Before the

UNITED STATES DEPARTMENT OF COMMERCE

National Telecommunications and Information Administration

Washington, D.C. 20230

In the Matter of	**)**	
	)	**Docket No. 181130999–8999–01**
Developing a Sustainable Spectrum	**)**	
Strategy for America's Future	**)**	

To: **Office of Spectrum Management, NTIA**
Attention: **Mr. John Alden**
Via: **spectrum-strategy-comments@ ntia.doc.gov**

COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO
IN RESPONSE TO NOTICE AND REQUEST FOR COMMENTS

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 *Notice and Request for Comments* (the Notice) in the captioned proceeding. The Notice was published in the Federal Register[1] on December 21, 2018, and therefore these comments are timely filed. In this proceeding, the United States Department of Commerce's National Telecommunications and Information Administration (NTIA) seeks comments to assist in the development of a comprehensive, long-term national spectrum strategy pursuant to a Presidential Memorandum entitled *Developing a Sustainable Spectrum Strategy for America's Future*, issued October 25, 2018. That Presidential Memorandum requires that the Secretary of Commerce, through NTIA and in consultation with, among other Federal agencies, the Administration's Office of Science and Technology Policy and the Federal Communications

1 83 Fed. Reg. 65640.

Commission (FCC) to submit a long-term National Spectrum Strategy (Strategy) to the President, within 270 days. The Strategy is to include legislative, regulatory, or other policy recommendations to: (a) Increase spectrum access for all users, including on a shared basis, through transparency of spectrum use and improved cooperation and collaboration between Federal and non-Federal spectrum stakeholders; (b) Create flexible models for spectrum management, including standards, incentives, and enforcement mechanisms that promote efficient and effective spectrum use, including flexible-use spectrum licenses, while accounting for critical safety and security concerns; (c) Use ongoing research, development, testing, and evaluation to develop advanced technologies, innovative spectrum utilization methods, and spectrum sharing tools and techniques that increase spectrum access, efficiency, and effectiveness; (d) Build a secure, automated capability to facilitate assessments of spectrum use and expedite coordination of shared access among Federal and non-Federal spectrum stakeholders; and (e) Improve the global competitiveness of United States terrestrial and space-related industries and augment the mission capabilities of Federal entities through spectrum policies, domestic regulations, and leadership in international forums. For its comments on these topics and the basic elements of a modern spectrum management process, ARRL states as follows:

1. ARRL welcomes the opportunity to address the development of a long-term spectrum management policy for the United States. This is the first time since 2004 that NTIA has asked for broad spectrum policy input[2] intended to improve spectrum management overall going

2 NTIA issued a *Notice of Inquiry* in February of 2004 in Docket No. 040127027-4027-01 which asked an extensive series of questions intended, among other things, to (1) facilitate the creation of a modernized and improved spectrum management system; (2) to facilitate policy changes to create incentives for achieving more efficient and beneficial use of the spectrum, and to provide a higher degree of predictability and certainty in the spectrum management process as it applies to incumbent users; and (3) to develop policy tools to streamline the

forward. The radio spectrum is a renewable, though finite natural resource. The Amateur Radio Service is itself a national public resource of volunteer communicators and technicians, and it has a unique and tenured perspective on the issues in this proceeding. ARRL is the national Amateur Radio society in the United States. It has more than 150,000 members, and has been the principal advocate [3] for the interests of the Amateur Radio Service, numbering more than 750,000 licensees of the FCC. ARRL has served in this advocacy capacity for over one hundred years.

2. One of the longstanding concerns of ARRL in the development of spectrum policy is the tendency of both NTIA and FCC to advocate, sometimes without the apparent exercise of technical discretion, entrepreneurial uses of the spectrum. In an effort to achieve the overarching goal of competition in delivery of telecommunications services and products and the perfectly reasonable goal of promoting new technologies, FCC has from time to time acted as a self-described "cheerleader" for new (typically but not always unlicensed) technologies, without the benefit of a firm evaluation of technical compatibilities and incompatibilities and the present and predicted future effect on incumbent radio services. On the other hand, NTIA has dual (and often potentially conflicting) roles as (1) the principal telecommunications advisor to the President of the United States and the advocate of the Administration's telecommunications policy; and (2) the spectrum manager for Federal agencies. It is somewhat ironic that FCC is in this context

---

deployment of new and expanded services and technologies, while preserving national and homeland security and public safety, and encouraging scientific research. ARRL filed extensive comments in that proceeding.

