed for use in the 1900-2000 kHz band", but then later in its filing explained the complete absence [15] of any non-Federal licenses in the ULS database by stating that (1) since these buoys are "primarily (sic) used offshore" in "international waters" the operators did not license them for use in the USA; and (2) the owners already have licenses for the vessels' "transmitting equipment" and believed that the buoys fall under their licenses as "ship's equipment." Neither of those cavalier explanations had any validity,[16] and in fact, these hundreds of deployed buoys have been and are used without any regard whatsoever for the potential interference caused. For years, radio Amateurs, who utilize exceptionally sensitive receivers in the MF range, have suffered (1) ongoing interference in the 1900-2000 kHz band from these illegal, unlicensed ocean buoys (which is not surprising given the large numbers of them),[17] and (2) the complete absence of any practical, enforceable limitation on the geographic area of deployment, except on an anecdotal (and thus ineffective) basis. It is unclear how, if the Commission should enact the proposed Part 80 rules providing for blanket licensing of these devices, it intends to enforce any restrictions on the geographic areas of deployment of them, or to prevent their use in inland waters. The simple

[14] The record is silent heretofore as to the need to use radio buoys in this frequency range. There is no information as to the necessary path distances for these devices and why a band with very long distance propagation is necessary for these buoys rather than VHF or some other suitable alternative.

[15] As of July, 2012, according to the *Notice* in this proceeding, the Commission's Universal Licensing System (ULS) database showed no non-Federal radiolocation licensees at 1900-2000 kHz.

[16] No reading of 47 C.F.R. § 80.17(a)(4) or of *Amendment of the Commission's Rules Concerning Maritime Communications*, PR Docket No. 92-257, *Second Report and Order and Second Further Notice of Proposed Rule Making*, 12 FCC Rcd. 16949, 16978 at para. 54 (1997) ["each applicant for a new ship station license will be automatically authorized to operate a marine VHF radio, a single-sideband radio, any type of radar or emergency position indicating radio beacon (EPIRB), on-board communications equipment, and satellite communications equipment"] could possibly allow a reasonable assumption that these buoys were authorized under a ship license heretofore. Authorization for use of such equipment had to be specifically requested.

[17] ITM's statement in their comments in Docket 12-338 that the 1900-2000 kHz band is "getting crowded" refers apparently to the burgeoning numbers of illegal buoys and the number of Amateur stations using the band. If the perception in the fishing community is that the band is crowded for these illegally operated buoys, it is easy to imagine what the RF environment is for Amateur Radio licensees attempting to *legally* use the allocation that they have had all along. The "crowded band" argument is in effect an admission by ITM that the band is unsuitable for ongoing radio buoy operation due to incumbent use.

fact is that the Commission has taken no action over the past "30 to 40 years" to enforce its rules relative to the deployment of these unlicensed buoys or to protect the Amateur Service from interference. Amateur Radio operators therefore have no confidence that the Commission has the enforcement resources or a sufficient interest in addressing interference to the Amateur Service from these devices going forward.

6. ARRL has not quantified the interference from these radio buoys to date and there is no good way to do so in the short term. However, Amateur Radio operation in the 1900-2000 kHz band is substantially hampered by interference from these buoys.[18] Since no commenter in Docket 12-338 made a showing of need for the operation of these devices in this band in particular, there is no record justification for the proposed amendment of Footnote NG92 of the table of allocations to provide for operation of radio buoys in the 1900-2000 kHz band in the maritime mobile service on a primary basis in Regions 2 and 3, restricted to radio buoy operations on the open sea.[19] The Commission's concurrent proposal to limit the harmful interference protection for stations in the Amateur Service only to the extent that radio frequency radiation exceeds the level which would be present if the buoy is operating in compliance with the technical standards or criteria applicable to the service in which it operates is neither a helpful nor practical metric for determining when harmful interference is actionable and again, it is largely unenforceable in this context. First of all, the interference test does not address the

[18] The radio buoys are typically narrow bandwidth devices, operating typically with an occupied bandwidth of one kilohertz. The Commission asks whether there should be bandwidth limitations for these devices or channelization requirements. This narrow bandwidth, and the relatively high EIRP levels makes co-channel operation with an amateur station problematic. Channelization of the buoys is not helpful in establishing compatibility between these buoys and Amateur station operation due to the absence of channelization and variable emission types in the Amateur Service, unless the number of channels within the 1900-2000 kHz band available to radio buoys is limited.

[19] The Commission claims that its proposed footnote restricting buoy operation to the open sea is based on the areas where radio buoys are in use now, and that the restriction would provide greater protection for amateur stations by excluding radio buoys from "inland waters." Neither radio amateurs nor the Commission have the practical ability to police this requirement, and the record to date indicates that neither the manufacturer of the buoys nor the fishing fleet can or should be relied on for compliance with this requirement.

aggregate adverse effect of the proliferation of these buoys on the RF environment at 1900-2000 kHz, even if they do operate at the technical parameters proposed. That is not an assumption that follows from a current understanding of the RF environment in this band now. Second, the proposed technical standards for buoy operation are quite liberal, given the fact that salt water provides an excellent ground, assuring long distance propagation of the signals from these buoys, especially at night and over grey line paths.[20] ARRL estimates that the EIRP from these buoys over a salt water ground is between 1-5 watts each and there is no record evidence that such a substantial EIRP is necessary to serve the needs of the United States' fishing fleet. Third, the Amateur station suffering the interference has no ability whatsoever to determine the operating parameters of a given buoy (and neither does the Commission) and therefore no ability to establish whether or not the harmful interference that disrupts his or her communications is actionable. The Commission has not a proper foundation in this proceeding to proceed with a permanent authorization for radio buoys, and it should not adopt the proposed, unique determinant for what constitutes actionable harmful interference.

7. Given the foregoing, should the Commission proceed with its proposal to amend Section 80.375 of the Rules to make the 1900-2000 kHz band available to commercial fishing vessels for use by radio buoys on the open sea and to include them in the equipment authorized as part of a ship station license, it should not do so by means of a primary allocation for these devices in ITU Regions 2 and 3 as proposed. The entitlement to utilize radio buoys should be on a secondary basis to the Amateur Service (and other radio services operating in the 1900-2000 kHz band), and the buoys should be prohibited from causing harmful interference to Amateur stations *without qualification*. The proposal to protect Amateur stations from harmful

[20] There is somewhat less concern about sel-call buoys than for normal buoy operation due to the reduced duty cycle of the former.

interference only to the extent that radiation from an individual buoy exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates is not a workable proposal.

8. The Commission notes that, while most radio buoys currently operate in the radiolocation service, some also transmit their GPS coordinates, and thus, the associated ship station does not necessarily use radio direction-finding to locate these radio buoys. The *Notice* proposal to allocate the 1900-2000 kHz band to the maritime mobile service would support the transmission of a radio buoy's GPS coordinates and other data, such as the identification number of the buoy and water temperature. The Commission proposes to add a note to Section 80.375(f) to specify that such use is permitted. ARRL suggests that the transmission of GPS coordinates of radio buoys should be mandatory, or alternatively that some other unencrypted means of identification of the buoys should be required in order that the source of harmful interference could be identified. This requirement should apply to all radio buoys, including those already deployed.[21]

9. Lastly, the Commission asks a series of questions involving alternatives or supplemental provisions to the *Notice* proposals. First, it is asked whether the deployment of radio buoys should be restricted to the open sea. This proposed requirement is based on a determination of the areas where radio buoys appear to be in use, and because excluding radio buoys from "inland waters."[22] would allegedly provide greater protection for Amateur stations due to geographic separation. Nevertheless, the Commission asks for comment from those who

[21] The Commission notes (*see*, the *Notice*, at footnote 351) that some buoys now transmit their GPS position to their associated fishing vessel via satellite communications, "which suggests that the need for additional spectrum for traditional radio buoys may be reduced or obviated." *Citing* Marine Star sel-call buoy (SV-1800 Type). *and* "Evolution of Radiobuoys Technology for FADS[:] Past, Present and Future," Marine Instruments presentation, Oct. 2012 (available at http://ebfmtuna-2012.sciencesconf.org/file/23474).

[22] "Inland waters" means the waters shoreward of the territorial sea baseline. 33 C.F.R. § 2.26.

believe that radio buoys are necessary in the Chesapeake Bay, the Great Lakes, or other inland waters. There is no record justification for allowing such authority, nor any indication of compatibility of radio buoys at close geographic separation from Amateur receivers at 1900-2000 kHz. As such, it is urged that any inland use of radio buoys, if indeed there is any justification for them at all, should be in a band not shared with the Amateur Service.

