Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	**)**	
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TECHNOLOGICAL ADVISORY COUNCIL RECOMMENDATION FOR IMPROVING RECEIVER PERFORMANCE	**)**	**ET Docket No. 13-101**

To: The Office of Engineering and Technology

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, hereby respectfully submits its comments in response to the *Public Notice* (the Notice), DA 13-601, released April 22, 2013, 78 Fed. Reg. 26777.[1] The Notice requests comment from the public on a white paper prepared for the Commission by its Technological Advisory Council (TAC)[2] reporting on a study of the role of receivers in ensuring the efficient use of spectrum. Specifically, the TAC Study addresses obstacles posed by receiver performance in the course of accommodating new services in the increasingly deployed radio spectrum. ARRL has for many years urged and encouraged the Commission to incorporate receiver performance specifications into the United States' spectrum policy on a broader basis. Indeed, this proceeding is overdue. For its comments, ARRL states as follows:

[1] These comments are timely filed. The Chief, Office of Engineering and Technology, released on June 10, 2013 a Public Notice, DA 13-1344, extending the comment period in this proceeding to and including July 22, 2013 in response to a joint motion filed by the Consumer Electronics Association, the National Association of Broadcasters and the GPS Innovation Alliance seeking additional time to file comments.

[2] See, Receivers and Spectrum Working Group, Technological Advisory Council; *Interference Limits Policy – The use of harm claim thresholds to improve the interference tolerance of wireless systems*; February 6, 2013, Version 1.0 (referred to herein as the "TAC Study")

I. Introduction: The TAC Study

1. The fundamental premise of the TAC Study is that increased spectrum user density is the inevitable result of new wireless services. Given that this intensification of the use of the radio spectrum will necessitate new overlays of dissimilar radio services in increasingly shared spectrum, it is necessary to depart from the traditional regulatory model that the Commission has utilized for spectrum allocations. That model has, almost without exception, placed limits only on transmitters.[3] However, the inability of some receivers to reject out-of-band emissions, for example, constrains new allocations in adjacent bands. There is not now the luxury of ignoring this level of inefficiency due to the full deployment of the radio spectrum, and thus what the TAC describes as a "holistic" approach to transmitter and receiver performance is called for. The TAC Report urges a minimal regulatory intervention on receiver manufacturers, however, suggesting that the Commission need only establish an "interference limits policy" by establishing "harm claim thresholds" (HCTs) on in-band and out-of-band signals. These are signal strength limits[4] that must be exceeded before a radio service can claim that it is experiencing harmful interference. Limits would be established throughout a service's assigned frequency range, and at some range of frequencies outside that range. Manufacturers could, in receiver product development, either adhere to these standards or not. The standard would not constrain receiver design or performance *per se*. It would determine only a threshold condition, to delineate the ability of an interference victim to seek redress for such interference

[3] For example, Section 2.102(f) of the Commission's Rules states that "(t)he stations of a service shall use frequencies so separated from the limits of a band allocated to that service as not to cause harmful interference to allocated services in immediately adjoining frequency bands." This places the burden of interference avoidance in a given band on the transmitter operator in the adjacent band, because it does not take into account the selectivity or sensitivity of receivers and the needs of the victim radio service for that level of sensitivity and/or selectivity.

[4] HCTs would be expressed in terms of field strength density or power flux density at a percentage of times and locations within a service area.

phenomena.[5] Transmitter regulation based on the normal radiated power and emission mask formulae (or in some cases, such as Part 15 unlicensed intentional radiators, field strength limits) would continue as has been the case all along.

2. The TAC Study suggests that HCTs will result in clarity in expectations of licensees and spectrum users of entitlements to interference protection in given frequency assignments.[6] It acknowledges anomalies, however, in cases where the licensee is not in control of the receiver, or where the assignments involve safety-of-life services such as aviation and public safety. The TAC suggests a three-step implementation process for establishing HCTs. First, there would be identification of frequency allocations and their boundaries where HCTs would provide an immediate benefit. Second, a multi-stakeholder process would be initiated (as the TAC put it, "encouraged" by the Commission, suggesting that this should be a private-sector initiative) to address "boundary issues and implementation choices" including methods for determining HCTs, parameters, and enforcement procedures in cases of dispute. Third, if necessary, the Commission would initiate a Notice of Inquiry and/or Notice of Proposed Rule Making defining HCTs for new assignments.

3. One principal difficulty with the HCT concept, of course, is the establishment of reasonable HCTs for each type of radio service. This is not possible with respect to some radio services, and an exceptionally difficult task generally. There is a very real danger in establishing HCTs that are too high and thus not providing sufficient protection for radio services that require it and by relying on standards such as, for example, signal decay distance extrapolation factors

[5] It is unclear whether this would simply be a minimum interference claim threshold, or, if exceeded, it would also create, without more, an entitlement on the part of the interference complainant to relief from the Commission.
[6] This is not necessarily true. To the extent that an interfering signal exceeding the HCT "entitles" the interference victim to redress from the Commission, the licensee's expectations cannot be fulfilled absent sufficient enforcement resources to address each and all of those complaints. The sufficiency of those enforcement resources has not been apparent to date, and the predicted increases in spectrum overlays can be assumed to spread the Commission's enforcement resources even thinner than they are now.

that are not valid for the frequency band or channel at issue. There are also difficulties in accommodating receivers – especially consumer products - already deployed in large numbers for use with incumbent radio services such as the Global Positioning System (GPS) which cannot conveniently be retrofit. Nevertheless, the establishment of receiver performance standards, whether they be mandatory or voluntary, is overdue, so as to not constrain new and incumbent licensees of radio transmitters.