3 ARRL has had appointments to the FCC's Spectrum Policy Task Force (SPTF) and has contributed to the FCC Spectrum Policy Task Force Report, entitled *Recommendations for Spectrum Policy Reform*. ARRL has been an active participant in forums of the SPTF, the Johns Hopkins University Capstone Project, and the Forum on Spectrum Management Policy Reform organized by the National Academies' Computer Science and Telecommunications Board. ARRL has extensive domestic and international spectrum management experience, and is a regular participant in United States delegations to meetings and conferences of the International Telecommunication Union, as well as a regular contributor in FCC proceedings dealing with the Table of Allocations, 47 C.F.R. §2.106.

typically a lead advocate for commercial spectrum uses, while NTIA has properly focused on the portion of its role as the protector of non-commercial (Federal) spectrum use. Yet, this arrangement tends to provide a reasonable balance between important, but potentially conflicting goals and policies. ARRL's experience is that the FCC has been inconsistent in its spectrum management efforts, to the extent that there are not always technical compatibility analyses completed before a spectrum sharing proposal is adjudicated. NTIA's spectrum management office, on the other hand, regularly provides professional and impartial evaluations of new technologies and has a proper focus on the interference potential of those technologies to government exclusive and shared Federal and non-Federal spectrum. A bifurcated system of spectrum management contributes to NTIA's ability to temper the FCC's "cheerleader" role toward spectrum use by new technologies by addressing directly the technical necessities of interference prevention and electromagnetic compatibility.

3. Looking forward, however, it might be more efficient to have a single, centralized spectrum management agency or entity. There is only one Table of Allocations, prioritized among government and non-government uses, and international and domestic uses. There has been in the last decade a substantial increase in sharing of bands between Federal and non-Federal users (a trend which will inevitably become even more pronounced in the near future), and a single spectrum management entity could improve the efficiency of decisionmaking with respect to spectrum overlay compatibility and coordination issues. Spectrum allocations decisionmaking at FCC is now measured in years, and the inefficiency of the existing processes works very much to the disadvantage of virtually all non-government spectrum users and especially proponents of new technologies, including manufacturers. A single spectrum management agency could utilize "negotiated rule making" procedures in which spectrum

stakeholders are invited to the table by agency facilitators, as opposed to the present "command and control" approach. ARRL has for many years advocated increased use of negotiated rulemaking in spectrum allocation rulemaking, and continues to believe that advocates of new technologies are in the best position to address and resolve formally, transparently, and in good faith (in advance of receiving regulatory authorizations) any compatibility issues with incumbent users and other interested parties.

4. In the interim, recognizing that there is a need for expeditious resolution of spectrum management issues, and rapid implementation of compatible spectrum overlays, ARRL suggests that FCC and NTIA should adopt a "best practices" guide, to allow spectrum management professionals at FCC and NTIA to work closely, transparently and cooperatively, and with regular communication at the staff level. The current process, in which FCC participates as a member of the IRAC is necessary but not sufficient, in terms of expediting spectrum management decisionmaking, and it is hardly transparent. FCC spectrum management officials in the Office of Engineering and Technology should regularly meet with the NTIA Spectrum Management Office.

5. There is an inevitable trend, due to the need for spectrum overlays on completely allocated and occupied spectrum, away from exclusive allocations. Flexible use and spectrum overlay mechanisms are workable and stand to increase spectrum efficiency when implemented prudently and correctly, but they absolutely must be prefaced by (1) a technical compatibility analysis in order to determine the limits of flexible use relative to avoiding predictable, harmful interference; and (2) a comprehensive and ongoing analysis of the Radio Frequency (RF) noise environment in the subject allocations. The FCC has considered the use of receiver immunity, interference temperature metrics, harm claim thresholds and cognitive radio technologies as

various mechanisms to facilitate overlays in what are currently compartmentalized, exclusive or shared allocations for various incumbent services. These are each reasonable techniques under certain circumstances, and may offer a means of increasing spectrum efficiency in lieu of exclusive allocations. However, neither FCC nor NTIA has ever conducted a reliable evaluation of ambient noise in the radio spectrum over time, and neither agency is adequately cognizant of trends, upward or downward, in terms of man-made noise. *No new spectrum management paradigm premised on flexible uses can be confidently adopted unless and until these trends are known and factored into the planning for spectrum overlays*. Allowing certain spectrum overlays in formerly exclusively allocated bands may appear reasonable now, but in the future, increases in ambient noise in the subject bands resulting from, for example, aggregate deployment of millions of mobile, itinerant, unlicensed devices may make those same overlays incompatible with incumbent services. ARRL suggests that it is untimely to adopt spectrum management principles without first knowing the nature of and quantifying the RF environments in which the radio services that are subject to recommended spectrum management policies operate.

6. It is an inescapable fact that neither NTIA nor FCC has any idea at all what ambient noise levels are currently or what the trends are, because there has not been any comprehensive study, over time, of ambient noise in different environments. This is especially problematic in the area of man-made ambient noise levels and the radio noise floor – an area of enquiry that was one of the fundamental bases for the establishment of the FCC's Technological Advisory Council (TAC) in 1998. On December 11, 1998, the FCC created the TAC to provide technical advice and to make recommendations on the issues and questions presented to it by the Commission.[4] On May 26, 1999, the Commission requested that the TAC study the noise floor

4 See TAC Charter (December 11, 1998).

and propose new approaches to spectrum management based on emerging and future technologies.[5] In making this request, FCC noted that electromagnetic noise levels had not been studied for more than twenty years prior thereto.[6] There was either no study conducted pursuant to the FCC's 1999 request, or else the results were not made public. However, FCC did again task the TAC in 2016 to conduct a study of the noise floor in various environments and asked the public for input on the methodologies of the study in ET Docket 16-191.[7] However, *before that study even got started*, and despite extensive industry support for the study reflected in comments on the study's methodology, the Commission, *sub silentio*, terminated it abruptly. It is difficult to imagine how NTIA or FCC can adopt specific spectrum management principles to facilitate flexible use of spectrum in order to accommodate new technologies, and incorporating such concepts as receiver immunity, harm claim thresholds, and interference temperature determinations, without having as a predicate therefor a firm grasp on ambient noise levels in basic RF environments and geographical areas.[8] Without knowing noise floors in various

---

5 Official Requests from the Commission to the Technological Advisory Council, Memorandum of Requests No.1 (May 26, 1999).