10. The *Notice* also asks whether new radio buoy use should be transitioned to another MF band, and, if so, how the costs to manufacturers and operators would relate to benefits that Amateur operators may realize from such a transition. The *Notice* asserts that the domestic table of allocations includes an allocation at 1705-1800 kHz band for the radiolocation and mobile services on a primary basis for Federal and non-Federal use and that the upper 50 kilohertz of this band, 1750-1800 kHz is "lightly used." The Commission has found as well that all of the MF radio buoy transmitters currently being marketed are capable of operating in the 1750-1800 kHz band. Therefore, given the absence of any definitive studies showing that there is compatibility between ocean buoy operation at 1900-2000 kHz and Amateur radio operation, and because the only justification for such deployment is historical, unlawful operation of those buoys in that band (which the manufacturer of these devices admits is "getting crowded"), the conclusion is apparent that any new radio buoys should be operated in the 1750-1800 kHz band. Moreover, a sunset date for 1900-2000 kHz buoys should be established for those currently deployed.

III. The 2200 Meter (135.7-137.8 kHz) and 630 Meter (472-479 kHz) Bands.

11. Because the *Report and Order* in this proceeding adds a secondary allocation for the Amateur Service to the 2200 meter band (as does RR 5.67A) which limits Amateur stations in the band to a maximum radiated power of 1 W EIRP, the *Notice* asks for suggestions for Part 97 service rules for that band. The *Notice* also proposes to allocate the 630 meter band to the

Amateur Service on a secondary basis and with that Part 2 allocation proposes a footnote, RR 5.80A, which would limit U.S. amateur stations to a maximum power of 5 W EIRP in that band. The *Notice* also asks for comment on service rules for amateur stations that promote compatibility with PLCs.

12. PLC systems[23] operate pursuant to Section 15.113 of the Commission's rules on an "unprotected and non-interference basis" with respect to licensed services[24] in the 9-490 kHz

[23] A PLC system is an "unintentional radiator" used by an electric power utility entity on transmission lines for protective relaying, telemetry, *etc*., for general supervision of the power system. An unintentional radiator is a device that intentionally generates RF energy for use within the device, or that sends RF signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction. 47 C.F.R. §§ 15.3(t), (z). PLC systems operate by the transmission of RF energy by conduction over the electric power transmission lines of the system. PLC systems do not include those electric lines which connect the distribution substation to the customer or house wiring. PLC systems "are subject only" to the requirements specified in Section 15.113 (47 C.F.R. § 15.113) and operate within the 9-490 kHz band "without a limit on the level of radiated emissions that leak from the power lines." Revision of Part 15 of the Rules regarding operation of radio frequency devices without an individual license. GEN Docket No. 87-389, *Memorandum, Opinion and Order*, 5 FCC Rcd 7060, para. 3 (1990).

[24] Section 15.113 presently states as follows:

> Power line carrier systems.
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> Power line carrier systems, as defined in § 15.3(t), are subject only to the following requirements:
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> (a) A power utility operating a power line carrier system shall submit the details of all existing systems plus any proposed new systems or changes to existing systems to an industry-operated entity as set forth in § 90.35(g) of this chapter. No notification to the FCC is required.
>
> (b) The operating parameters of a power line carrier system (particularly the frequency) shall be selected to achieve the highest practical degree of compatibility with authorized or licensed users of the radio spectrum. The signals from this operation shall be contained within the frequency band 9 kHz to 490 kHz. A power line carrier system shall operate on an unprotected, non-interference basis in accordance with § 15.5 of this part. If harmful interference occurs, the electric power utility shall discontinue use or adjust its power line carrier operation, as required, to remedy the interference. Particular attention should be paid to the possibility of interference to Loran C operations at 100 kHz.
>
> (c) Power line carrier system apparatus shall be operated with the minimum power possible to accomplish the desired purpose. No equipment authorization is required.
>
> (d) The best engineering principles shall be used in the generation of radio frequency currents by power line carrier systems to guard against harmful interference to authorized radio users, particularly on the fundamental and harmonic frequencies.
>
> (e) Power line carrier system apparatus shall conform to such engineering standards as may be promulgated by the Commission. In addition, such systems should adhere to industry approved standards designed to enhance the use of power line carrier systems.

segment. They are restricted to operating only on transmission lines and "therefore, in general, do not operate in residential areas" according to the *Notice*. Because of this, and because the Amateur Service is expected to use the bands mainly for experimental purposes (and thus non-intensively), the *Notice* states the Commission's confidence that, with certain technical rules, amateur stations can operate on the same frequency bands as PLC systems without adverse interaction. Indeed, the history of PLC operation indicates that the presence of licensed transmitters in the band 9-490 kHz has not adversely affected PLCs.[25] Nevertheless, the *Notice* asks for comment on any necessary physical separation between Amateur stations and the transmission lines upon which PLC systems operate. The *Notice* proposes that Amateur stations should be permitted to operate in both the 2200 and 630 meter bands only when separated from transmission lines by some specified minimum distance and only from fixed locations (i.e. fixed or temporary fixed locations). Mobile operation would not be permitted. The *Notice* does not identify a specific minimum separation distance between the Amateur antenna and the nearest PLC-carrying transmission line. Whatever it is, that separation, together with limits on Amateur station EIRP and antenna heights, should be sufficient (according to the *Notice*) to ensure compatibility, but the *Notice* asks for comment on that general regulatory paradigm nevertheless.

13. The *Notice* also asks for detailed comment on the technical characteristics of PLC systems and Amateur stations in order to develop appropriate Part 97 service rules, asserting that the record heretofore in Docket 12-338 did not contain sufficient data in order to establish a

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> (f) The provisions of this section apply only to systems operated by a power utility for general supervision of the power system and do not permit operation on electric lines which connect the distribution substation to the customer or house wiring. Such operation can be conducted under the other provisions of this part.

[25] See, Hohn, J.W., et al., *Power Line Carrier Practices and Experiences*, IEEE Transactions on Power Delivery, Vol. 10, No. 2, April 1995 (Survey of power utilities shows that authorized RF systems are not an interference problem for PLC systems; PLC system operators have little concern about interference from licensed systems; 88 percent of surveyed utilities report no interference problems from LF stations.)

minimum separation distance between Amateur stations in these two bands and PLC systems.[26] ARRL submitted to the Commission in Docket 12-338 a technical analysis based on a technical report published by the National Telecommunications and Information Administration (NTIA). These supported the argument that PLC systems at 2200 meters will be sufficiently protected from amateur stations transmitting at an EIRP of 1 W with a separation distance of 1 km from the transmission lines carrying the PLC signals, beyond which there is no interference potential at all, and therefore no need for regulatory restrictions.

14. The NTIA TR-85-181 Study[27] which has not been alleged, much less shown to be outdated or invalidated in any way, evaluated the compatibility of PLC systems and relatively high-powered licensed transmitters[28] operating in the same frequency range as PLC systems. When the methodology of that study is applied to proposed amateur allocations at 2200-meter frequencies, the potential for interference is determined to be very low overall, and the only area for any concern whatsoever is those Amateur stations that may be located closer than 1 km to an existing transmission line carrying PLC signals in that frequency range. At distances of 1 kilometer or greater, Amateur Radio operation at the 1-watt EIRP level on a co-channel basis with PLC facilities at 2200 meters[29] will create signal strengths *at least 6 dB lower* than the field

[26] ARRL filed comments in February of 2013 in Docket 12-338, establishing that there is not any interference potential whatsoever from Amateur stations at 135.7-137.8 kHz to PLC systems carried on transmission lines upstream from distribution substations *at geographic separation distances greater than 1 kilometer from the transmission line carrying PLC signals*. ARRL's reply comments in March of 2013 in that proceeding suggested a *notification* requirement for Amateur stations whose station locations called for operation at LF within 1 km of a transmission line. ARRL offered to act as a clearinghouse for information about such operations if that is determined to be necessary.

[27] Andrew Farrar et al., Evaluation Techniques—Fixed Service Systems to Power-Line-Carrier Circuits; NTIA Report 85-181 (1985).

[28] There are three licensed stations within the 472-479 kHz range now shown in the ULS. All are maritime coast stations: WNE at 472 kHz, and Globe Wireless assignments at 476 kHz (KFS) and 478 kHz (WNU). The authorized ERPs for these stations are 5,000 watts for WNE, 30,000 watts for KFS, and 17,600 watts for WNU.

[29] The study did not address the 630-meter band or operation at 5 watts EIRP now proposed in the instant *Notice*. However, the fact that there are far fewer PLCs operated in that band (see discussion *infra*) makes the power level proposed at 630-meters a non-issue.

intensity that the NTIA determined would allow PLC systems to function reliably in the presence of licensed emitters. This 6 dB margin is based on worst-case assumptions. The polarization difference between Amateur Radio vertical antennas that will typically be used on this band and horizontally configured power lines would provide an additional margin of interference protection. Therefore, based on the (reasonable) assumptions of NTIA Study TR-85-181, amateur operation at the 1 watt EIRP level will not under any circumstances create predictable interference to PLC systems used on transmission lines at separation distances at or beyond one kilometer and no regulatory obligations need be considered for Amateur stations operated outside that distance.