II. Background

4. Establishment of receiver performance standards has been an issue about which the Commission has made several false starts over a fairly long period of time. Most recently, in 2003, in ET Docket 03-65, the Commission issued a *Notice of Inquiry*[7] noting an intention to depart from the regulation of transmitted or radiated emissions from radio frequency devices as the traditionally exclusive process by which it attempted to ensure spectrum efficiency. That *Notice of Inquiry* tentatively determined that incorporation of receiver performance (interference immunity) specifications could serve to promote more efficient utilization of the spectrum.[8]

[7] *Notice of Inquiry*, FCC 03-54, released March 24, 2003, 68 Fed. Reg. 23677.

[8] The issue of receiver immunity standards was debated many years before Docket 03-65, however. Radio frequency interference (RFI) legislation, including receiver interference susceptibility, was regularly proposed between 1972 and 1982. In 1973, H.R. 3516, a Bill to require that television receivers manufactured or sold in the United States be equipped with filters, was introduced by Representative Teague. In that year, the Commission received 42,000 RFI complaints, up 20 percent from the number of complaints received just three years earlier. In 1975, Representative Charles Vanik of Ohio introduced H.R. 7052, which proposed amendment of Section 302 of the Communications Act of 1934 to provide the Commission authority to regulate the manufacture of home electronic equipment to reduce the RF interference susceptibility of those devices. In 1977, during the peak popularity of the 27 MHz Citizen's Radio Service, Senator Barry Goldwater introduced legislation, S. 864, to grant the Commission authority to ensure that consumer electronics devices manufactured or sold in the United States have adequate protection against RF interception. In the March 2, 1977 Congressional Record, Senator Goldwater stated:

> "the Federal Communications Commission informs me that it is now receiving complaints about radio frequency interference to home entertainment equipment at a rate of about 200,000 a year. Now, understand that this only the tip of an iceberg. The FCC has made studies which prove that there are at least 14 other people in the same neighborhood as a person who files a complaint who are annoyed by the same problem. This factor alone would bring the total number of persons adversely affected by radio frequency interference up to about 2.5 million. Thus, the true dimension of this problem is gigantic. There are many, many millions of citizens who are troubled in their daily lives by annoying and disruptive interference to the proper operation of electronic equipment in their homes as a result

ARRL agreed with that determination at the time and suggested that the Commission was long overdue in establishing mandatory performance specifications for receivers and RF devices in certain services.

5. However, ARRL also noted at the time that the establishment of minimum performance specifications for receiver interference immunity would not be suitable (or necessary) for all radio services and in all contexts: The establishment of such standards should not, ARRL argued, be done in such a way as to reduce the communications effectiveness of incumbent, licensed radio services. Nor should it be done as a pretext, in order to justify the overlay of incompatible sharing partners in bands substantially occupied by incumbent services. There are some services, such as the Amateur Radio Service (which has many of the characteristics of an experimental type service), in which receiver immunity standards are inapplicable and would preclude or largely frustrate one of the essential purposes of the service and a substantial portion of its operations.[9] *See*, 47 C.F.R. §97.1.

> of the susceptibility of such equipment to radio frequency emissions…. What is not commonly understood is that the great majority of these complaints results from defects in home electronic equipment that pick up signals they should not be receiving. In fact, FCC has found in past years that 90 percent of all television-interference problems can be cured only at the television receiver. Interference has not been caused by the CB or amateur transmitter; it has resulted from basic design defects in the TV set itself….
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> It is my intention that the bill cover television receivers, AM and FM radio receivers, tape recorders, high-fidelity audio systems, phonographs, intercom systems and electronic organs. Public address systems would also be reached by the Bill. The legislation is not, however, limited to the above products. In a change from the Bill which I introduced last year, the new Bill drops the restrictive term "audio and visual electronic equipment" and substitutes for it the term "consumer electronic equipment." My purpose in making this drafting change is to reach electronic control devices and warning devices, as well as the above kind of equipment."

This legislation did not pass. However, there were hearings on S.864, held June 14, 1978, during which then-FCC Chairman Ferris was pointedly asked by the Senate Subcommittee on Communications why the Commission had not requested authority to regulate the interference-rejection capabilities of receiving devices, when its own bulletins on the subject of RFI place much of the blame on their inadequate design. The Chairman replied that a Notice of Inquiry was necessary on the subject.

[9] This is, in part, because of the extremely sensitive receivers used by radio Amateurs for communications in all portions of the radio spectrum for the purpose of receiving very weak transmitted signals over long transmission paths. These received signal levels are often below ambient noise levels. It would be impossible to establish HCTs

6. That said, the most important reason for incorporating receiver interference immunity standards in service rules is for the purpose of avoiding interference between and among licensed services, and between licensed services and unlicensed RF devices. The latter type of interference phenomenon, especially, has been experienced extensively for many years. The Commission has had the authority to implement interference immunity standards for home electronic equipment for more than thirty years, but it has not utilized that authority. In fact, it has consistently resisted use of that authority, deferring instead to marketplace forces which have, over time, proven insufficient to address in-band and out-of-band interference in some cases.