6 *Id.* at 2.

7 See, Office of Engineering and Technology Announces Technological Advisory Council (TAC) Noise Floor Technical Inquiry, Public Notice DA 16-676, released June 15, 2016.

8 FCC staff, in 1999, summarized the importance of the TAC's efforts as follows:

> The regulatory limitations the Commission places on intentional and unintentional emissions are premised on long-standing assumptions about the relevant ambient environmental noise. Given the dated nature of the Commission's knowledge underlying those assumptions, as new and innovative radio communications devices emerge it is becoming increasingly important that the Commission base its decisions on a reliable assessment of the noise floor within the United States and its territories. In examining technical limitations, the Commission must determine whether certain restrictive limitations should be relaxed because the incremental noise contribution is insufficient to justify the economic and innovation burdens associated with the restrictions or whether certain limitations should be continued or even increased because the incremental noise increase could impair the efficacy of existing systems. As we head into the next millennium and the Commission grapples with new and innovative communications technologies, it is essential that the Commission better understand the state of the current noise floor, and the impact of radio emissions on the efficacy of telecommunications systems.

environments, it is impossible to conduct accurate, quantitative analyses of interactions between and among radio services. It limits the tools that NTIA and FCC have at their disposal to evaluate and implement new, innovative spectrum management techniques and metrics. It is strongly suggested that NTIA or FCC conduct, or engage appropriate technical studies to determine predictable ambient noise floor conditions in various environments before adopting any comprehensive spectrum management plans and strategies.

7. Indeed, all spectrum overlay and flexible use concepts entail (1) knowing the nature of and quantifying the RF environments in which the radio services that are subject to these recommended spectrum management policies operate; and (2) a means of determining and managing interference risk by balancing the entitlements and obligations of both transmitters and receivers, especially in congested RF environments. The mechanisms that have been discussed to facilitate compatible spectrum overlays over the past two decades are premised primarily on notions of (a) interference temperature evaluations; (b) receiver immunity standards proposals; and (3) the suggested adoption of harm claim thresholds. It is instructive to review the earlier docket proceedings and studies of these concepts, to inform an evaluation of spectrum management principles based on them.

8. Prior to 2002, a Spectrum Policy Task Force (SPTF) composed of Commission staff members was formed by FCC "to assist the Commission in identifying and evaluating changes in

---

Official Requests from the Commission to the Technological Advisory Council, Memorandum of Requests No.1 (May 26, 1999) at page 3.

In response to the Commission's 1999 directive, the TAC concluded *that it would be impossible for the Commission to engage in effective spectrum management until it "develop[s] a more complete understanding of the current state of the radio noise environment…"* FCC Technological Advisory Council, Second Meeting Report at 1, 9 (Oct. 28, 1999). Thus, the TAC in 1999 urged the Commission to immediately undertake a multi-part study of the noise floor that would include a detailed analysis of available noise floor literature, the creation of detailed noise floor models, performance simulations, and verification of the simulations. These efforts should precede adoption of specific spectrum management techniques predicated upon receiver immunity, harm claim thresholds and interference temperature determinations.

spectrum policy that will increase the public benefits derived from the use of radio spectrum." [9] On November 7, 2002, the SPTF issued a Report recommending sweeping changes in the FCC's approach to spectrum management.[10] In particular, the SPTF Report suggested that the Commission adopt a new and untested approach to spectrum management that incorporated an "interference temperature" concept. Basically, the staff proposed to divide each spectrum block horizontally into a licensed portion above a specified signal level and an unlicensed portion below that level. Given the newness of the concept and the dangers of implementing a new scheme of spectrum management, the SPTF identified two prerequisites to the implementation of the interference temperature concept: (1) the compilation of current, comprehensive data regarding the noise floor (including a standard method for measuring the noise floor) and existing spectrum usage; and (2) an evaluation of current and future receiver environments. The SPTF Report, at p.28 stated:

> The Commission could use the interference temperature metric to establish maximum permissible levels of interference, thus characterizing the "worst case" environment in which a receiver would be expected to operate. Different threshold levels could be set for each band, geographic region or service, and these thresholds should be set after the Commission has reviewed the condition of the RF environment in each band. This review should include actual spectrum measurements of the RF noise/interference floor. In addition to obtaining better data regarding the noise floor, the Commission should adopt a standard methodology for measuring the noise floor. Further, the Task Force recommends that the Commission create a public/private partnership for a long-term noise (interference temperature) monitoring network and for the archiving of data, for use by the FCC and the public.