15. Notwithstanding the foregoing, the likelihood of an Amateur station conducting operations in the 2200- or 630-meter bands from a fixed station located less than 1 kilometer from a PLC-carrying transmission line upstream from a distribution substation is so low[30] that a notification requirement would be more than sufficient to provide a reasonable level of protection for existing PLCs in those instances. Consider the following: (1) many transmission power lines do not carry PLC at all; [31] (2) most PLCs do not use the very small Amateur allocations at 2200 or 630 meters; and (3) the purpose of this band for radio amateurs is experimentation; all equipment and antennas must be constructed by the licensees themselves; and therefore the Amateur use of the bands for the foreseeable future is expected to be considerably less than the 160-meter or higher frequency bands. To preclude any adverse

[30] Because Amateur stations must avoid high ambient noise areas in order to make use of the LF, MF or HF bands generally, they will not locate LF stations near transmission lines, because the noise from the lines (whether or not unrelated to PLC) will inhibit or preclude two-way Amateur communications or reception of propagation beacons in the LF allocation in close geographic proximity to the line.

[31] Section 15.3(t) of the Commission's rules [47 C.F.R. § 15.3(t)] permits PLC operation by conduction over the electric power transmission lines of the system. The definition in Section 15.3(t) states that "(t)he system does not include those electric lines which connect the distribution substation to the customer or house wiring." Therefore, PLCs are not found in residential areas, where the vast majority of fixed Amateur Radio stations operating below 50 megahertz are located.

interaction in those rare instances in which an Amateur LF station would be located closer to a transmission line carrying PLC signals than one kilometer, the rules could reasonably require advance notification to the utility involved. Should the notified utility object to a given Amateur Radio operation in these two bands within a limited period of time thereafter, based on a substantial, quantitatively documented interference concern, the radio Amateur would be expected to, and would obviously want to work with the utility to reach an accommodation that does not involve disruption of the PLC system operation or preclude the Amateur operation. However, the available remedies in such rare circumstances should include use by the utility of alternate frequencies for the PLC system[32] as well as technical solutions involving the Amateur station.

16. The locations and frequency uses of individual PLC systems[33] are known and knowable. Under the Commission's rules, a power utility operating a PLC system is required to submit the details of all existing systems plus any proposed new PLC systems or changes to PLC existing systems to an "industry-operated entity."[34] Existing LF and MF PLC systems are subject to 47 C.F.R. § 90.35(g), the provisions of which are repeated in all relevant substance in the *NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management* (the "NTIA Redbook"), at § 8.3.27. Section 90.35(g) (2014) reads as follows:

[32] It is possible for PLC systems to notch, or make no use of the two small segments of the 9-490 kHz band at issue, because the current state of the art for PLC systems permits frequency agility. *See also* the following footnote.
[33] *See*, the 2002 article in IEEE Transactions on Power Delivery entitled *Evaluation of the Potential for Power Line Carrier (PLC) to Interfere With Use of the Nationwide Differential GPS Network* (Silva, Michael, Senior Member, IEEE and Whitney, Bruce, Member, IEEE), Volume 17, No. 2, April, 2002. The article stated that, of the 28,816 PLC transmitters that reportedly existed in March, 1999 in the United States, 8,788 operated in the band 100-150 kHz. Even if all of those PLC transmitters that operated *somewhere* in the 100-150 kHz band in 1999 are still operational, and even if <u>any</u> of those which were operating in 1999 and which are still operational now are presently operating in the 2.1 kHz segment 135.7-137.8 kHz, it would surely be reasonable for utilities to retune those very few PLC transmitters less than 4 kilohertz (the maximum occupied bandwidth of a PLC signal), which is *less than 1 percent of the available operating frequencies for PLC systems at LF and MF*.
[34] 47 C.F.R. §§ 15.113(a), 90.35(g). Currently, the Utilities Telecom Council (UTC) acts in this capacity.

> The frequencies 9-490 kHz are used to operate electric utility Power Line Carrier (PLC) systems on power transmission lines for communications essential to the reliability and security of electric service to the public, in accordance with part 15 of this chapter. Any electric utility that generates, transmits, or distributes electrical energy for use by the general public or by the members of a cooperative organization may operate PLC systems and shall supply to a Federal Communications Commission/National Telecommunications and Information Administration recognized industry-operated entity, information on all existing, changes to existing, and proposed systems for inclusion in a data base. Such information shall include the frequency, power, location of transmitter(s), location of receivers and other technical and operational parameters, which would characterize the system's potential both to interfere with authorized radio users, and to receive harmful interference from these users. In an agreed upon format, the industry-operated entity shall inform the FCC and the NTIA of these system characteristics prior to implementation of any proposed PLC system and shall provide monthly or periodic lists with supplements of PLC systems. The FCC and NTIA will supply appropriate application and licensing information to the notification activity regarding authorized radio stations operating in the band. PLC systems in this band operate on a non-interference basis to radio systems assigned frequencies by the NTIA or licensed by the FCC and are not protected from interference due to these radio operations.

UTC, which is acting as the "recognized industry-operated entity" referenced in § 90.35(g) and subsection 2 of NTIA Redbook § 8.3.27, maintains a comprehensive web site at http://www.utc.org/plc-database, which provides references to the regulations cited above; instructions to utilities on how to submit and update information;[35] instructions to utilities for calculating an annual assessment (presumably, a financial assessment for the maintenance of the database which is based on the number of transmitters); forms and instructions (including paper forms - last updated in 1983 - for collecting system contact information and transmitter/receiver information).

17. Assuming that these procedures are followed by utilities operating PLC systems and that the database is current as per the Commission's Rules, it can be concluded that the location and characteristics, operating frequency, and bandwidth of each and every PLC system in the

[35] This page emphasizes that a utility must submit information in advance of operation to "verify there will be no interference with *federal* frequency use" (emphasis added). This is an incomplete statement of the required verification; the plain language of § 90.35(g) specifies that PLC systems operate on a non-interference basis to stations licensed by the Commission.

United States is known to UTC and knowable by others. The number of PLC transmitters and receivers operating in or receiving within the internationally allocated amateur segments is also known to UTC and knowable by others. And there is a mechanism and form by which existing licensed users of the LF spectrum, through the Commission and NTIA, inform UTC of authorized LF and MF radio stations within 9-490 kHz.[36] It would seem, using the Section 90.35(g) procedure as a model, that those few individual radio Amateurs who wish to commence operation in the 2200- or 630-meter bands within one kilometer of a transmission line could simply provide notification to UTC (or to the local utility) prior to commencing operation and, if no specific objection is received within a reasonable time (such as 30 days), then the operation could commence. Since the database already exists, and since the notification procedure to UTC from the Commission and from NTIA relative to licensed LF stations is already in place, the process seems well-suited to add Amateur notification in those few instances where it would be beneficial. If the database is not up-to-date currently, creating a notification procedure for Amateur Radio facilities proposing to operate within one kilometer of a transmission line carrying PLC would serve as a positive incentive to utilities to comply with the requirement to provide data to UTC, thus to improve the quality of the database.

18. Indeed, the appropriateness of notification procedures versus formal advance coordination is well-established in connection with LF PLC system operation. In 1982, in General Docket 82-9, which was initiated to consider establishment of what is now Footnote US2 (formerly US294) in the Table of Allocations (for the purpose of recognition of PLC

[36] UTC's web site referenced above, however, makes reference to "10-490 kHz."

systems and to provide for notification by other users of the LF and MF spectrum to utilities), the Commission stated[37] as follows:

> Based on several comments in the proceeding [which] incorrectly speak of coordination rather than notification and of maintaining existing status of PLC relative to other Part 15 users, the Commission seeks to dispel any misunderstanding concerning the intent of this proceeding. Accordingly, the Commission wants to reaffirm its position that this proceeding does not elevate the status of PLCs in any way and that their operation in the band must be on an unprotected, noninterference basis to authorized users operating under Part 15 provisions. Cooperation between parties to the extent practicable is expected but, in any event, the PLC users must realize that in the event conflicts on spectrum usage cannot be resolved on a cooperative basis, their operation on an unprotected, noninterference basis must adjust to meet the requirements of the authorized radio users.

The language in the footnote[38] was intended to urge, but not require, cooperation in preventing potential interference.[39] The admonition was in the nature of a notification action. The Commission eschewed mandatory language requiring cooperation/coordination because "the stricter … language could be misinterpreted to convey that Commission or NTIA intervention

[37] See*, Amendment of Parts 2, 15 and 90 of the Commission's Rules to Provide Recognition for Power Line Carrier Operations of Electric Utilities in the Bands 10-490 kHz,* Report and Order, 48 Fed. Reg. 5922, 52 Pike & Fischer Radio Regulation 2d 1713 (1983).