7. Largely in response to the urging of the Senate Communications Subcommittee, the Commission initiated an Inquiry in November of 1978 in Docket 78-369, which asked a series of questions concerning interference susceptibility of consumer devices. The Commission was interested at the time in ascertaining the scope of the problem from the perspectives of both the consumers and the manufacturers, and whether consumers would prefer aftermarket remedies for consumer electronic interference susceptibility, with higher attendant costs, or to have equipment made less susceptible to interference at the manufacturing stage. Viewing the matter properly as one of consumer protection, the Inquiry also asked what the proper level of government intervention in this matter should be. It asked other government agencies what comparable consumer protection programs existed, and whether they were premised on mandatory standards, incentive standards, or self-regulatory programs at the manufacturer level. Finally, the Commission asked a series of questions on engineering issues, including whether there should be, as had been implemented in Canada, an "immunity grading" program; what type of

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that would be appropriate for Amateur Radio receivers without severely compromising the effectiveness and efficiency of the Service.

equipment should be included in a receiver immunity program; whether the RF environment should be characterized differently for different types of electronic equipment; what measurement methods would be needed; whether there were, using these methods, reliability and repeatability problems; and what the aggregate effects might be of multiple transmitters affecting a single victim receiver. More generally, the Commission asked what technical methods now existed to protect electronic equipment from interference.

8. In response to the comments received in response to the *Notice of Inquiry* in Docket 78-369, the Commission issued a staff report and *Further Notice of Inquiry*. The staff report noted that the interference environment included "on-channel and off-channel interference." The former occurs where the receiver reacts to unwanted signals on a desired channel from an assigned on-channel user. The latter occurs when RF energy from a licensed or unlicensed emitter properly operating in an adjacent channel falls within the passband of the victim receiver. The staff report concluded that the only way to resolve on-channel interference is to reassign the transmitting source to another frequency, which is not generally practical, or by increasing the ratio of the desired-to-undesired signal power. Off-channel interference occurs even when a transmitting device is operating in accordance with Commission technical specifications. For example, with respect to television receivers, the RF environment is such that much stronger signals than were assumed in receiver design are actually present. The staff also concluded that interference from unlicensed spectrum users was a "sleeping giant", with the number of complaints of interference to victim receivers from those sources on the increase. The largest number of complaints, however, was attributed to receiver brute-force overload. The Commission staff claimed not to have a sufficient regulatory solution for those incidents. Another problem was inadequate receiver selectivity. The staff report discussed policy options,

including a program of receiver grading and labeling with respect to the immunity to interference of home electronic equipment, either mandatory or voluntary. It also discussed minimum performance standards, and possible allocation of liability for interference resolution. One option even included placing the obligation for interference resolution on the transmitter operator, regardless of the extent of receiver interference susceptibility.

9. The interference environment at the time was not encouraging. In 1979, the number of interference complaints to the Commission regarding consumer electronics was 55,000. The next year that number had increased to 63,000, and by 1981, more than 64,000 complaints were lodged. As Senator Goldwater had earlier noted, only a small percentage (the Commission's estimate was 12 percent) [10] of all citizens actually experiencing interference, actually lodged complaints. Senator Goldwater, noting little progress in resolving these incidents, introduced S.929, a Bill which would authorize the Commission to mandate the use of technology to address radio interference susceptibility in home electronic equipment. He indicated that he was "reluctant" to take that step to extend FCC jurisdiction over a matter which had been "left to the marketplace." But, he noted, after "repeated unsuccessful efforts to obtain the electronics industries' voluntary cooperation", he believed it necessary to "rely on the FCC for guidance on a resolution of this issue." [11] In November of 1981, hearings were held in the House Telecommunications Subcommittee on H.R. 5008, which would authorize the Commission to contract out testing of RF devices capable of causing interference. ARRL testified at that hearing concerning the need for legislation such as S.929, so as to clarify the Commission's jurisdiction to promulgate minimum interference rejection standards.[12]

[10] *Hearings Before House Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce.* 96th Cong., 2d Sess. At 124 (1981).
[11] 127 Cong. Rec. S.3702.
[12] ARRL's testimony included the following:

10. In May of 1982, an amended H.R. 5008, which included Commission authority to promulgate minimum performance standards for receivers, was introduced. The House Telecommunications Subcommittee noted in Report No. 97-751 that the lack of voluntary action necessitated the legislation, but that the Commission had flexibility in exercising it. It was enacted to explicitly clarify the Commission's jurisdiction to regulate interference susceptibility of home electronic equipment and systems. A new Bill, H.R. 3239, was reintroduced, which contained both the provisions of S.929 and H.R. 5008. A joint conference committee reported the Bill out on August 19, 1982. The conference report stated that the Commission clearly had authority to prescribe minimum performance standards for home electronic devices, and that it expected "significant reduction of interference susceptibility" to radio frequency energy. Public Law 97-259 was enacted September 13, 1982.

