Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C. 20554

In the Matter of	**)**	
	)	
TECHNOLOGICAL ADVISORY COUNCIL	**)**	**ET Docket No. 17-340**
SPECTRUM POLICY RECOMMENDATIONS	**)**	

To: The TAC Spectrum and Receiver Performance Working Group and The Chief, Office of Engineering and Technology
Via: ECFS Electronic Filing

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 17-1165, released December 1, 2017.[1] The Notice requests comment from the public on a series of spectrum policy recommendations of the Commission's Technological Advisory Council (TAC), pursuant to a series of white papers[2] promulgated by the TAC over the past several years. Specifically, the TAC's Spectrum and Receiver Performance Working Group has developed recommendations for revised Commission spectrum policy, so as to fulfill the Commission's statutory obligation to "make such distribution of licenses, frequencies, hours of operation, and of power among the several States and communities as to provide a fair, efficient, and equitable distribution of radio service to each of the same." 47 U.S.C. §307(b). The Commission, in an effort to address the "increasing challenges of efficient and fair allocation of spectrum in congested RF environments,

[1] The Notice established a comment date of January 31, 2018. Therefore, these comments are timely filed.
[2] *See*, https://www.fcc.gov/general/tac-reports-and-papers, last visited on December 15, 2017.

and in particular, the challenges of finding a balance between the rights and responsibilities of transmitters and receivers" asks for comment on the TAC's recommended policies and principles for spectrum management. With respect to these policies and principles, and the effect thereof on the Amateur Radio Service, ARRL states as follows:

I. Introduction.

1. ARRL is exceptionally supportive of the work of the TAC. ARRL's representative on the TAC, Dr. Greg Lapin, N9GL, has been a steadfast, positive contributor to the work of the TAC for many years now, and the collegial, academic composition of the TAC has resulted over time in an impressive body of work. ARRL would suggest, however that the Commission has, by limiting the areas of study with which the TAC has been tasked, artificially limited the flexibility of the TAC (and hence its productivity). 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 TAC in the first place. On December 11, 1998, the Commission created the TAC to provide technical advice and to make recommendations on the issues and questions presented to it by the Commission.[3] On May 26, 1999, the Commission requested that the TAC study the noise floor and propose new approaches to spectrum management based on emerging and future technologies.[4] In making this request, the Commission noted that electromagnetic noise levels had not been studied for more than twenty years prior thereto.[5] The Commission, *sub silentio*, has apparently terminated the recently announced TAC noise study in ET Docket 16-191[6] *before that study even got started,* despite

[3] See TAC Charter (December 11, 1998).
[4] Official Requests from the Commission to the Technological Advisory Council, Memorandum of Requests No.1 (May 26, 1999).
[5] *Id.* at 2.
[6] *See, Office of Engineering and Technology Announces Technological Advisory Council (TAC) Noise Floor Technical Inquiry,* Public Notice DA 16-676, released June 15, 2016.

extensive industry support for it reflected in comments on the study's methodology. Indeed, it is difficult to imagine how the Commission can now, in the instant proceeding, suggest the adoption of specific spectrum management principles, 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.[7] Terminating the noise floor study limits the extent to which the Commission can conduct accurate, quantitative analyses of interactions between and among radio services and therefore limits the tools that the Commission has at its disposal to evaluate and implement new, innovative spectrum management techniques. It is suggested that, going forward, the TAC should be provided additional flexibility in its areas of study without artificial academic limits being imposed by the Commission on the effort. It is also strongly suggested that the Commission task the TAC with pursuing the Noise Study announced in June of 2016.

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[7] 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.
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> *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.

2. The Notice in this proceeding asks for comment on the TAC's recommended Basic Spectrum Management Policies; the principles underlying them; and the regulatory requirements necessary to implement them. The policies are articulated as follows:

> (1) Implement and formalize the TAC's recommendations for *Basic Spectrum Principles* as policies, and set clear expectations about the affected system's capabilities regarding interference, such as harm claim thresholds.
>
> (2) Adopt risk-informed interference assessment and statistical service rules more widely.
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> (3) Implement steps for improving interference resolution, including a next-generation architecture for radio spectrum interference resolution, creating a public database of past radio-related enforcement activities, and incorporate interference hunters in the resolution process.