[38] Footnote US2 (formerly, prior to renumbering, US294 which was identically worded) reads as follows:

> In the band 9–490 kHz, electric utilities operate Power Line Carrier (PLC) systems on power transmission lines for communications important to the reliability and security of electric service to the public. These PLC systems operate under the provisions of 47 CFR part 15, or Chapter 8 of the *NTIA Manual,* on an unprotected and non-interference basis with respect to authorized radio users. Notification of intent to place new or revised radio frequency assignments or PLC frequency uses in the band 9–490 kHz is to be made in accordance with the Rules and Regulations of the FCC and NTIA, and users are urged to minimize potential interference to the extent practicable. This footnote does not provide any allocation status to PLC radio frequency uses.

[39] Footnote US2 makes it clear that PLC systems operating in this band are unprotected, and it is therefore anomalous for the Commission to require notification of a licensed service's operations to a representative of users of unlicensed, unallocated low power RF devices. However, it could be practical in this unique instance to implement a limited notification plan due to the anticipated low level of amateur occupancy of this band overall; its nominal bandwidth; and the resultant exceptionally low likelihood of location of an Amateur Station experimenting with LF communications being located at distances of less than 1 kilometer from a power line carrying PLC in that small frequency segment.

for enforcement purposes is expected if parties will not cooperate, a situation which would implicitly elevate the status of PLC operators in an unintended manner." [40]

19. Therefore, because of the extremely limited size of the 2200- and 630-meter bands, and the very low likelihood of co-channel operation in either band between Amateurs and PLCs situated less than 1 kilometer apart, there is no justification for a regulatory requirement more stringent than 30-day advance notification by the Amateur station in that situation to either the utility directly or to UTC. This Commission has repeatedly noted that sharing of spectrum is necessary now and in the future, to maximize efficient deployment of this limited resource. PLC operation represents an exceptionally *inefficient* use of the entirety of the 9-490 kHz band, and yet, until now, PLC operation has served as the basis for precluding other uses of that large band. In connection with the notification procedure, there must be provisions to ensure against frivolous claims of interference potential. Within 30 days of submitting the required information about his or her planned operation to the utility directly or to UTC, the radio Amateur must be able to proceed on a negative-option basis; or else receive an explanation from the utility or UTC with a technical justification for any objection based on actual calculations.

20. In order to accurately evaluate whether there is a regulatory need for any separation distance between Amateur stations operating in the 2200- or 630-meter bands, the *Notice* asks a series of questions about the technical characteristics of PLC systems. First, it asks how tolerant PLC systems are of signals received from other stations transmitting in the same band, and what RF field strengths at the location of a transmission line will cause a PLC system operating on that line to malfunction. ARRL has little data about these points other than that which is included in the NTIA TR-85-181 Study. Figure 47 of that study, reproduced below, establishes the field

[40] Op.cit. *Amendment of Parts 2, 15 and 90 of the Commission's Rules to Provide Recognition for Power Line Carrier Operations of Electric Utilities in the Bands 10-490 kHz, Report and Order, 48 Fed. Reg. 5922, at ¶12*

intensity resulting from adverse weather present at power lines of different configurations. The noise power induced onto a transmission line configured for PLC during adverse weather sets the noise floor of the PLC System's link budget. This would establish in turn the level of susceptibility to interference in general terms. As a practical matter, interaction between licensed radio stations and PLC systems has historically been effectively nonexistent. [41]

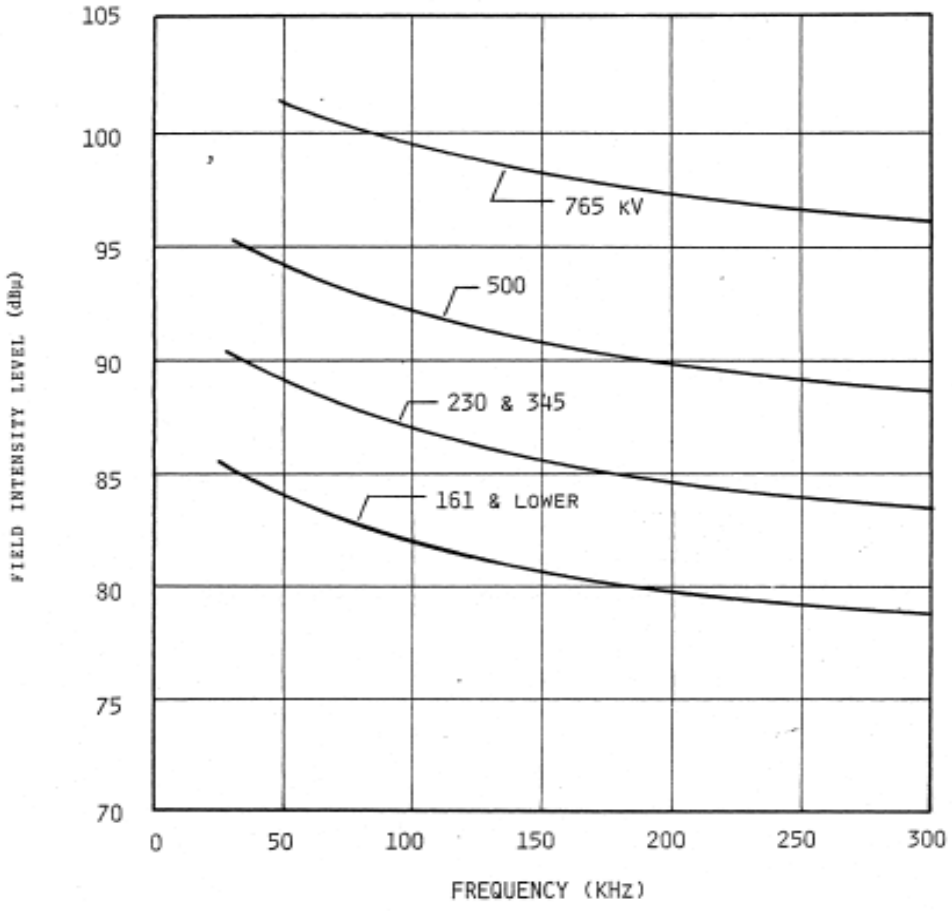

Figure 47. Field Intensity Levels From a Radio Transmitter Near a Transmission Line.

[41] *Op. cit. footnote 24;* Hohn, J.W., et al., *Power Line Carrier Practices and Experiences,* IEEE Transactions on Power Delivery, Vol. 10, No. 2, April 1995.

Figure 47 from NTIA TR-85-181 Adverse Weather Noise Floor Presented as Field Intensity (in dBu/m) versus Frequency. This shows the field intensity resulting from adverse weather present at power lines of different configurations.

21. PLC systems are required by Commission rule to comply with industry standards for immunity. Specifically, PLCs must "adhere to industry approved standards designed to enhance the use of power line carrier systems."[42] This rule is obviously intended to facilitate additional overlay uses in the same LF or MF spectrum. PLC systems are or can be capable of compatible sharing through the frequency agility of PLC transmitters (either using software-defined radio equipment or by simply notching small segments of the 9-490 kHz band available to them) and more especially by PLC system design in compliance with the immunity standard IEEE-1613-2009. That standard sets a high bar for immunity of PLC systems. ARRL has argued in Docket 12-338 that this standard, if met, would virtually guarantee that there would be no interaction between Amateur Stations and PLC systems in this range, even of the latter were operated on a co-channel basis.[43] Compliance with this standard is clearly called for by Section 15.113 of the Commission's rules, and PLC devices sold to utilities and placed within substations since 2002 have been subject to this standard. If that rule is complied with, current immunity standards will preclude interaction between Amateur stations operating at LF or MF at the operating parameters proposed in the *Notice*. In this respect, it is instructive to note that the PLC systems operating in the lower portions of the 9-490 kHz band internationally utilize "listen-before-transmit"

[42] See, 47 C.F.R. §15.113(e).