9. On July 7, 2003, the TAC convened a public meeting regarding the measurement and management of spectrum interference.[11] The TAC presentations at that meeting again noted that

---

9 Spectrum Policy Task Force Report, ET Docket No. 02-135 (Nov. 7, 2002) ("SPTF Report").

10 *Id.*

11 See, *Technological Advisory Council ("TAC") to Hold Meeting*, Public Notice, DA 03- 1991 (June 17, 2003).

there was no then-current data regarding either the noise floor or current spectrum usage.[12] From the foregoing, it is clear that, starting a decade and a half ago, the need for a thorough investigation of the RF noise floor in various environments has been repeatedly acknowledged to be a prerequisite to and a necessary first component of any improved spectrum management plan in a given frequency band to the extent that the effort involves establishment of maximum permissible levels of interference.

10. During the FCC's consideration of the concept of "interference temperature" following the 2002 release of the Spectrum Policy Task Force Report, the Commission heard from many commenting parties in various radio services who noted that the interference environment in which a receiver operates can be highly variable and its characteristics may often be strongly service-related. That environment should first be identified and characterized to allow, at least in principle, the development of emission criteria that provide for quantitative comparisons of receiver performance. The argument was that the FCC could not begin a realistic evaluation of the benefits of receiver standards until noise floor studies are completed, and any such evaluation should include an analysis of the noise floor in various environments (i.e., discrete bands of spectrum in varied geographical areas, including urban, suburban, exurban and rural areas) with respect to different services and different technologies.

11. Despite this oft-repeated argument, the Commission on November 13, 2003, without commissioning any noise floor study at all, adopted a *Notice of Inquiry and Notice of Proposed Rule Making* in Docket 03-237 (FCC 03-289). The *Notice* sought comment on the need for, development of, and implementation of a new "interference temperature" model for managing interference. That model, said the Commission, would "shift the current method of assessing

12 TAC, Measurement Technology and Issues, presentation by Robert J. Matheson, NTIA/ITS (July 7, 2003).

interference which is based on transmitter operations, to an approach that takes into account the cumulative effects of all undesired radiofrequency energy, *i.e.*, energy that may result in interference from both transmitters and noise sources, that is present at a receiver at any instance of time." The proceeding also sought comment on establishing interference temperature limits and procedures for assessing interference temperature in the 6525-6700 MHz band and portions of the 12.75-13.25 GHz band in particular. The comments received in response to that *Notice of Inquiry and Notice of Proposed Rule Making*, however, were generally negative. The Commission, almost four years later, summarized the comments in an *Order* terminating the proceeding (FCC 07-78, released May 4, 2007) as follows:

> Commenting parties generally argued that the interference temperature approach is not a workable concept and would result in increased interference in the frequency bands where it would be used. While there was some support in the record for adopting an interference temperature approach, no parties provided information on specific technical rules that we could adopt to implement it. Further, with the passage of time, the *Notice* and the record in this proceeding have become outdated. We are therefore terminating this proceeding without prejudice to its substantive merits.

Therefore, whether due to the absence of available noise data, or because of some other factor, the public was not optimistic about a spectrum management plan premised on the interference temperature concept. ARRL suggests that FCC was, in November of 2003 placing the cart well before the horse, and that same problem exists today.

12. Far more attention has been paid academically to the use of receiver immunity standards in updated spectrum management policy. Recently, however, spectrum overlays and flexible use proponents have also included the concept of "harm claim thresholds" or HCTs as spectrum sharing techniques. ARRL has for many years urged and encouraged FCC to incorporate receiver performance specifications into the United States' spectrum policy on a

broader basis as an interference limitation. We reiterate that encouragement to NTIA herein. ARRL accepts as a given that increased spectrum user density is the inevitable result of new wireless services, both fixed and mobile, and of new wireless products generally. Given that this intensification of the use of the radio spectrum will necessitate new overlays of dissimilar radio services (and potentially, unlicensed devices and systems) in increasingly shared and densely utilized spectrum, it is necessary to depart from the traditional regulatory model of frequency-division multiplexing and geographic separation requirements that FCC has utilized for spectrum allocations for decades. That model has, almost without exception, placed limits only on transmitters.[13] 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 a more "holistic" approach to transmitter and receiver performance is called for, albeit with due regard to the proliferation of current-generation receivers in mature, incumbent services, such as, for example, the Global Positioning Service. There has in the past been a consistently minimal level of regulatory intervention on receiver manufacturers, suggesting that NTIA and FCC could establish an "interference limits policy" by establishing HCTs on in-band and out-of-band signals. These are signal strength limits[14] 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 to some extent, on frequencies outside that range. Manufacturers

13 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.

14 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.

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 phenomena.[15] 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.

13. The FCC's TAC suggested[16] in 2013 that HCTs will result in clarity in expectations of licensees and spectrum users of entitlements to interference protection in given frequency assignments.[17] It acknowledged 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 suggested in 2013 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 FCC, 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

15 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 regulatory relief from FCC.

16 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.