The principles underlying these policies and goals are the following:

> *Principle #1* -- Harmful interference is affected by the characteristics of both a transmitting service and a nearby receiving service in frequency, space or time;
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> *Principle #2* – All [radio] services should plan for non-harmful interference from signals that are nearby in frequency, space or time, both now and for any changes that occur in the future;
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> *Principle #3* – Even under ideal conditions, the electromagnetic environment is unpredictable. Operators should expect and plan for occasional service degradation or interruption. The Commission should not base its rules on exceptional events;
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> *Principle #4* – Receivers are responsible for mitigating interference outside their assigned channels;
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> *Principle #5* – Systems are expected to use techniques at all layers of the stack to mitigate degradation from interference;
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> *Principle #6* – Transmitters are responsible for minimizing the amount of their transmitted energy that appears outside their assigned frequencies and licensed areas;
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> *Principle #7* – Services under FCC jurisdiction are expected to disclose the relevant standards, guidelines and operating characteristics of their systems to the Commission if they expect protection from harmful interference;
>
> *Principle #8* – The Commission may apply Interference Limits to quantify rights of protection from harmful interference;

Principle #9 – A quantitative analysis of interactions between services shall be required before the Commission can make decisions regarding levels of protection.

ARRL variously has both praise and criticism for these policies and principles, assuming *arguendo* that it is timely to adopt any such spectrum management principles without first knowing the nature of and quantifying the RF environments in which the radio services that are subject to these recommended spectrum management policies operate. It is useful, however, to note *ab initio* that the concepts underlying the principles and policies are not in any sense new. Rather, they are each 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. As the Commission attempts to apply the TAC policies and principles in a way as to fairly and equitably balance the entitlements and obligations of both transmitters and receivers, especially in congested RF environments, there is already a mature body of public comment and discussion available on these subjects.

II. Background

A. Interference temperature.

3. Prior to 2002, a Spectrum Policy Task Force (SPTF) composed of Commission staff members was formed by the Commission "to assist the Commission in identifying and evaluating changes in spectrum policy that will increase the public benefits derived from the use of radio spectrum." [8] On November 7, 2002, the SPTF issued a Report recommending sweeping changes in the Commission's approach to spectrum management.[9] In particular, the SPTF Report

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

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.

4. On July 7, 2003, the TAC convened a public meeting regarding the measurement and management of spectrum interference.[10] The TAC presentations at that meeting again noted that there was no then-current data regarding either the noise floor or current spectrum usage.[11] From the foregoing, it is clear that, starting well more than a decade 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] See, *Technological Advisory Council ("TAC") to Hold Meeting*, Public Notice, DA 03- 1991 (June 17, 2003).
[11] TAC, Measurement Technology and Issues, presentation by Robert J. Matheson, NTIA/ITS (July 7, 2003).

5. During the Commission'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 Commission cannot 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.

6. 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 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 it was placing the cart well before the horse, and the same problem exists in the instant proceeding today.

B. Receiver Immunity and Harm Claim Thresholds.

7. Far more attention has been paid academically to the use of receiver immunity standards in updated spectrum management policy, and, more recently, to the concept of "harm claim thresholds" or HCTs. 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. We reiterate that encouragement herein. ARRL accepts as a given 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 (and potentially, unlicensed devices and systems) 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.[12] 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 "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. The TAC has in the past urged a minimal regulatory intervention on receiver manufacturers, suggesting that the Commission need only establish an "interference limits policy" by establishing HCTs on in-band and out-of-band signals. These are signal strength limits[13] 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 phenomena.[14] 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.

[12] 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.

[13] 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.

[14] 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.

8. The TAC suggested[15] in 2013 that HCTs will result in clarity in expectations of licensees and spectrum users of entitlements to interference protection in given frequency assignments.[16] 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 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.

9. 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 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

[15] 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.

[16] 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; the Commission 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.

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.

10. 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. In 2003, in ET Docket 03-65, the Commission issued a *Notice of Inquiry*[17] 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.[18] ARRL agreed

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

[18] 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 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 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….

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.

11. 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.[19] *See*, 47 C.F.R. §97.1.

12. 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

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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.

[19] 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.

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-five 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.

13. 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 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.

14. 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. 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.

15. 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) [20] 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 issue." [21] 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.[22]

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[20] *Hearings Before House Subcommittee on Telecommunications, Consumer Protection, and Finance of the Committee on Energy and Commerce.* 96th Cong., 2d Sess. At 124 (1981).
[21] 127 Cong. Rec. S.3702.
[22] 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

16. 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.