[43] IEEE standard (1613-2009) – *IEEE Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations*. Because the Commission's rules require that PLC systems conform to engineering standards promulgated by the Commission and adhere to industry approved standards designed to enhance the use of PLC systems, the *Notice* asks whether compliance with this IEEE standard is required by the Commission's rules as an industry approved standard designed to enhance the use of PLC systems. Clearly, if Section 15.113(e) means anything at all, it means that this IEEE standard applies to PLC systems. The *Notice* then asks whether compliance of PLC systems with this standard facilitate the sharing of these bands between amateur stations and PLC systems. The answer is that it would and it does. The industry, in ARRL's experience, has a good track record of compliance with this standard. There may surely be PLC systems deployed that do not comply with this standard, and if so, they should not be entitled to assert an interference claim, even as deployed systems. ARRL reiterates that compliance with this standard, among other things, obviates any need for Amateur stations to maintain a specific separation distance from transmission lines.

protocols. Pursuant to CENELEC[44] international standards, the lower part of the frequency range 9-490 kHz is segmented. Under the applicable CENELEC standard, 3 to 95 kHz is designated for "utility" use (Band A). Band B, 95-125 kHz, is designated for consumer use. Band C, which includes135.7-137.8 kHz, is designated for consumer use, with a mandated carrier-sense, multiple-access protocol (CSMA).[45] This requires that the PLC devices listen before transmitting, to avoid interference between devices or to sensed carriers from external sources, such as licensed radio services. The fact that these devices are mandated to wait some unspecified period of time before transmitting in this part of the band means that the only applications that can be put there are those that can tolerate having to wait occasionally without causing significant harm to the desired operation of the device or system.

22. The Commission next asks what types of malfunctions the electric power grid might experience from electrical interference; how many PLC systems are currently operating in the 2200 and 630 Meter bands; whether existing PLC systems can be modified; and whether new PLC systems can be designed to operate in other portions of the 9-490 kHz band, thus avoiding co-channel operation with Amateur stations. While ARRL cannot speak to the extent to which existing PLC systems can be modified, newer PLC systems apparently are both frequency programmable and frequency agile, and they can therefore be designed or modified to operate outside the 2200- and 630-meter bands at no cost to utilities. As to the number of PLC systems operating within the small 2200-meter and 630-meter segments, utilities can provide information as to the former. With respect to the 630-meter segment, there is apparently almost no PLC operation at all. According to the 2002 article in *IEEE Transactions on Power Delivery* entitled

[44] CENELEC, the European Committee for Electrotechnical Standardization, is responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of harmonized worldwide markets.
[45] CSMA is a probabilistic Media Access Control protocol in which a node verifies the absence of other traffic before transmitting on a shared transmission medium, such as a frequency band segment.

Evaluation of the Potential for Power Line Carrier (PLC) to Interfere With Use of the Nationwide Differential GPS Network (Silva, Michael, Senior Member, IEEE and Whitney, Bruce, Member, IEEE),[46] of the 28,816 PLC transmitters that existed in the United States in 1999, *only 20 operated anywhere in the band 450-490 kHz*.[47] Of that 40 kHz-wide segment referred to in that article, only 7 kHz is proposed to be allocated domestically to the Amateur Service now. Therefore, even if any of those 20 PLC transmitters that operated *somewhere* in the 450-490 kHz band in 1999 are still operational 16 years later, and even if any of those which were operating in 1999 and which are still operational are presently operating in the small segment 472-479 kHz, it would surely be a simple matter indeed to retune those very few PLC transmitters less than 4 kilohertz,[48] which is less than 1 percent of the available operating frequencies for PLC systems at LF and MF. So, very little adjustment would be required, if any would be called for at all, and it would be a simple, no-cost process to do so.

23. The *Notice* next asks at what power level PLC systems operate, and how long the transmission lines are over which they send signals; at what voltage level the transmission lines upon which PLC systems are deployed operate; and how the PLC systems' tolerance of other signals depend on the voltage level. A related question is what electric field strengths are produced in the vicinity of transmission lines by PLC signals traveling over the transmission lines. The regulatory answer to these questions is that there are presently no rules limiting the power that PLCs can use. There are no conducted or radiated emission limits for PLC systems in this frequency band. So, the radiated emission levels from PLC systems are effectively

[46] Volume 17, No. 2, April, 2002.
[47] By contrast, 1,169 transmitters operated at that time at 10-50 kHz; 5,986 operated at 50-100 kHz, 8,788 operated at 100-150 kHz, 8,897 operated at 150-200 kHz, and 989 operated at 250-300 kHz. Above 200 kHz, the number of transmitters drops off very rapidly.
[48] The operating bandwidth of PLC transmitters (defined as that within 3 dB of the peak response) is generally less than 3.4 kilohertz, according to the IEEE article cited hereinabove.

unlimited. Because the radiated emissions from PLC systems and radio noise from transmission lines generally dictate as a practical matter how close geographically an Amateur receiver can be located to a co-channel PLC system on a transmission line, the potential for interference to PLCs from Amateur stations in the 2200-meter and 630-meter bands will be largely self-regulating.

24. The *Notice* calls for information about the technical characteristics of amateur stations and the results of experimental licensing in these bands by Amateurs. The Commission asks what electric field strength generated by PLC systems operating on transmission lines would impede the operation of Amateur stations. The *Notice* cites a study conducted on a PLC system operating at 1 W at 152 kHz, which found that the PLC system generated an electric field strength of 20 dbμV/m at 1 km,[49] and asks whether a signal with this field strength would interfere with the operation of Amateur stations. The Commission notes that, given that high-voltage transmission lines generate a significant level of noise at this frequency range, it is relevant to the issue of how close to high-voltage transmission lines Amateur stations can operate as a practical matter. Attached hereto as **Exhibit A** is a paper entitled *Harmful Interference from Existing PLC Systems to Stations in the Amateur Radio Service Operating in the Low Frequency and Medium Frequency Bands* prepared by Mr. Ed Hare, ARRL's Laboratory Manager. Mr. Hare's study, which was based in part on some antenna modeling, concludes among other things that, at the frequencies used by PLC systems, electrical transmission lines are not efficient antennas and do not radiate much of the PLC signal that is differentially coupled onto the lines. Transmission lines can also be noisy, making it unlikely that any PLC emissions will be greater than the ambient noise levels commonly found on these frequencies near transmission lines. It is therefore not likely that Amateurs will choose to operate on these bands if their antennas must be

[49] R.C. Madge, G.K. Hatanaka, *Power Line Carrier Emissions from Transmission Lines*, 7 IEEE Transactions on Power Delivery 1775, 1776 (Oct. 1992).

located very close to transmission lines. Amateurs have also established an excellent record of configuring their stations to minimize noise, and of attempting to work cooperatively with operators of noisy devices, typically seeking FCC enforcement in only the most egregious interference cases. For these reasons, harmful interference to Amateur stations from PLC systems, and complaints of the same, are unlikely. For a number of reasons discussed in the study, harmful interference from PLC systems to Amateur Radio is not likely to result at distances greater than 300 meters from a transmission line carrying PLCs.[50]

25. The *Notice* at paragraph 171 discusses the relatively large number of Amateur stations which have operated in these bands under experimental licenses, with most licenses permitting powers of between 1 to 20 watts ERP.[51] The *Notice* asks how close these Amateur stations have operated to transmission lines; and whether any of these Amateur stations received signals from PLC systems operating on transmission lines. Indeed, ARRL has sponsored an extensive course of experimentation in the MF spectrum near 500 kHz since 2006. In September of 2006, a group of 23 Amateur stations scattered throughout the United States was permitted to operate in the band 505-510 kHz for a course of experimentation with propagation and interference testing. See, Experimental License WD2XSH, File No. 0105-EX-PL-2005. This experiment has been extended several times.[52] Over time, the number of participating Amateur stations increased to 42 and now includes all geographic areas of the United States including Alaska and Hawaii. The frequency bands utilized were modified to include the entirety of 461-478 kHz and 495-510 kHz. Emissions, at power levels up to 20 Watts ERP, include 150 HA1A,

[50] Among these is the fact that electrical noise on the transmission lines will be radiated more efficiently than the PLC signal, generally making the noise environment near the lines high enough that Amateur operation in the immediate vicinity of the power lines unlikely due to preclusive noise at the Amateur receiver.
[51] A number of licenses permitted powers of up to 1 kW.
[52] The current experimental license is subject to a pending renewal application, timely filed. See, 0322-EX-RR-2015.

62H0J2B, 62H0F1B, and 62H0G1D. No reports of interference have been received, despite the fact that a number of these stations were operated at close geographic proximity to various types of power lines.[53] This is a disciplined program of experimentation with regular reports and analyses of interference potential to other services (including PLC systems) and experimentation with equipment and antennas. The fact that absolutely no interference has been reported from any of these active experimental stations is evidence that the predicted level of compatibility hereinabove is accurate.