17 This is not necessarily true. To the extent that an interfering signal exceeding the HCT "entitles" the interference victim to redress from FCC, 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; the FCC has eviscerated its field staff that would be called upon to address the complaints; and the predicted increases in spectrum overlays can be assumed to spread the Commission's enforcement resources even thinner than they are now – and they are already virtually unavailable to non-safety-of-life services. As the instant Notice states, the flexible models for spectrum management that should be developed must include "enforcement mechanisms that promote efficient and effective spectrum use…"

necessary, the Commission would initiate a Notice of Inquiry and/or Notice of Proposed Rule Making defining HCTs for new assignments.

14. 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 it is an exceptionally difficult task generally. There is a very real danger in establishing HCTs that are too high, and thus which would not provide sufficient protection for radio services that require it; or which rely on standards (such as, for example, signal decay distance extrapolation factors) 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 and have significantly long product use terms once deployed. Nevertheless, the establishment of receiver performance standards in some contexts, whether mandatory or voluntary, is overdue, so as to not constrain new and incumbent licensees of radio transmitters and other intentional emitters.

15. Establishment of receiver performance standards has been an issue about which the FCC has made several false starts over a fairly long period of time. In 2003, in ET Docket 03-65, FCC issued a *Notice of Inquiry*[18] 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 (i.e. interference immunity) specifications could serve to promote more efficient utilization of the spectrum.[19] ARRL agreed with that determination at

18 *Notice of Inquiry*, FCC 03-54, released March 24, 2003, 68 Fed. Reg. 23677.
19 The issue of receiver immunity standards was debated many years before Docket 03-65, however. Radio frequency interference (RFI) legislation, including receiver interference susceptibility regulation, was regularly

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

16. 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

---

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 then-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 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….
>
> 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.

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.[20] *See*, 47 C.F.R. §97.1.

17. That said, the most important reason for incorporating receiver interference immunity standards in service rules is for the purpose of avoiding, *ex ante*, 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. FCC has had the authority to implement interference immunity standards for home electronic equipment for more than thirty-six 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.

18. 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

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

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 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, FCC asked what technical methods now existed to protect electronic equipment from interference.

19. In response to the comments received with respect 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. 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.

20. 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 FCC's estimate was 12 percent) [21] of all citizens actually experiencing interference 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

21 *Hearings before House Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce.* 96th Cong., 2d Sess. At 124 (1981).

issue." [22] 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 FCC's jurisdiction to promulgate minimum interference rejection standards.[23]

21. 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.

---

22 127 Cong. Rec. S.3702.

23 ARRL's testimony included the following:

> (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).

22. 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 need for regulations.[24] The Consumer Electronics Group of the Electronic Industries Association undertook the major voluntary activity.[25]

23. 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

24 Under the oversight of the C63 Main Committee, there was established Subcommittee 5 – Immunity, in which ARRL has regularly and actively participated to the present time.

25 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 roughly 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 were best dealt with by on-site, post-market remedies, such as the addition of high-pass filters.

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.

24. The Petition was summarily dismissed by letter from the then-Chief Engineer only a month after it was filed. It was alleged to be "premature" since the susceptibility of home electronic equipment was then being addressed by ANSI.[26] 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.

25. 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

26 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.

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. The GAO Report that was released in February of 2013 in response to this legislation was entitled *Spectrum Management: Further Consideration of Options to Improve Receiver Performance Needed*, GAO 13-265. It noted that the Commission had 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 were "of the view that the Commission lacks direct authority to impose regulations governing receiver performance for receivers other than home electronic equipment." Therefore, GAO concluded, 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.

26. GAO stated that for their part, manufacturers and licensees have taken actions such as adopting industry standards to improve receiver performance. While FCC has generally relied on the marketplace to improve receiver performance, it did at least define the minimum levels of performance that a receiver must meet to make a claim of harmful interference in the 800 MHz band. FCC 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.

27. 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.

28. Whether it is more practical: (1) to establish HCTs; (2) 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 (3) to impose mandatory performance standards for receivers, is subject to some debate. ARRL is of the view 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 case-by-case 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, typical receiver performance being only one of them.

29. In numerous instances in the recent past, FCC in making allocation decisions or in permitting new intentional or unintentional unlicensed emitters in allocated bands has 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 (and because they are not recognized as licensable radio stations (as are stations in licensed, allocated radio services pursuant to Section 301 of the Communications Act of 1934, as amended). 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 (and usually is) unaware of the operating condition until after

he or she acquires the device,[27] 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 the regulatory requirement that unlicensed RF devices must accept any interference received from authorized radio services.

30. 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 FCC and NTIA 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 (and operate) 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.

31. 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

27 Part 15 does have labeling requirements, but these labels appear on the devices themselves, or in user's manuals, and cannot generally be read by consumers who purchase such products in sealed cartons in advance of point of sale.

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 in the Amateur Service. The issue for radio Amateurs is, rather, protection from spurious and out-of-band emissions from other services.[28]

32. 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

28 This is not something that the FCC has handled at all well to date. 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, and dismissing the consequences of the failure to fairly and candidly investigate the overlay as a technical matter.

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, for example, 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 they are not a complete solution. The HF environment is not conducive to fixed receiver standards, and it would be impossible to establish reasonable HCTs for HF radio equipment.