17. 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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> 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.[23] The Consumer Electronics Group of the Electronic Industries Association undertook the major voluntary activity.[24]

18. 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.

19. 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

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

[24] 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 were 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.[25] 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.

20. 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.

21. 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

[25] 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.

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.

22. GAO stated 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 recommended 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.

23. 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.

III. Receiver Immunity Standards and HCTs.

24. 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 incorporate mandatory performance standards for receivers in Commission rules, 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.

25. In numerous instances in the recent past, the Commission, 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 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 unaware of this operating condition until after he or she acquires the device,[26] 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

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

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.

26. 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.

27. 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 in the Amateur Service. The issue for radio Amateurs is, rather, protection from spurious and out-of-band emissions from other services.[27]

28. 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, 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

[27] This is not something that the Commission 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.

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

29. 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.

30. 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 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 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.[28] 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.

31. 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.[29] 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.

[28] 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.

[29] 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.

32. 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.

33. 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.

34. 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.

35. 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, so as to allow incumbent licensees to benefit from the service life of the existing equipment.

36. 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 Service. It has been previously recommended 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, based on Section 15.209 of the Commission's rules. If this provision is adopted 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 *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 least 30 dB greater than the median values of man-made noise at HF as outlined in ITU-R Recommendation P.372-10[30] 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.

37. The 2013 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

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

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 spoke 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.[31] 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.

38. The 2013 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.

[31] 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.

39. 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 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.

IV. Proposed Spectrum Policies.

40. As to the proposed spectrum policies and the fundamental principles underlying them, ARRL has the following comments. First, the Commission proposes to *"implement and formalize the TAC's recommendations for Basic Spectrum Principles as policies, and set clear expectations about the affected system's capabilities regarding interference, such as harm claim thresholds."* As discussed above, it is impossible to fairly set HCTs for the Amateur Radio Service because of its essentially experimental character. If the Commission was to establish HCTs for the Amateur Service nevertheless, it would have to establish a number, band by band, using median values of man-made noise. But those values are environment-dependent and hence potentially applicable only anecdotally in a limited number of environments. Furthermore, there are different aspects of man-made noise. The noise level, especially at HF but also at VHF and UHF, is subject to propagation effects: interference appears at greater distances depending on the band at issue. Moreover, the Amateur Service does not have a specific system design, and any increase in noise is a detriment to the stations' communications effectiveness. The Amateur

Service doesn't work on a system basis, and so one HCT cannot fit station designs and locations generally. Interference thresholds are both frequency-dependent and geography-dependent. In a frequency-agile, shared RF environment, Amateur stations are *exceptionally* agile, and dynamically search for and use quiet pieces of spectrum alternately. If there is a standardized HCT, it will fail to account for the inherent flexibility to use allocations to find in real time the best combination of propagation and noise environment.

41. If HCTs are to be used as proposed in this policy for "setting expectations" regarding interference to an "affected system", 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 from or to Part 15 devices*. The concept has no place with respect to unlicensed devices at all.[33] HCT limits

[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.

[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.

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 Commission has abdicated its obligation to protect licensed radio services from harmful interference from unlicensed devices.

42. ARRL is concerned that the HCT concept is dependent in part, or perhaps the HCT level might be determined in part on the relative perceived value of two radio services. For example, if it is stated that the private land mobile radio service should be reliable 90% of the time, but that 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 allocated 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 noise.

43. Receiver immunity of Amateur Radio receivers is an issue best resolved cooperatively within the Service. Radio Amateurs need no protection from in-band, fundamental signals. Amateur commercially available equipment is already the best in the world in terms of adjacent band interference rejection and dynamic range. However, radio Amateurs must have

continued protection from out-of-band emissions (which is a transmitter regulatory issue). As noted above, the Amateur Service has some of the characteristics of an experimental radio service; Amateur receivers make extensive use of bandwidth filters and collectively, the licensees have the technical skill to install necessary mechanisms to avoid interference.