[53] A report dated June 30, 2015 from the Experiment Coordinator, Dr. Fritz Raab, W1FR, included an appendix of station locations and their distances relative to the nearest power lines:

STATION	BAND	ERP, W	D, km	COMMENTS
WD2XDW	2200	3	1.6	138 kV
WD2XSH/6	630	15	1.6	Lines to Navy base
WD2XSH/12	630	1	0.4	Xcel Energy
WD2XSH/14	630	2	0.93	
WD2XSH/15	630	2	3.2	Major N-S line, Entergy
WD2XSH/16	630	1	0.30	
WD2XSH/19	630	0.25	0.61	
WD2XSH/23	630	5	0.27	PLC 196 kHz
WD2XGJ	2200	4		
WE2XEB/2				
WE2XGR/1				
WD2XSH/26	630	0.01	0.015	Comm. distrib., local grid
WD2XSH/31	630	20	0.77	128 kV CW
WG2XFQ	630	20	0.77	Full-carrier AM
WD2XSH/33	630	0	1.25	161 kV
WD2XSH/44	630	0	0.61	
WD2XSH/45	630	1.7	1.44	100-ft poles
WE2XPQ	630	30	5.26	Multiple LF/MF PLCs
	2200	1		Interconnector
Wasalia/Palmer				
WE2XPQ	2200	3	0.06	Buried
		2.1		Main generator Chugach
Anchorage				
WG2XKA	630	5	2.0	Substation, hydro, solar
WG2XPJ	630	1	0.8	
WG2XSV UT	630	1	0.13	
WG2XSV WA	630	1	0.33	
WH2XGP	630	10	1.6	DoI Columbia Grand Coulee
			2.0	Pair, Grant County PUD
VE7BDQ	630	5	0.56	2200 0.2

26. The same is true of the experiences of Amateur stations and utilities in other countries and along the United States border with Canada.[54] Amateurs in the following countries now have permission to use the 630-meter band: Germany, Greece, Malta, Monaco, Norway, Phillipines, Czech Republic, Ireland, Switzerland, New Zealand, Finland, Spain, France, Poland, Burgaria, Canada, Vietnam, and Japan. ARRL is unaware of any interference claim by any utility operating PLCs in any of these countries related to Amateur Radio operation.

27. The *Notice* states at Paragraph 172 that if the Commission adopts the proposal to permit Amateur operations only when separated by a specified distance from transmission lines, when a new transmission line is built close by an Amateur station, the Amateur station either would have to relocate farther away from the transmission line or cease operating. So the Commission asks how the Part 97 rules should address the potential for new transmission lines to be constructed closer than the specified distance to pre-existing amateur stations, given that the Commission does not want to inhibit growth of either PLC systems or Amateur operation. The Commission asks whether utilities can refrain from geographically expanding their PLC operations within the relatively small portion of the 9-490 kHz band that will be available for Amateur operations, given the Part 15 status of PLC systems, or whether Commission rules should explicitly prohibit utilities from deploying new PLC systems in these bands. Two other related questions stem from this concern: (1) Whether utilities are likely to deploy more PLC systems in these bands in the future to meet the communication needs of the smart grid; and (2) whether the characteristics of these PLC systems will differ from PLC systems that have been used by utilities in the past.

28. As to the Part 97 rules addressing future potential for new transmission line construction closer than a specified distance to pre-existing Amateur stations, this issue is

[54] Canada allows amateurs to operate in the 630-meter band.

addressed fully and completely by virtue of the frequency agility of PLC systems. There is no reason why an Amateur station should have its license modified, either summarily by the Commission or by means of a Commission hearing pursuant to Section 316 of the Communications Act, simply because a utility unilaterally wants to modify its unprotected, Part 15 PLC facility and in the process chooses to continue to use either of the exceptionally small segments of the 9-490 kHz band that are allocated internationally to the Amateur Service. It would be at the point that the utility chose to modify its PLC facilities or create new ones that its Part 15 status should trigger obligations to do what is necessary unilaterally to protect its own facilities from operation without intrusion into the operation of an allocated, licensed and deployed radio service.[55] As noted above, PLC equipment is now frequency-agile and subject to technical standards that oblige utilities to take steps to minimize interference susceptibility, which in ARRL's experience appear in fact to be complied with on a widespread basis. No substantial hardship could possibly be alleged by a utility by virtue of having to avoid use of the small segments at 2200- or 630-meters for a new or modified PLC system. It is not for the Amateur Radio community to discuss the likelihood of future expansion of PLC systems in view of the communications needs of the smart grid, but the Part 15 paradigm for PLC systems using LF and MF frequency bands is incompatible with the security needs of the power grid. It is quite clear, in any case that future PLC systems which utilize modern polite protocols and frequency agility in their system architecture are better suited to the frequency sharing environment (which is inevitable going forward) than are past generations of the same thing.[56]

[55] The regulatory paradigm for unlicensed RF devices and systems in the United States precludes the Part 15 system operator from coming to an interference problem. The newcomers, and those which modify their systems, should be required to utilize non-Amateur frequencies, given the vast alternatives available and the ability to notch the amateur allocations.

[56] The inconvenient truth in this proceeding is that, to the extent that PLC is part of critical infrastructure and is susceptible to interference from the low-EIRP levels to be used by Amateur radio stations at *any* distance separation from the transmission lines, PLCs are not an example of responsible system architecture, and Part 15 is the wrong

29. The *Notice* proposes that Amateur stations in the 2200-meter band be limited to a maximum EIRP of 1 Watt, as is required by footnote RR 5.67A, but asks whether this EIRP limit is appropriate for facilitating sharing between PLC systems and Amateur stations. For the 630-meter band, consistent with RR 5.80A, the *Notice* proposes Amateur stations to be limited to 1 watt EIRP in the portion of Alaska within 800 km of the Russian Federation and 5 watts EIRP elsewhere but asks whether these levels are appropriate, and whether Amateur stations should be required to reduce EIRP below 5 watts when close to transmission lines and if so, at what distance. These power levels are entirely appropriate. The five-watt EIRP maximum power specification recommended at WRC-12 for the 630-meter band will not affect the utility of the allocation for radio Amateurs, and, given typical antenna efficiencies in this frequency range, Amateur Radio stations operating in this band are likely to fall ***well*** within this limit. As to the 2200-meter band, the one-watt EIRP level is the minimum power level for effective communications via Amateur Radio at this frequency. Given the other factors mentioned above, these power levels, developed via studies from WRC-07 and WRC-12, are appropriate for Amateur operation generally. These operating parameters, together with a notification procedure for Amateur operation within one kilometer of a PLC-carrying transmission line, should be ample to avoid interference to PLCs in either band *ex ante.*

30. The Commission identified the practical question that would apply whether or not a separation distance requirement or a notification requirement is implemented: How can radio Amateurs identify and determine the location of transmission lines in their vicinity. The *Notice* states, and ARRL agrees that it is not always easy to differentiate transmission lines from electric distribution lines that connect distribution substations to customer or house wiring. Furthermore,

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regulatory paradigm for them. However, as noted above, the combination of factors here makes a notification system for geographically proximate amateur station locations in either the 2200- or 630-meter bands eminently workable.

some segments carry both transmission lines and distribution lines. The distribution lines use step down transformers which are not present on transmission lines. Transmission lines can be attached to wooden poles or large steel support structures. The Notice asks whether Amateur licensees will be able to identify the transmission lines in their locality, and if not, should the Part 97 rules "require amateurs or ARRL" to affirmatively verify the locations of transmission lines with utilities or UTC before an amateur station begins transmitting in either band. It is overkill to call for this type of burdensome requirement. It is perfectly reasonable to call on an Amateur Radio licensee to use best efforts to determine in every case, prior to commencement of operation at either 2200-meters or 630-meters, whether or not the fixed antenna for that operation will be located within a kilometer of what could be a transmission line and if so, to make the notification to the utility (or to UTC), even if the line is determined later to be other than a transmission line. At that point, following the notification, the burden fairly shifts to the utility (or to UTC) to establish that interference is likely and to explain timely to the radio Amateur as a technical matter why that conclusion was drawn.

31. As to the proper way to specify the separation distance between an Amateur station in these bands and the transmission lines, as between the slant-range distance as per the Part 15 rules[57] or the horizontal distance between the transmission line and the amateur station antenna,[58] ARRL recommends specification of the horizontal distance calculation. This is because, at 1 kilometer, the difference between the two distance calculations is negligible, and the horizontal distance provides the most conservative case. Also, as the Commission notes, calculation of the slant range distance is complicated by the need to know the height of the transmission line at the

[57] i.e. the diagonal distance measured from the center of the measurement antenna to the nearest point of the overhead power line.

[58] i.e. the horizontal (lateral) distance between the center of the amateur station antenna and a vertical projection of the overhead transmission line down to the height of the center of the amateur station antenna.

point closest to the measurement antenna as well as the height of the center of the measurement antenna, so for the horizontal distance method is simplest under any circumstances.