33. Certain modulation schemes and emissions produce radically different interference susceptibility conditions. For example, data emissions 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, ultra-wideband and spread spectrum emission types 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.

34. FCC has in the past been concerned with how to "trade off" the level of receiver performance with the practical issues of cost and implementation that result from mandating such. The 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 narrowband 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 use 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.[29] 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.

35. 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

29 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.

implementation.[30] 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.

36. 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. These constitute the bulk of the instances of interference complaints involving Amateur Radio operators.

37. Manufacturers should not be relied upon *exclusively* to agree on performance categories or to define quantifiable ranges or to establish HCTs. FCC and NTIA should, in implementing receiver immunity performance in spectrum policies, utilize voluntary industry standards, guidelines promulgated by FCC (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

30 Although the 2013 TAC Study did make recommendations for a generic HCT level, it also clearly recognized that HCT levels must be determined on a service-by-service basis.

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 NTIA and FCC oversight sufficient to insure that the standards are sufficient to protect licensees and consumers of RF products.

38. 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. Receiver inefficiencies and interference susceptibility of unlicensed and unprotected RF devices and systems should not be permitted to preclude an otherwise reasonable, expanded allocation decision in that context.

39. There should not be required 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, so as to allow incumbent licensees to benefit from the service life of the existing equipment.

40. The real issue with HCTs is whether they should be mandatory immunity levels or 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*. It would be reasonable to set HCTs at a relatively high level for immunity to transmitters operating *outside* of a particular service's allocation, but also to set a lower threshold *within* a particular service's allocation, 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 communications conducted. If, as has been previously suggested, the levels specified in Part 15 for the emissions from intentional emitters are used as the threshold below which interference would not be considered to be harmful interference, (based on Section 15.209 of the FCC's rules) without excluding 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 <u>*all*</u> 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[31] 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, represent interference levels that would effectively preclude virtually all Amateur Radio communications.

41. NTIA and FCC might appropriately consider implementing either mandatory receiver immunity standards, guidelines or HCTs in some radio services as a spectrum management tool. 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 government and industry, licensees, standards setting organizations and consumer groups. 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.

42. If HCTs are to be used as a means of "setting expectations" regarding interference to other stations or systems, they should be implemented for the purpose of establishing appropriate service rules for radio services. Interference resolution policies with respect to individual station operation should continue to be based on harmful interference, according to the standard ITU definition.[32] Most urgently, *no HCT should be applicable to interference to a victim receiver*

31 Radiocommunication Sector of the ITU, Recommendation P.372-10, *Radio Noise* (rev. October 2009), at 12–15.
32 RR 1.169 defines harmful interference as "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 Radio Regulations". Section 2.1 of the Commission's Rules contains a virtually identical definition, taken directly from the ITU regulations.

from or to unlicensed devices. The concept has no place with respect to unlicensed devices at all.[33] HCT limits for licensed, allocated services should be developed *ex ante*, based on desired reliability, but if actual harmful interference results *ex post*, it should be resolved on the basis of current regulatory obligations. This paradigm has worked reasonably well for many years, though again enforcement resources are required, and in many, perhaps most cases, the obligation to protect licensed radio services from harmful interference from unlicensed devices cannot be fulfilled due to the lack of available enforcement resources.

43. The HCT concept should not be dependent in whole or in part, and the proper HCT level should not be determined in whole or in part, on the relative perceived value of two radio services. For example, if it is stated that a mobile broadband system should be reliable 90% of the time, but public safety communications systems must be reliable 100% of the time, a value judgment has been made. If these two services were being evaluated for potential operation on a co-channel basis, HCTs are difficult to calculate. Arguably, HCTs should apply with respect to

33 With respect to refereeing competing uses of spectrum for communications purposes, the principal tool for that control is the requirement in section 301 of the Communications Act of 1934 that anyone who wishes to operate a device that emits radio frequency energy first obtain a license from the Commission. 47 U.S.C. § 301. Section 301's licensing requirement contains no exceptions. That section forbids the "use or operat[ion of] any apparatus for the transmission of energy or communications or signals by radio [in or affecting interstate commerce], except . . . with a license[.]" Nevertheless, since 1938 the Commission has permitted the use without a license of certain devices that radiate extremely low levels of radio frequency energy, as long as that use does not cause harmful interference to licensed operations. While the claimed statutory justification for permitting these unlicensed devices shifted somewhat in the early years, the Commission settled on the rationale that a device transmitting too little RF energy to interfere with licensed uses does not constitute an "apparatus for the transmission of energy" under section 301. The Commission's adopted rules governing the use of unlicensed devices, codified in Part 15 of the rules, 47 C.F.R. pt. 15 prescribe technical standards for particular types of unlicensed devices. These are backed up by the overriding command that unlicensed devices may be operated only to the extent that they do not harmfully interfere with licensed operations. This command is embodied in three rules. First and foremost, the "operation of a [Part 15] device is subject to the condition[] that no harmful interference is caused." 47 C.F.R. § 15.5(b). Second, operators of Part 15 devices must accept any interference "that may be caused by the operation of an authorized radio station." *Id.* Finally, "[t]he operator of a radio frequency device shall be required to cease operating the device upon notification by a Commission representative that the device is causing harmful interference." *Id.* at § 15.5(c). Consistent with the Commission's legal rationale for allowing unlicensed devices under section 301, the agency's principal obligation with respect to such devices is to ensure that their operation will predictably not interfere with licensed radio services. For this reason, there is no possible application of HCTs to interference to or from Part 15 devices because there is no statutory support for such a requirement.