44. The second spectrum management principle proposed is that the Commission should *"Adopt risk-informed interference assessment and statistical service rules more widely."* When talking about statistical service rules, it is unclear from the Public Notice and the TAC published studies whether the interference assessment is with reference to a current user; to the entire band where there isn't a current user; or whether it is based on predictive interference levels. The term "risk-informed" is worrisome; Amateur Radio operators are already fully risk-informed relative to intra-service users, co-channel and adjacent-channel. What radio amateurs use to manage it is band planning and informal, in-service frequency coordination. However, the term as used in the context of the instant proceeding, it seems to refer to the risk of interference during some percentage of the time, operating within a single frequency band and perhaps on a single frequency. The concept is not applicable to the Amateur Service, where an operator might utilize another band if crowding or high noise levels exist in one band. "Risk-informed" is a concept without much application to the Amateur Service because Amateur Radio operators are technically skilled and do their own risk informing assessments each time they initiate communications. Statistical service rules are not possible in the Amateur Service because licensees can use almost any and all emission modes in most bands. "Risk assessment," given this huge range of operating parameters, can only be interpreted conceptually to be applicable to interference in terms of actual instances of harmful interference. The TAC calls for creation of an inventory of hazards which vary by emission mode, by frequency range, and by geographic area.

That type of risk assessment may be applicable in radio services that have one primary set of operating parameters. With innumerable permutations of frequency bands, operating parameters, infinite path distances and azimuths, and an infinite set of station and system configurations, it is impossible to conduct a meaningful risk assessment of interference in the Amateur Service. Statistical methodology is not easily adaptable generally where a multifaceted radio service of 750,000 licensees is scattered across 50 states and U.S. territories. There is no way to conduct a meaningful statistical analysis for such a large group and it is not a useful mechanism for interference management in the Amateur Service.

45. The third proposed spectrum management principle is to *implement steps for improving interference resolution, including a next-generation architecture for radio spectrum interference resolution, creating a public database of past radio-related enforcement activities, and incorporate interference hunters in the resolution process.* This policy addresses a wide variety of concepts, actually. The TAC Receiver Group paper addresses spectrum sensing and dynamic frequency selection as contributing to next-generation interference resolution efficiency. Since its inception, the Amateur Service has as standard operating procedure utilized real-time dynamic frequency selection in shared allocations, performed by the operator himself or herself. This is not a simple matter to automate in HF allocations due to the "hidden transmitter effect" which makes any automated listen-before-transmit capability subject to failure. Furthermore, dynamic frequency selection and spectrum sensing assumes either a high level of compliance on the part of licensees and users of spectrum, and/or that the Commission has a high level of control over access to spectrum. In many services, neither is the case.

Speaking only to the Amateur Radio Service, there is a high degree of self-regulation[34] and peer pressure to observe good shared operating procedures including careful, real-time frequency selection and rapid changes in frequency or other operating parameters in cases of unintentional interference. Neither the high level of compliance nor the peer pressure among licensees to address interference to promote maximum spectrum use efficiency and to minimize interference exists in many other services. The Office of Engineering and Technology has urged that a useful paradigm for access to spectrum is pursuant to a shared database, accessible by internet to users, who would query the database for real time access. This could work in some cases, but absolutely not in others. Amateur Radio emergency communications cannot rely in emergency or disaster relief communications for access to a shared database, nor could they rely on the currency or accuracy of such a database. Nor would this plan work for broadcasters who need to access auxiliary spectrum in real time in order to cover breaking news. In the broadcast auxiliary service, as in the Amateur Service, users rely on private sector developed and maintained databases and real time coordination intra-service by skilled licensees themselves. Amateur band plans, individual dynamic frequency selection and cooperative interference avoidance and resolution techniques all contribute intra-service to compatible sharing of shared allocations by large numbers of users at once. In the Broadcast Auxiliary service, where shared allocations also exist, the broadcast engineering community utilizes locally maintained, continually updated databases and private sector coordination to the same end, and with the same high level of success in terms of efficiency and interference avoidance. Where these processes tend to break down is in cases in which overlays of different services are made in the same allocations. Intra-service dynamic frequency selection in shared allocations does not extrapolate well to inter-

[34] There is a long history of scrupulous rule compliance in the Amateur Radio Service. This widespread attitude is critical in a Service in which virtually all frequencies in all bands are shared; where there is no exclusivity in channel use; and where there is local, regional, nationwide and worldwide propagation at any given time.

service sharing scenarios. With respect to frequency selection by users via databases of available frequencies, it is notable that the database would not show local RF interference sources. The idea of seeing available frequencies is not practical when there are local noise sources. The scope of that problem, in turn, is dependent on the level of enforcement of the Commission's rules governing harmful interference, illegal RF devices, and illegal marketing of non-consumer devices (Part 18 and Part 15) to consumers for residential deployments.