11. In response to the enactment of P.L. 97-259, the Commission in 1982 anomalously terminated a proceeding considering grading and labeling of television receivers, commenced four years previously, in Docket 78-307. However, industry efforts to address interference immunity in consumer electronic equipment commenced at the same time. The Commission staff requested the assistance of the American National Standards Institute (ANSI) Accredited Standards Committee C63-EMC to ensure that the voluntary standards community produced recommendations to decrease television receiver and VCR susceptibility, so as to obviate the

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> (e)ducational FM broadcast stations…(are) not being issued licenses by the FCC…because television receivers cannot reject the FM station's signal…(depriving) entire communities and cities…of educational radio programming. Hospitals and other safety of life services are denied authorizations for …paging systems because of potential interference to television receivers. Police, fire, ambulance and other services are continually plagued and hampered by interference problems with individual consumers' home electronic equipment. These problems need not occur and millions of consumers need not suffer because of a marketplace failure to address a growing problem.

Hearings Before House Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce. 96th Cong., 2d Sess. at 120 (1981).

need for regulations.[13] The Consumer Electronics Group of the Electronic Industries Association undertook the major voluntary activity.[14]

12. In April of 1986, ARRL filed a Petition for Rule Making which would have required interference susceptibility labeling for home electronic devices pursuant to P.L. 97-259. The proposed label would indicate whether or not the device incorporated shielding, filtering or circuitry designed to reduce the susceptibility of the device to RFI. The argument was that such labeling would serve as a non-burdensome regulatory incentive to manufacturers both to adopt industry-generated RF rejection standards and to incorporate such design in their receivers or electronic devices that are otherwise RF-susceptible. It would be the least restrictive means of implementing the P.L. 97-259 authority, and it would also serve an educational function for the consumer. It would have been an immediate response to an immediate problem, so as to provide a source of relief at the manufacturer level for the consumer regarding interference resolution. Finally, it would be ancillary to the establishment of voluntary industry standards, and it would not burden FCC enforcement resources. The proposal did not presuppose *mandatory* RF susceptibility standards, nor would it have required an evaluation of the sufficiency of the means by which immunity is incorporated into a particular device.

13. The Petition did not receive a file number. It was, rather, summarily dismissed by letter from the then-Chief Engineer only a month after it was filed. It was alleged to be

[13] Under the oversight of the C63 Main Committee, there was established Subcommittee 5 – Immunity, in which ARRL has regularly and actively participated.

[14] In particular, EIA interim Standard No. 10 (Immunity of TV tuners to Internally-generated Harmonic Interference in the Band 535 kHz to 30 MHz) dated May, 1984 and Interim Standard No. 15 (Immunity of TV Receivers and VCRs to Direct Radiation from Radio Transmissions, 0.5 to 30 MHz) dated October 1985 were developed to provide measurement techniques and an immunity level guideline of a nominal value of 1 Volt/meter. Beginning in 1983, ARRL participated in the ANSI C63 Committee work, and ARRL's participation continues to the present. ARRL did not concur in the above-referenced immunity standard No. 10, because of ARRL's view that receiver rejection guidelines should reflect real-world transmitted power levels, and thus should provide adequate protection to consumers. The 1 V/m standard was probably 20 to 30 dB lower than that needed to protect consumers against geographically proximate Amateur Radio transmissions. EIA believed, however, that protection levels beyond Standard 10 are best dealt with by on-site, post-market remedies, such as the addition of high-pass filters.

"premature" since the susceptibility of home electronic equipment was then being addressed by ANSI.[15] In June of 1986, ARRL Petitioned for Reconsideration of the dismissal of the Petition, but this too was denied in October of 1986. The Memorandum Opinion and Order dismissing the Reconsideration Petition argued that any labeling was inextricably tied to establishment of a standard, which in this case did not exist. That argument was inconsistent with the instructions to the Commission from Congress, which had contrasted the establishment of standards (as the most substantial means of implementing P.L. 97-259) to merely requiring labeling of RF-susceptible devices (as the least restrictive means of implementing the authority conveyed by the legislation). Because labeling was the least restrictive means of exercising its jurisdiction to regulate RF susceptibility of receivers and electronic devices, ARRL did not pursue the matter further, but instead continued to work with industry groups to arrive at reasonable industry standards for interference immunity for receivers.

III. The GAO Report.

14. Section 6408 of the *Middle Class Tax Relief and Job Creation Act of 2012,* Public Law 112-96, required that the Comptroller General study and report on the design and operation of telecommunications transmission systems that use the radio spectrum "so that reasonable use of adjacent spectrum does not excessively impair the functioning of such system." The report was to consider, among other things, the "value of improving receiver performance as it relates to increasing spectral efficiency" and the feasibility of industry self-compliance versus Commission or NTIA rules governing the use of adjacent portions of spectrum.

15. The GAO Report that was released in response to this legislation, entitled *Spectrum Management: Further Consideration of Options to Improve Receiver Performance Needed*,

[15] To date, C63 has not established a standard that specifies an immunity level for general consumer devices, under its general policy to not set limits that should in its view be established by regulation.

GAO 13-265, February, 2013, noted that the Commission has not set mandatory receiver standards for nonfederal spectrum users, though it has specific statutory authority to establish minimum performance standards for (at least) home electronic equipment such as televisions. The GAO noted that Commission "officials" interviewed for the Study are "of the view that the Commission lacks direct authority to impose regulations governing receiver performance for receivers other than home electronic equipment." Therefore, GAO concludes, the Commission has generally relied on the marketplace to provide incentives for nonfederal licensees and manufacturers to produce receivers that can reject unwanted signals and limit interference.