allocated, licensed services on a co-channel basis only where there are co-primary uses. With respect to adjacent band interference, there are two types. One is based on brute force overload. This phenomenon assumes that the transmitted signal is contained within its proper operational bandwidth. The victim receiver is unable to reject, and reacts adversely to properly operating adjacent channel transmissions. Out-of-band emissions, however, assume the proper operation of the receiver but envision an overly wide bandwidth of the transmitted signal. HCTs should be based only on in-channel or in-band emissions.

44. Private Sector frequency coordination should be increasingly relied on in order to increase spectrum efficiency and maximize frequency re-use. Within the Amateur Radio Service there are a number of frequency coordinating bodies which operate on a volunteer, cooperative basis. Most of them coordinate frequencies for repeaters in the VHF and UHF bands to promote efficient operation while maintaining desired frequency and distance separations. Overall, this practice has been successful and will continue for the foreseeable future. Coordinators have no enforcement power except for cooperation between users and through peer pressure. In a few cases, it is necessary for the FCC Enforcement Bureau to help resolve problems and generally a station not having gone through the coordination process has a principal obligation to resolve interference, but cooperation with a coordinated user is expected and urged. For Amateur-Satellite Service frequencies, the International Amateur Radio Union has a Satellite Adviser who appoints an advisory panel of experts to assist in coordinating frequencies and maintaining a database of existing and proposed Amateur satellites. Satellites, such as developed as university projects operating in Amateur-Satellite bands, are also considered even though they may be experimental stations not licensed as Amateur Satellites.

45. The experience with volunteer, non-mandatory frequency coordination in the Amateur Service is, overall, a positive one. The view of other radio services, exposed to mandatory private sector frequency coordination, is not as positive. The land mobile frequency coordination procedures are expensive and somewhat slow, and they have led to inequities due to lack of consistent coordination procedures among various private sector entities. They work well from FCC's perspective, since FCC administrative application review procedures are obviated. The private sector fixed microwave coordination procedures are similarly expensive and time consuming, but they do tend to result in an accurate database of fixed licensees. FCC, some years ago, mandated a large step backward in frequency coordination for the fixed broadcast auxiliary services which were, until that time, coordinated (by local market coordinators sponsored by the Society of Broadcast Engineers) using a volunteer, market-based coordination procedure similar to, and modeled after, the private, volunteer coordination system for fixed facilities developed by the Amateur Service. It worked exceptionally well.[34] FCC substituted a prior written notification procedure using commercial frequency coordinators identical to that used in the fixed microwave service, necessitating the use of commercial frequency coordinators. This added cost and delay for licensees, but no benefit whatsoever over the earlier volunteer system. Any future spectrum management paradigm must include expanded private sector coordination planning.

46. There have been several long-range spectrum planning activities by NTIA and other agencies. These activities should be continued. It should be a transparent process in which the agencies and the public work collaboratively. The process should be initiated by notices of

34 The SBE private sector coordination program continues to work exceptionally well with mobile broadcast auxiliary spectrum in shared bands. A current, ongoing example of the efficiencies provided by these volunteers is the integration of substantial Department of Defense shared uses in mature spectrum used for electronic news gathering and video production in the 2025-2110 MHz band. That band is exceptionally heavily used by broadcasters and video production entities, but it is now being shared with DOD tactical radio relay point-to-point systems and other uses displaced from the AWS-3 bands (which were auctioned) that could not be accomplished but for the private sector coordination program sponsored by SBE.

inquiry requesting inputs from Federal and non-Federal entities as to their spectrum requirements. History suggests that there should be sufficient flexibility to take into account both predetermined requirements and allowances for new technology not yet in development. After a first round of inputs, the stakeholders should be invited to participate in small groups to explore ways of satisfying the needs of different entities. This process was used essentially in preparing an excellent report, *U.S. National Spectrum Requirements: Projections and Trends*, NTIA Special Publication 94-31, released in March of 1995. Though now of course outdated, this was a thorough and extremely useful document, developed by a process which should be repeated periodically, and which should serve as a premise for NTIA and FCC spectrum planning.