46. *Post hoc* interference resolution is not discussed in the TAC papers in terms of new strategies that are recommended. There is merely the stated obligation to do this, but there is no formula that is being recommended. The Amateur Radio Service's use of dynamic frequency selection in real-time by individual live, skilled operators in shared bands makes interference resolution *ex ante*. It is interference avoidance. This is important because *post hoc* interference resolution by the Commission is impractical in virtually all radio services. As discussed above, the Commission has notably inadequate enforcement resources, and frankly, that situation has appertained for many years. It is simply worse now than in prior decades. It is urgent that the Commission take this into account and carefully evaluate next generation systems architecture in terms of interference avoidance, and to not rely on or assume the availability of *post hoc* spectrum interference resolution will work.

47. On the other hand, creating a public database of past radio-related enforcement activities is a very good idea. Given the very limited and recently, severely diminished availability of field enforcement resources, it is urgent to publicize those enforcement actions that pertain to intentional or harmful interference in order to maximize the deterrence value thereof. The Commission has a web site, which, though not updated adequately, nevertheless lists enforcement actions taken in the Amateur Service over recent periods of time. This is

notably effective, contributing to an atmosphere of deterrence among licensees and rule compliance. ARRL is of the view that what has proven successful over time in the Amateur Service is applicable in virtually all licensed radio services: Few Commission resources are needed in order to ensure a high level of rule compliance where there is a sense of deterrence among licensees. In the Amateur Service, due to shared spectrum, long-distance propagation and the absence of secrecy of content in this Service, a very few chronic rule violators are very visible. The longer a person is allowed to violate rules or create interference without visible sanctions, the more the violator is encouraged to continue the behavior and the more likely that others may emulate the behavior. Conversely, the faster and more visibly the Commission acts, the greater the level of deterrence for violators and other potential violators. So, what little FCC enforcement is necessary must be both (1) timely, and (2) visible.[35] Without the deterrence value provided by a very few timely and visible enforcement actions, compliance deteriorates markedly and quickly. ARRL is of the view that these principles are applicable among all radio services to a greater or lesser degree.

48. As to developing a corps of "interference hunters" and deploying them in interference resolution efforts, this is an area in which the Amateur Radio Service has excelled over many years, in two different programs. ARRL participates in and sponsors (in partnership with the Commission) the "Official Observer" or "Amateur Auxiliary" program: a legislatively authorized program that the Commission has implemented pursuant to a written agreement with the Commission which provides for a large number of ARRL-appointed and trained volunteers

[35] The underpinning of compliance in the Amateur Service is the *perception* of an active enforcement presence in the field that creates deterrence and promotes compliance. This perception was prominent in the Commission's Amateur Radio enforcement program between 1998 and 2008, when the program worked exceptionally well. Compliance during those years was successful because of (1) the visibility in the Amateur Radio community of a single member of the Commission's Enforcement Bureau staff at Amateur Radio events; and (2) by making available to the Amateur Radio media everything that was done by the Bureau and the publicizing of those actions, except where privacy rights would be violated or where confidentiality had been requested.

to monitor Amateur frequencies for compliance issues and to provide the results of that monitoring to the Commission. In serious or repeated rule violation cases, recordings of on-air communications of non-compliant operation are made by volunteers and sent to ARRL and to Enforcement Bureau staff, along with notations of times, frequencies and, if known, the likely location of a rule violator, determined by direction-finding techniques. The information gathered by these volunteers is not used directly as evidence by the Commission, but it has allowed prediction of times and days a particular rule violator might be operating and patterns of rule violations. This enables the limited staff in the field offices to focus their evidence-gathering effort for maximum efficiency. Even with this volunteer assistance, however, the other work of the field offices precludes dedication of much time to necessary evidence gathering. The other mechanism that is utilized by ARRL for interference resolution is administered by ARRL's Laboratory staff. The Staff advises radio Amateurs who have serious, ongoing RF interference issues from non-Amateur sources how to determine interference sources, how to resolve them cooperatively with the source of the interference (e.g. power utilities, RF lighting users, etc.) and, using volunteers, doing on-site interference resolution work. ARRL staff also works cooperatively in these cases with Commission Enforcement Bureau staff to obtain cooperation from the interference sources in resolving the cases informally. The combination of these two ARRL programs is notably effective in interference resolution.