16. GAO states that for their part, manufacturers and licensees have taken actions such as adopting industry standards to improve receiver performance. While the Commission has generally relied on the marketplace to improve receiver performance, it has essentially done as the TAC now recommends in one instance. It defined the minimum levels of performance that a receiver must meet to make a claim of harmful interference in the 800 MHz band. The Commission set minimum levels for receiver performance for non-cellular systems (primarily public safety radios), as part of the reconfiguration of the 800 MHz band to mitigate interference between non-cellular and cellular systems. In that band, licensees and their customers that choose to use receivers that do not meet the minimum levels are not entitled to full protection from interference. The public safety community and manufacturers recommended that the Commission establish objective criteria to qualify for interference protection. At 800 MHz, the Commission preferred the HCT to any other action to improve receiver performance, such as requiring public safety radios to fully comply with industry standards in order to claim harmful interference, because it claimed that the latter would impose costs that outweighed the resulting interference protection.

17. Ultimately, GAO's study concluded as follows:

> As demand for and use of spectrum continues to increase, improving the performance of receivers is one of several ways to more efficiently use spectrum and accommodate new services. To date, there have been a limited number of instances where interference concerns driven by receiver performance have impeded a licensee's planned use of adjacent spectrum. Even so, PCAST and FCC, among others, have recognized the growing impact of receivers on efficient spectrum use, and adjacent-band interference concerns may increase in years to come as spectrum management agencies look to allocate additional spectrum for wireless broadband and other new services in an already crowded environment. Therefore, many stakeholders feel that more can and should be done to improve receiver performance in concert with other efforts to increase spectrum efficiency—the status quo is increasingly becoming untenable. Stakeholders have identified and studied several options to improve receiver performance and the efficient use of spectrum. In some instances, these options entail direct federal intervention, such as imposing mandatory standards for receivers, whereas in others, federal policy creates an environment where industry participants' individual and collective actions can improve receiver performance. Each of these options entail advantages, including reduced actual and potential interference and improved spectrum efficiency, and disadvantages, including possibly higher equipment costs. FCC and NTIA have each explored receiver performance in the past, and recent recommendations from advisory committees specific to this topic provide Congress, NTIA and FCC, and industry stakeholders with options for further consideration and testing. Since the topic has been the subject of considerable study, the potential advantages and disadvantages of various options are generally understood. However, less is known about the practical effects of implementing these options to address interference. Several options have not been implemented, such as safe harbor standards and interference limits, and others, such as mandatory standards, have only been implemented for certain federal users, and it is unclear how these experiences would translate to nonfederal users. Greater understanding of the practical effects of these options will allow FCC to make more informed spectrum-management decisions moving forward to ensure the efficient and effective use of spectrum.

IV. Some Practical Considerations in Developing Receiver Immunity Performance Guidelines.

18. Whether it is more practical to establish HCTs, as the TAC proposes; to address interference complaints with reference to applicable, refereed and accepted industry standards for receiver performance on a service-by-service, case-by-case basis, or whether the Commission should incorporate mandatory performance standards for receivers in its rules is subject to some

debate. ARRL is in general agreement with the GAO's conclusion, however, that some practical considerations should be addressed, and in some form, receiver performance standards should be either incentivized or made mandatory now. However, it is critical that the Commission not view these standards as a panacea or a means of obviating the compatibility studies that are increasingly necessary in *any* spectrum overlay situation and in establishing necessary out-of-band emission standards. There are numerous factors to be taken into account in such studies, receiver performance being only one of them.

19. In numerous instances in the recent past, the Commission has, in making allocation decisions or in permitting new intentional or unintentional unlicensed emitters in allocated bands, taken no account of receiver performance at all. In some cases, this is based on the existing regulatory paradigm. For example, the Commission disregards the receiver performance of unlicensed RF devices due to one of the fundamental conditions of operation of those devices, which is that Part 15 devices operate on an at-sufferance basis: their operators must accept any interference "that may be caused by the operation of an authorized radio station." 47 C.F.R. § 15.5(b). The user of such a device has an infinitely high HCT by rule. However, that regulatory approach does nothing for consumer protection if the Part 15 device is a consumer electronic device. This is because the consumer, who may be unaware of this operating condition until after he or she acquires the device,[16] typically blames the transmitter operator for "causing" the interference. It is not intuitively obvious to a non-technical consumer that the device could be subject to improper operation because of the presence of a nearby transmitter. Amateur Radio operators are constantly regulated by municipalities, subjected to civil actions and refused land use authorizations as the result of concerns over RFI to Part 15 consumer electronics, in spite of

[16] Part 15 does have labeling requirements, but these labels appear on the devices themselves, and cannot generally be read by consumers who purchase products in sealed cartons in advance.

the regulatory requirement that unlicensed RF devices must accept any interference received from authorized radio services.

20. The most pressing need for receiver immunity specifications is in the area of consumer electronics. This has been the case for well more than 35 years, as the foregoing history clearly establishes. With the exponential increases in the numbers and types of consumer electronics and unlicensed devices, the Commission should, concurrently with consideration of receiver immunity standards in licensed radio services, incentivize or mandate interference rejection standards for unlicensed home electronic equipment and systems as well. The HCT concept would not work well in this context because consumers of electronics are not in a good position to evaluate for themselves the RF environment into which they will bring the consumer electronic device, and they are not technically capable in general of making interference immunity evaluations for themselves. Nor, historically, have manufacturers adequately responded to the need for receiver interference immunity in their consumer products.