47. The current spectrum management mechanisms at NTIA are reasonably adequate as far as they go. The process, however, is not as transparent as it should be. Simply inviting public input without providing a window into the deliberative process is not sufficient. It is necessary to involve non-Federal entities in the deliberation of alternatives. Many bands are shared resources. Having the participation of the affected parties should lessen the chances of unintended consequences. Nor do FCC's processes of long-range spectrum planning provide any assurance to consumers, service providers, or government institutions that sufficient spectrum will be available to satisfy projected requirements, or even any assurance that FCC knows how realistic those projected requirements really are. The FCC's allocation decisionmaking falls into an all-too-familiar pattern: An advocate of a new service appears on the scene with a petition for rule making announcing that it has a new technical concept, device or system that is not configured to operate in the allocations available, or according to operating parameters permitted in the various radio services. The promoter of the technology touts the alleged public benefits of the service, but typically provides *no technical compatibility study* showing that its proposed allocation or

operating parameters are consistent with incumbent users' deployed uses of the spectrum. The FCC, looking uncritically only at the claimed public interest benefits of the technology, or its contribution to competition in the delivery of telecommunications services, proposes to proceed with the allocation, and routinely ignores the effect on incumbent radio services. This is repeated in recurring cycles of piecemeal allocation planning. FCC does not appear to have any long range plan for spectrum management, and development of one should be a cooperative, open, and negotiated process, collaborative with NTIA and the public.

48. How spectrum efficiency is defined is also a critical prerequisite for a determination of spectrum policy. ITU-R has in the past considered definitions of spectrum efficiency and published a comprehensive Recommendation.[35] Further efforts should be made to facilitate and realize the benefits and spectrum efficiency of software defined radio, spread spectrum and ultra-wideband (UWB) systems and to increase their sharing with traditional narrow band technologies. Modern mitigation techniques, such as digital signal processing (DSP), waveform orthogonality, antenna-directivity and diversity techniques are now being used to improve spectrum efficiency, and should be factored in any new studies of spectrum efficiency. Technical efficiency is the only universally applicable definition of spectrum efficiency. Looking at the Amateur Service for example, which uses the radio spectrum just as the public uses a public park, there is no relevance of any concept of economic efficiency. One might determine through economic analysis whether portions of the radio spectrum should be dedicated to public access and public use for the betterment of emergency communications, international goodwill, technical self-training and improvement in technology, as opposed to other applications.

35 International Telecommunication Union, *Definition of Spectrum Use and Efficiency of a Radio System*, Recommendation ITU-R SM.1046-1, 1997.

However, in a radio service which has no pecuniary nexus whatsoever, the economic efficiency of allocations for Amateur Radio has no direct relevance. The same could be said of radio astronomy or public safety services, as other examples.

49. ARRL believes that spectrum efficiency should be determined by its most universally applicable test, which is technical efficiency. The measure of technical spectrum efficiency is the ratio of resources required divided by resources consumed. Thus, a spectrum use that is greater than the need is less efficient than a use that matches the need. While spectrum efficiency is of course not equivalent to the "public interest", it is the technical efficiency of a proposed use that is the appropriate consideration, reserving for separate analysis the relative merits of a proposed use to the public.

50. Any future spectrum management system should employ a flexible means of accommodating temporary uses on a coordinated basis. Temporary spectrum uses could be managed by a single entity having the function of making temporary, preemptable authorizations for specific frequencies, locations and times with appropriate mitigation provisions. The FCC's experimental licensing program, which now works exceptionally well in this area, should be part of this single entity so that both Federal and non-Federal frequencies could be used for the temporary application. There is a good opportunity here for exclusive Federal spectrum secondary market deployment. A good model for this exists in the use of Aeronautical Flight Test Telecommunications. The Aerospace and Flight Test Telecommunications Coordinating Council (AFTRCC) performs temporary frequency coordination for other uses of Flight Test allocations, which are not used all the time, and where substantial capacity exists for other uses. Broadcasters and video production entities, among others, apply for use of these frequencies for wideband video at short term venues, and pay the AFTRCC coordination fees for that use. The

FCC grants experimental licenses or Special Temporary Authorizations based on AFTRCC coordination. It is a good example of short term secondary markets in spectrum that is good for all involved and FCC staff does an excellent job of processing these temporary authorizations and facilitating experimental and developmental operation in occupied spectrum.

51. In summary, ARRL welcomes the opportunity to comment in this proceeding. Many of the concepts that discussed above are only briefly discussed, but have been the subject of extensive academic literature on spectrum management. The foregoing comments are the product of decades of ARRL's experience in spectrum sharing, especially between Federal government agencies and radio Amateurs. the existing spectrum management process does not always lead to compatible overlays, and it is certainly not efficient. However, the key elements of any successful spectrum management plan going forward must include technical compatibility studies and increased transparency and partnership between and among NTIA, FCC telecommunications manufacturers, their customers and the public. ARRL is ready, willing and able to partner with NTIA and FCC to develop and implement a spectrum management plan for the future.

Therefore, the foregoing considered, ARRL, the national association for Amateur Radio,

respectfully requests that NTIA take these comments into consideration in its planning and future processes looking toward reforming spectrum management and establishing a sustainable spectrum management policy for the United States.

Respectfully submitted,

ARRL, the national association for Amateur Radio

225 Main Street
Newington, CT 06111

By: Christopher D. Imlay
Christopher D. Imlay
Its Communications Counsel

Booth, Freret & Imlay
14356 Cape May Road
Silver Spring, MD 20904-0611
(301) 384-5525 telephone
(301) 384-3684 facsimile
W3KD@ARRL.ORG

January 22, 2019