32. Finally, the Commission asks about additional service and operational rules for amateur operation. ARRL has asked for an antenna height limit of 200 feet AGL in these bands due to obstruction marking considerations. The *Notice* indicates that a height limit would define the number of transmission lines that would potentially be in direct line-of-sight of Amateur station antennas. So, the *Notice* asks for comment on the maximum antenna height, if any, which should be specified in the Part 97 service rules. The *Notice* also revisits the issue of Amateur transmitter power limits other than EIRP limits, in part because of the possible difficulty of measuring the EIRP of an Amateur station in this frequency range. The Commission asks whether transmitter power limits should vary depending on antenna height and whether the transmitter power limits should differ between the 2200 meter band and the 630 meter band. ARRL interposes no objection to a reasonable limit on transmitter output power and antenna height *subject to* the absolute 1 watt EIRP limit in RR 5.67A and the 5 watt EIRP limit per RR 5.80A. A transmitter power limit of 1500 watt PEP output would be consistent with the existing §97.313(c) of the Commission's rules and therefore could be incorporated into the Rules.[59] Because in any case, 1 watt EIRP or 5 watts EIRP depending on the band would be absolute limits, the specification of a limit of 1500 watts PEP output in the Part 97 rules would have no

[59] It is difficult to make an antenna of practical size that will be efficient at LF and MF. For example, a 50-foot base-loaded vertical with four radials, an antenna that would be typically used by amateurs at these frequencies, would have an antenna gain of approximately -30 to -40 dBi gain, based on various antenna models run by ARRL Laboratory staff. Even at the full power limit permitted to Amateurs on most other Amateur bands, 1500 watts PEP, the EIRP of this antenna operated over typical ground would be only approximately 500 milliwatts for a typical 50-foot vertical antenna. Amateurs' choices of antennas in this frequency range are limited by available space, cost considerations and local land use regulations. The only absolute power limit that would reasonably complement the antennas that most amateurs would use as a practical matter would be the present power limit of 1500 watts PEP. For locations more than one kilometer distant from transmissions lines, the EIRP of an Amateur station is irrelevant to any issues of the degradation of PLC systems on transmission lines. In cases where the Amateur station is located within one kilometer of transmission lines, it would be sufficient for the Amateur to include his or her estimate of EIRP as part of the notification the Amateur will give to the utility.

effect at all on the interference potential of Amateur stations with respect to PLCs. There is no good reason to call for different transmitter power limits as between the 2200-meter and 630-meter bands. It is conceded that EIRP is difficult to calculate[60] because ground losses are taken into account in the calculation and there is no equivalent to the Commission's M3 map for this calculation that would help radio Amateurs make the calculation. Therefore, a one-watt or five-watt EIRP limit for the respective bands, or, subject to those absolute limits, a 200-foot AGL antenna height limit and a 1500-watt TPO limit, using accurate measurements for determining EIRP (including antenna modeling) could be specified as alternative means of regulating Amateur emissions in these bands.

33. The *Notice* includes other questions relative to Part 97 rules for the two new bands. These include the following: Should automatic control be permitted in these bands? The answer to this is yes, because propagation beacons are an important component of experimental operation in these bands. Should software-driven modes that determine their own operating frequency without human intervention be prohibited? This is something of a moot point given the very small bandwidths of each band. Should the Commission adopt any bandwidth limitation for either of the frequency bands? No. ARRL knows of no rationale for limiting occupied bandwidth by rule to less than 2.1 kHz, and it is suggested that such a limit is not necessary. Nor is it conducive to experimentation with narrowband data emission modes going forward. Should operating privileges in the 2200 meter band be limited, *e.g.*, to Amateur Extra Class licensees? ARRL has previously argued in Docket 12-338 that it would be consistent with Commission policy to make this frequency band available to Amateur Extra, Advanced, and General Class

[60] However, Amateurs now have two circumstances under which they are obligated to calculate EIRP, ERP or field strength: (1) as a prerequisite to operation on the 60-meter Amateur band; and (2) in order to determine that Amateur stations meet RF-exposure limits. Although there are currently categorical exemptions, most General Class and higher operators must evaluate their station to determine compliance with maximum permitted exposure levels. Amateur Radio operators have a good track record in both contexts.

licensees. While Amateur experimenters in the 2200-meter band are more likely than not to hold Amateur Extra Class licenses, operating privileges in this frequency band should not be limited to Amateur Extra Class licensees. Amateur Extra, Advanced, and General Class licensees are afforded operating privileges with all emission types in all frequency bands that are allocated to the Amateur Service, with certain subband limitations within some bands applicable to Advanced and General Class licensees. Thus it would be consistent with Commission policy to make the 2200-meter frequency band available to Amateur Extra, Advanced, and General Class licensees. Technician and Novice class licensees have more limited frequency privileges and it would be unlikely that any significant number of those licensees, if any, would choose to experiment in this band. They might more properly be excluded therefrom. Should the Commission authorize CW, RTTY and data emissions throughout the 630 and 2200 meter bands? Yes, the maximum flexibility with emission types should be permitted in both bands. Phone and image should be permitted as well, especially at 630 meters. The 2200-meter band is narrow, but analog SSB is certainly not impractical in the 630-meter band, and in any case digital voice is an important experimental emission at that order of frequency. Should the Commission amend Section 97.3 by adding definitions for the terms effective radiated power, isotropically radiated power, and LF? Yes, all three are appropriate terms now relevant in Section 97.3. Because other radio services use the 2200 meter band, should the FCC adopt exclusion zones or use other methods to protect Federal uses (fixed service and maritime mobile service) in the band? There is no basis in the record heretofore to necessitate exclusion zones for Federal uses. However, if a Federal agency or NTIA provides a technical justification for protection of certain Federal facilities in this proceeding, including a likelihood of interference, obviously the

Commission will have to evaluate such. And clearly, the ULS database for these bands should be maintained accurately by deleting the unused non-Federal allocations therefrom.

34. The Commission's proposal to implement the International Table of Allocations by requiring that Amateur fixed stations operating in the 2200-meter band not cause harmful interference to stations in the fixed and marine mobile services that are authorized by other nations is reasonable, as is the proposed requirement that Amateur stations in that band take any and all necessary corrective action, if harmful interference is reported to the Commission. None is expected. The 630-meter band has unused Federal MMS and ARNS allocations as well, and those too should be removed from the Federal Table. Consistent with the International Table, Amateur stations transmitting in the 630-meter band should not cause harmful interference to, and can accept interference from, stations authorized by other nations in the ARNS and MMS.

IV. Conclusions.

35. It is timely and urgent that the outdated regulatory provisions for reaccommodation of displaced MF radiolocation stations from 1605-1705 kHz to the 1900-2000 kHz band be removed, and that the Amateur Radio primary allocation be restored in that upper half of the important 160-meter allocation. ARRL supports the Commission's proposal to do so. However, as there is no evidence of compatibility between ongoing Amateur Radio operation at 1900-2000 kHz and the heretofore illegal offshore ocean buoy operation in that band, alternative allocations for ocean buoys going forward, enforced at the equipment authorization stage are called for.

36. ARRL respectfully requests that the Commission finalize the service rules as proposed herein for the LF Amateur Radio allocation at 135.7-137.8 kHz, conforming to the allocation status and limitations set forth in the international Radio Regulations; and to create an allocation as proposed for the 472-479 kilohertz band. With a 1 watt EIRP limitation at 2200-

meters and a 5 watt EIRP limitation at 630-meters, and within that absolute EIRP limit a 1500-watt PEP transmitter power output limitation and a 200-foot maximum antenna height limit, combined with the anticipated continued compliance by PLC systems with Section 15.113(e) of the existing rules, ARRL urges that there is no significant interference potential to PLC systems operated on an unlicensed basis in that very small segment of the 9-490 kHz band that is available for PLC operation, even at separation distances of less than 1 kilometer from the transmission line. At distances of one kilometer or more, there is no chance of interference to a PLC line whatsoever and no restrictions on Amateur operation outside of that distance need be imposed. Because the frequency bands under consideration are very narrow; because the numbers of PLCs operating in those segments that would be used by radio Amateurs are limited (and they are virtually absent in the 630-meter band); because applicable industry standards call for frequency agility in PLC systems and the incorporation of listen-before-transmit protocols and other immunity safeguards; because the number of Amateurs likely to pursue experimentation in the band is quite limited; and because transmission lines carrying PLC communications do not include electric lines connecting the distribution substation to the customer or house wiring, the probability of an Amateur station operating in either band being located less than 1 kilometer of a PLC system that uses the same frequency band segment is *very* low. The interference susceptibility of PLCs is apparently quite low as well. ARRL is unaware of any reports of interference to PLC systems arising from operation conducted pursuant to numerous Part 5 experimental licenses issued by the Commission to radio Amateurs in the large band utilized by PLCs, or otherwise. Finally, due to RF noise from transmission lines generally, it is quite unlikely that an Amateur station using these two bands in particular would be located geographically close to one kilometer in any case. Should the Commission nevertheless remain

concerned about interference to PLCs from Amateur stations located less than 1 kilometer from the transmission lines, the most that should be enacted is a notification procedure, to be conducted entirely in the private sector. Such a procedure, if necessary as a precondition for amateur utilization of either allocation must be limited to Amateur stations proposed to be located within 1 kilometer of a PLC-carrying transmission line. There must be provisions to ensure that any actual coordination is not unreasonably withheld. Further, the burden of proof of interference, once notification is made, is properly placed on the utility. Within 30 days of submitting the required notification about his or her planned operation to a utility or to UTC, the radio Amateur must receive one of two things (or no response from the utility at all): clearance to proceed, or an explanation with a technical justification of any proposed modification of the planned Amateur operation at that location.