21. The Amateur Service should not be subject to receiver immunity standards, as noted above. The Amateur Service utilizes a wide variety of propagation types, emissions, bandwidths, power levels, receivers and antennas. Any performance standards for Amateur receivers would be purely arbitrary, and would compromise the experimental purposes of the Service. Amateurs have the technical knowledge to differentiate between interference from spurious or out-of-band emissions from nearby transmitters and that caused by receiver deficiencies. Nor does the HCT concept fit the Amateur Service particularly well: any interference suffered by Amateur Radio operators from other Amateur Radio operators is normally cooperatively resolved, and is essentially not a problem. Brute-force overload is occasionally encountered, but those instances are solved by radio amateurs without Commission intervention. Receiver immunity is not an

intra-service issue. The issue for radio amateurs is, rather, protection from spurious and out-of-band emissions from other services.[17]

22. Receiver performance factors are influenced by the nature of the RF environment. For example, the ability of a high-frequency (HF), narrowband receiver to reject unwanted signals is affected by the fact that the desired signal levels are quite weak, and there is required a commensurately high degree of receiver sensitivity. That sensitivity makes the receiver subject to interference from high in-band noise levels, and from noise due to power line leakage, conducted emissions, individual point-source radiators such as RF lighting devices, and adjacent-band or adjacent-channel transmitted signals. This cannot reliably be offset by higher transmitted power from the desired signal source, since the path lengths in the high-frequency bands are long and influenced by highly variable, ionospheric propagation factors independent of transmitted power and receiver sensitivity. Filters and variable bandwidth tuning can offset these factors somewhat, but are not a complete solution. The HF environment is not conducive to fixed

[17] This is not something that the Commission has handled at all well in the recent past. In Docket 07-293, the Commission's *Report and Order and Second Report and Order*, 25 FCC Rcd. 11710 (2010) in amending the Wireless Communications Service (WCS) rules to permit mobile broadband devices at and above 2305 MHz in close geographic proximity to Amateur stations operating in the 2300-2305 MHz band, the Commission dismissed any concern about interference to Amateur operations in the 2300-2305 MHz band. It held at Footnote 405 of that document that out-of-band emissions from WCS, when expanded to permit mobile broadband and portable devices at up to 250 mW EIRP, will have an effect on Amateur operations in that band:

> We note that some amateur stations operating around 2304 MHz may experience an increased antenna noise temperature caused by the implementation of mobile WCS operations, and will have to tolerate this change in the RF environment. Due to the technical flexibility allowed to amateur stations in Part 97 of our rules, however, we believe that operators of these stations may be able to offset or mitigate the effects of this change by relocating or redirecting their antennas, or by making other permitted technical adjustments.

This follows a series of prior instances in the past few years in which the Commission has made unwarranted and incorrect assumptions about the ability of Amateur stations to avoid preclusive interference from an incompatible spectrum use by "reorienting or relocating antennas." The most egregious recent example of this practice is in the case of establishing Part 15 rules governing broadband over power line systems, which was not an allocation proceeding, and it did not involve an adjacent band. These assumptions about the ability of a victim radio service to adjust its operations to respond to actual interference in a spectrum overlay context are made without any factual basis, in order to justify an overlay that the Commission desires to make, without reference to the actual level of receiver sensitivity or selectivity in the adjacent band.

receiver standards, and it would be impossible to establish reasonable HCTs for HF radio equipment.

23. Certain modulation schemes and emissions produce radically different interference susceptibility conditions. For example, data modes with error-correction protocols are of course most reliable in the presence of high noise environments or in the presence of interfering narrowband signals, as are wideband and spread spectrum emission modes generally. Modulation methods such as spread spectrum that facilitate immunity of receivers to unwanted signals should be taken into account in the process of establishing receiver performance guidelines and HCTs.

24. The Commission has in the past been concerned with how to "trade off" the level of receiver performance with the practical issues of cost and implementation mandating such. The TAC concept of HCTs is largely a means of avoiding the issue of cost and implementation, but in doing so it creates a different tradeoff: it places the decision whether to spend more money for a more interference-immune receiver (or less money on one without that immunity) on the licensee, customer or other type of receiver user. This decision largely depends on the level of degradation expected in the service, and the amount of degradation from co-channel or adjacent-channel (or in-band versus out-of-band) interference sources. For public safety receivers at 800 MHz, for example, where very little interference can be tolerated, a higher degree of mandated interference rejection is reasonable. This substantially increases the cost of the receivers, but the extra cost could be justified by the importance of interference immunity in that case. There should be very little flexibility in this area, due to the need to protect public safety communications and maximize reliability. With respect to unlicensed consumer electronic devices, a highly competitive industry, cost is more of an issue, and performance is not quite as

critical from the perspective of the *manufacturer* (though it is from the perspective of the *consumer*, as discussed above). The Commission should either mandate a standard for all consumer electronic devices, or adopt a labeling or grading system which is made available to consumers *at the point of sale* and to the public which allows the consumer to make his or her own choice about the importance of interference immunity and the value of such relative to increased cost.[18] Placing the burden on a consumer to evaluate the necessity for interference immunity in a given receiver presupposes a level of knowledge and the ability to evaluate RF environments that many licensees, consumers and other receiver users simply do not have.

25. Receiver performance is dependent not only on the radio service and the functions thereof, but also (1) whether the receiver is deployed in mobile, fixed or aeronautical mobile use; (2) the frequency range at issue; (3) bandwidth, (4) the normal desired-to-undesired signal ratios, and (5) the antenna to which it is connected. An assumption that all radio receivers function in the same generic environment is not realistic and would lead to substantial inequities in implementation.[19] Nevertheless, some generalities can be assumed. Digital, software controlled or defined radios with dynamic frequency control offer the most effective interference control opportunities. The benefits of dynamic frequency selection, dynamic transmitter power control, and dynamic selectivity and receiver sensitivity cannot be overemphasized. Clearly, the best opportunity to deal with receiver immunity is through Software Defined Radio (SDR) technology. Existing trunked radio technology is also a relatively efficient means of offsetting the effects of interference or narrowband noise in certain bands.

[18] At one point in the 1980s, the Commission published a study of telephone receiver handsets and rated them in terms of interference rejection/susceptibility. This provided a useful reference to consumers and to those transmitter operators accused of "causing" undesired operation in the telephone handset.

[19] Although the TAC Study did make recommendations for a generic HCT level, it also clearly recognizes that HCT levels must be determined on a service-by-service basis.

26. Though it is difficult in some circumstances to determine an appropriate HCT, minimum receiver immunity should be *at least* 3 V/m for receivers that might be located or commonly found in the near field of a residential Amateur Radio station. At this distance, a receiver would be immune to an Amateur Radio transmission at approximately 100 watts of transmitter power and an antenna of 0 dBd (free space) gain, at approximately 100 feet separation. Such a standard for receivers, however, would not address the interference immunity of wired telephones, computers, alarm systems, audio systems, and other consumer electronic devices which constitute the bulk of the instances of interference involving Amateur radio operators.

27. Manufacturers should not be relied upon *exclusively* to agree on performance categories or to define quantifiable ranges or to establish HCTs. The Commission should, in implementing receiver immunity performance in its spectrum policies, utilize voluntary industry standards, guidelines promulgated by the Commission (either in technical publications or as advisories in the rules) and mandatory standards adopted in the rules, as appropriate in given circumstances. Overall, the Commission should approach immunity standards from a cooperative, refereed approach. As suggested above, standards organizations such as ANSI should be consulted. Because receiver standards will differ from service to service, and from frequency band to frequency band, the development of receiver immunity guidelines, HCTs or mandatory standards should be established through cooperative industry participation, and if necessary, negotiated rulemaking, but with Commission oversight sufficient to insure that the standards are sufficient to protect licensees and consumers of RF products.

28. As a general principle, and with some exceptions, receiver interference immunity should be considered together with other factors in spectrum allocations decision making.

However, it should not be used as a means of justifying the overlay of otherwise fundamentally incompatible spectrum sharing partners. Specifically, receiver immunity standards should not be mandated for a particular service to the extent that the communications throughput, capacity or reliability in that service is materially reduced, or the cost of equipment substantially increased, merely to allow the addition of a new service to a band that otherwise would be incompatible. Requiring better performance from receivers or RF-susceptible devices is a valid, reasonable, and long overdue requirement, but the major goal of doing so should be to prevent instances of interference, not solely to allow the overlay of otherwise incompatible sharing partners in deployed spectrum to the detriment of incumbents. Inefficiencies in use of an allocation due to excessive interference susceptibility should be a criterion in determining whether a licensed radio service should be afforded an allocation in a given band. This is especially true in connection with proposals to add a licensed service to a band in which unlicensed (and hence unprotected) devices are deployed. For example, the Commission is now confronted with a proposal to allocate to the Amateur Service an extremely small, 2 kHz band in the 281 kilohertz-wide Low Frequency portion of the spectrum (9 to 300 kHz), overlaid on unlicensed power line carrier systems of unspecified interference susceptibility. Receiver inefficiencies and interference susceptibility of unlicensed and unprotected RF devices and systems should not be permitted to preclude an otherwise reasonable allocation decision in that context.

29. The Commission should not require involuntary replacement of receivers in order to implement improved receiver interference immunity, in order to meet HCTs, or even if the immunity standards ultimately adopted are mandatory. Once new standards are in place, there should be a reasonable transition period in any services to phase in equipment with greater immunity as older equipment becomes obsolete.

V. Section 15.209 is Not a Reasonable Baseline for Establishing HCTs.

30. The TAC's concept of HCTs does not include mandatory immunity levels, but rather the establishment of field strength levels below which receivers would not be entitled to protection. As noted above, the difficulty in this process is in determining proper HCT levels. *It is exceedingly dangerous to generalize in this process*. The TAC recommends setting HCTs at a relatively high level for immunity to transmitters operating *outside* of a particular service's allocation, but also recommends setting a lower threshold *within* a particular service's allocation ("in-block harm claim threshold"), below which the service and its operators would not be entitled to protection from interference. As discussed above, the HCT concept has little relevance or application to Amateur Radio Service receivers. There should not be HCTs established for Amateur receivers due to the nature of the Service.