Therefore, given the foregoing, ARRL, the national association for Amateur Radio respectfully requests that the Commission timely issue a Report and Order making the LF and MF allocation changes in Part 2 and the Part 97 service rule changes, as suggested herein.

Respectfully submitted,

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EXHIBIT A

EXHIBIT A

HARMFUL INTERFERENCE FROM EXISTING PLC SYSTEMS TO STATIONS IN THE AMATEUR RADIO SERVICE OPERATING IN THE LOW FREQUENCY AND MEDIUM FREQUENCY BANDS

Prepared by: Ed Hare, ARRL Laboratory Manager, 225 Main St., Newington, CT 06111

Abstract:

PLC systems are designed to send control signals along transmission lines between substations and generation systems. At the frequencies used by PLC systems, the electrical distribution wiring constitutes a reasonable radio frequency transmission line. The majority of the signal that is conducted onto the lines is not radiated, but is conducted to the PLC receiver or lost as heat in the lines. For this reason, electrical transmission lines are not efficient antennas and do not radiate much of the PLC signal that is differentially coupled onto the lines. Transmission lines can also be noisy, making it unlikely that any PLC emissions will be greater than the ambient noise levels commonly found on these frequencies near transmission lines. It is not likely that Amateurs will choose to operate on these bands if their antennas must be located very close to transmission lines. Amateurs have also established an excellent record of configuring their stations to minimize noise and of attempting to work cooperatively with operators of noisy devices, typically seeking FCC enforcement in only the most egregious interference cases. For all of these reasons, harmful interference to Amateur stations from PLC systems is unlikely.

Predicted noise levels:

For years, the International Telecommunications Union (ITU) has published information on the median levels of various types of noise that can degrade radio communications[61]. This noise includes natural noise and man-made noise, both of which are an expected occurrence that is taken into consideration as part of the normal design of radiocommunications circuits. Although FCC regulations don't define a specific level of noise that would constitute harmful interference to the Amateur Radio Service, in general, Amateurs have successfully lived with existing noise levels and have been able to communicate in the presence of some noise.

In general, if noise from PLC systems does not significantly exceed the existing levels of man-made noise on the proposed LF and MF bands, Amateur Radio should not be impacted any more than it is now from these median levels of man-made noise on other bands. Although the presence of harmful interference still must be evaluated and determined by the applicable definition thereof in 47 C.F.R. §97.4(23)[62], in general, man-made noise that is less than the median levels of man-made noise does not result in harmful interference complaints.

[61] Recommendation ITU-R P.372-12 (07/2015) Radio noise.

[62] *Harmful interference.* Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with the Radio Regulations.

Table 1 below shows the levels of man-made noise described in the document *Recommendation ITU-R P.372-12 (07/2015) Radio noise.* This was either taken directly from Figure 2 in the document or extrapolated from the slope of the lines in the graph.

Table 1: Levels of man-made noise not likely to result in harmful interference to stations operating in the Amateur Radio Service

Frequency	Fa (quiet location)	dBuV/m (quiet location)	Fa (urban)	dBuV/m (urban)
136 kHz	78 dB	+3.5 dBuV/m	99 dB	+24.6 dBuV/m
475 kHz	61 dB	-13.6 dBuV/m	83 dB	+8.6 dBuV/m

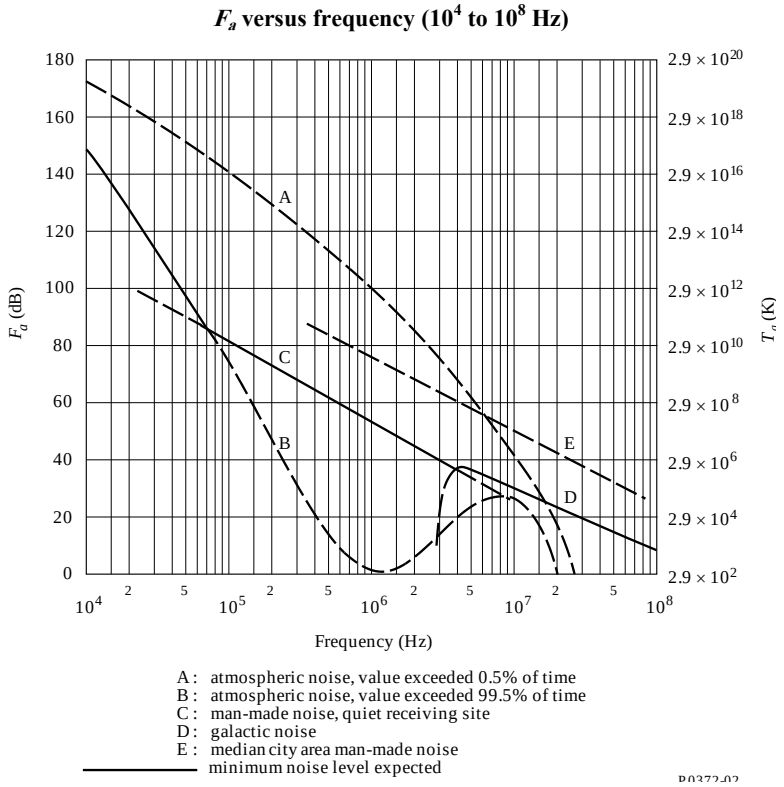

Figure 1 : This is Figure 2 from the P372.12 Recommendation on Radio Noise. In general, noise levels near electrical transmission lines would be at or near the levels for city/urban environments.

NEC models :

ARRL ran a number of antenna models of power lines, using various NEC calculating engines. These models showed that in general, PLC operating at distances of 300 meters from Amateur Radio receive antenna sites resulted in predicted noise levels of no more than 10 to 15 dB greater than the levels shown in Table 1.

There are number of reasons, however, that harmful interference is not likely to result at distances greater than 300 meters from a transmission line carrying PLC. These are as follows:

- Interference is only possible if the PLC is operating within the passband of the Amateur receiver, at the same time the Amateur is operating.
- Electrical transmission lines are universally horizontally configured, making them horizontally polarized. At these frequencies and heights of the transmission lines, the radiating element is a near-vertical incidence signal radiator (NVIS) which would not have strong emissions at lower angles towards Amateur antennas
- Antennas used by Amateurs are almost universally going to be either electrically short vertical radiators or horizontal loops. Vertical antennas will be cross polarized to the transmission-line radiator, resulting in additional attenuation. Horizontal loops would also be NVIS receiving antennas, which would offer additional attenuation at the relatively low angles between the receive antenna and electrical transmission lines.
- Electrical transmission lines can be strong incidental emitters, often creating local man-made noise. This noise is coupled onto the lines from sources such as corona discharge on the lines, tracking insulators and other phenomena. The coupling mechanism is more unbalanced than the carefully controlled injection of the PLC system onto the transmission lines, so there is a strong common-mode component to the noise on the lines. This means that electrical noise on the transmission lines will be radiated more efficiently than the PLC signal, generally making the noise environment near the lines high enough that Amateur operation in the immediate vicinity of the power lines unlikely.

Mitigation:

Under FCC rules, a Part-15 device operator is responsible for the resolution of harmful interference from the operation of unlicensed equipment to authorized radio service stations. However, Amateurs do not have to often rely on this provision of the rules. As a matter of good engineering practice, Amateurs are skilled at designing stations that minimize the pickup of local man-made noise. They control this with careful and knowledgeable selection of antenna type, polarization and location, and by use of various receiver technology, such as filtering, noise-impulse rejection, or digital signal processing to reduce the extent of interference and to be a practical solution, due to the decreasingly available Commission enforcement resources.

Amateurs are generally skilled at locating noise sources, correctly identifying noise sources and working effectively with the operators of noisy devices to harmful interference problems locally. There have been a number of cases involving electric utility companies that have required FCC intervention of various types, but this is due primarily to the number of interference problems coming from utility-operated neighborhood distribution lines. The process used by the ARRL and the FCC to resolve these power-line noise problems is an excellent example of the ways that Amateurs put in a lot of effort to mitigate the need for harmful interference complaints[63].

[63] The process developed is under development by the IEEE as a possible industry-standard recommended practice.

Amateur Radio has also effectively worked with industry to avoid and resolve harmful interference problems. ARRL staff, for example, serve in leadership positions on a number of industry committees, and have strong communication with various industry groups to help resolve interference problems in ways that can actually help industry improve its products and services. ARRL works cooperatively with any industry group that wants to address interference problems in a mutually cooperative way.