31. The TAC, however, at page 21, Section 4.1 of the Study, recommends generally that the levels specified in Part 15 for the emissions from intentional emitters be used as the threshold below which interference would not be considered to be harmful interference. It is based on Section 15.209 of the Commission's rules. If this provision is adopted without excepting the Amateur Radio Service, it would become the *de facto* standard on which all claims of harmful interference to the Amateur Radio Service are based. Interference protection based on Section 15.209 would effectively preclude all interference complaints by a licensee in the Amateur Radio Service. The noise level in an Amateur Radio receiver using the Section 15.209 limit is at <u>least</u> 30 dB greater than the median values of man-made noise at HF as outlined in ITU-R Recommendation P.372-10[20] and *much* greater than the minimum values of man-made noise found in the environment which typically determine the selection of operating frequency and even home fixed locations for most Amateur stations. It would, in the high-frequency bands,

[20] Radiocommunication Sector of the ITU, Recommendation P.372-10, *Radio Noise* (rev. October 2009), at 12–15.

represent interference levels that would effectively preclude virtually all Amateur Radio communications. Table 1 below shows the received noise levels expected from the field strengths permitted under Section 15.209 and recommended by the TAC Study:

Frequency	Antennas	15.209 Field Strength	RSL (9 kHz)	S-meter (9 kHz)	ITU-R man-made noise (9 kHz)	Degradation over the median levels in ITU-R P372.10
3.6 MHz	Dipole	29.5 dBuV/m_1	-56.7 dBm	S9+16 dB	12.0 dBuV/m	17.5 dB
14.2 MHz	Yagi (7.5 dBi)	29.5dBuV/m_1	-63.2 dBm	S9+10 dB	7.4 dBuV/m	22.1 dB
146 MHz	Yagi (12.5 dBi)	40.0 dBuV/m_2	-68.0 dBm	S9+5 dB	0.6 dBuV/m	39.4 dB

1. Specified at 30 meters distance in Sec. 15.209. At closer distances, interference levels may be higher.
2. Specified at 3 meters distance in Sec. 15.209. It is likely that most Amateur antennas will be located at greater distances.

Table 1 – Received signal levels from noise at the limits of Section 15.209.

32. The TAC study further recommends that adjacent-band services have an HCT stipulated not only in field strength, but also incorporating a statistical component that requires that this threshold be exceeded over a percentage of time *and geographical area*. This is rather loosely defined in the TAC study, but it does create a question as to how the percentage of geographical area that must be protected will be applied to individual licensees in a given service. The TAC speaks of a 90% reliability factor for all but emergency-related services. If this is implemented, it remains to be seen how it would be applied to individual licensees. The concept is inapplicable to the Amateur Service.[21] It would be illogical to tell an Amateur Radio licensee that he or she does not have a valid interference complaint because 90% of the area in their community is operating without any complaints, so it is presumed to be interference free.

[21] If there is adopted any specific HCT for the Amateur Radio Service, or a general HCT that applies to Amateur Radio Service receivers, in cases of interference to an Amateur station, the burden would fall on the affected licensee to demonstrate that an HCT based on field strength is being exceeded, in field strength, time and geographical area. Very few radio Amateurs have the equipment or expertise to measure field strength accurately.

33. The TAC Study also recommends that radio services be required to design receivers with immunity to higher levels of field strength from adjacent-frequency operation. These levels are typically 3 V/m in European standards. This is equivalent to 100 watts to a dipole antenna at 30 meters' distance. As discussed above, typical Amateur station transmissions create RF fields which routinely exceed a 3 V/m level in neighboring homes in residential areas. It is unclear how an interference complaint from a neighbor of an Amateur Radio licensee would be addressed by the Commission if the fundamental emission of an Amateur station exceeded the harm claim threshold of an adjacent service. If the interference is to Part 15-regulated home electronic equipment with an infinitely high HCT, there would not be an issue. Otherwise, however, it certainly can be, and establishing an HCT for residential consumer electronic equipment that is too low relative to ambient RF fields disserves the transmitter operator and the consumer of the home electronic equipment as well.

VI. Conclusions

34. The Commission might appropriately consider implementing either mandatory receiver immunity standards, guidelines or HCTs in some radio services. From service to service, and even intra-service, different receivers used for different functions in different environments will require unique standards. These standards should be established cooperatively among the Commission and industry, licensees and standards setting organizations and consumer groups. The most pressing need, however, is for improved immunity of consumer electronic devices and systems. The Commission has had the authority to require this for many years, and has failed repeatedly to exercise it. The explosive growth of unlicensed devices which are RF-susceptible has stymied allocations otherwise proper and reasonable in certain frequency bands, and it has resulted in many thousands of instances of complaints against Amateur Radio operators and in

some cases, civil and criminal actions being filed. At the same time, receiver immunity standards for the Amateur Radio Service are neither necessary nor practical. The Amateur Radio service includes extensive experimentation, and HCTs for the Amateur Service would be inherently arbitrary. The TAC recommendation to use the Section 15.209 field strength limits as a general HCT would be completely inappropriate and would effectively preclude all Amateur Radio interference complaints, no matter how preclusive the interference is to these experimental type communications.

Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio, requests that the Commission take further action regarding receiver immunity performance specifications as recommended herein and not otherwise.

Respectfully submitted,

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