49. ARRL is of the view that private sector interference resolution efforts using volunteers with effective and timely assistance from the Commission's Enforcement Bureau where necessary provides the best opportunity for *post hoc* interference resolution. This is not to suggest that *post hoc* interference resolution is to be relied on; it is clearly the long way around; it is far inferior to *ex ante* interference avoidance techniques in the allocation process and in the

updating of service rules for various radio services. In many cases, interference resolution efforts are unsuccessful in addressing RF interference cases.[36] Nevertheless, a cooperative private sector/FCC interference resolution program would be helpful in increasing the success rate of *post hoc* interference resolution and in creating deterrence among those licensees, manufacturers and operators of intentional and unintentional radiators that cause interference. ARRL would be pleased to participate in such a program and would be able to develop recommended practices to help train interference hunters. Commission staff, to the extent available, are skilled in finding non-compliant transmitters, but generally in areas such as identifying and cooperatively resolving broadband noise sources, ARRL would claim the highest degree of expertise and experience. ARRL staff and volunteers can find those sources and they can identify solutions. However, in order to create a meaningful interference hunting corps, the Commission will have to do far better than it has in the past in providing support once an interference source is identified and where the operator of that source is unwilling to participate voluntarily in arriving at a solution. The Commission has failed utterly over decades in calling power utilities, for example, to account for their failure to resolve interference cases brought to their attention. And the Commission's online interference complaint filing system is literally of no value or benefit at all.

V. Proposed Spectrum Principles.

50. The Public Notice sets forth a series of nine principles intended for use in implementing the three policies discussed above. The first of these principles is that "Harmful

[36] There is a burgeoning problem of interference from unlicensed devices, most especially radio-frequency RF lighting ballasts known as "grow-lights," which cause interference throughout entire communities. These and similar devices preclude Amateur Radio communications in those communities due to the very sensitive receivers used in the Amateur Service. They also create high ambient noise levels in the AM broadcast band over very wide areas, driving AM listeners to other media. The Commission is doing a decreasingly effective job addressing equipment authorization violations and in policing the interference from illegal radio frequency devices. Numerous cases over a decade old, repeatedly reported by ARRL laboratory staff to the Commission's Enforcement Bureau are allowed to continue unabated.

Interference is affected by the characteristics of both a transmitting service and a nearby receiving service in frequency, space or (sic) time." [37] ARRL takes no fundamental issue with this principle with two exceptions. First, ARRL is constrained to note that there is no "receiving service." There are just receivers. However, notably, this principle incorporates a policy definition of Harmful Interference. It would be more accurate to say simply that "interference is affected" by the listed factors. The use of the term Harmful Interference subsumes within it an implicit characterization of an obligation to resolve interference – a policy judgment related to the ITU and ARRL Rule Part 2 definitions[38] of the term, discussed above. Furthermore, the statement is not an absolute truth. Had it said "interference" only, it would be true. No policy judgments should be inferred from use of the term "Harmful Interference" as the term is used in ITU and Commission Part 2 rules parlance. Neither does the principle as stated have any application to interference to and from Part 15 devices, because the concept of Harmful Interference does not apply in the Part 15 context, as discussed above in Footnote 33.

51. The second principle proposed in the Notice is that "All [radio] services should plan for non-harmful interference from signals that are nearby in frequency, space or time, both now and for any changes that occur in the future." This principle presumably refers to receiver overload relative to frequency separation from the transmitted signal. But it also covers co-channel, or shared band uses. It states, somewhat ominously, that if a user is going to be operating a receiver, that user has to be ready for levels of "non-harmful" interference will arise at the current time using current technology and in the future using unspecified technology. It is not clear, however, what definition of non-harmful interference will be applied. Without a clear, common understanding of that term (one possibility being that level of interference which does

[37] The principle, in ARRL's view, should more inclusively read "…frequency, space and/or time".
[38] See Footnote 32.

not repeatedly disrupt or degrade communications in a non-public safety or non-safety of life radio service) it is impossible to determine whether or not a given radio service can accept the principle. If non-harmful interference is the converse of the definition of Harmful Interference in the ITU Radio Regulations and in the Part 2 rules definitions, ARRL is in general agreement with the principle. As to the future, spectral density is definitely expected to increase over time. Even so, the Amateur Service has new equipment that is regarded as state of the art, which has the ability to reject signals outside the Amateur bands, provided that other radio services use good engineering practices.

52. The third Principle states that "Even under ideal conditions, the electromagnetic environment is unpredictable. Operators should expect and plan for occasional service degradation or interruption. The Commission should not base its rules on exceptional events." This is quite problematic for the Amateur Service. Radio Amateurs' operating techniques often exploit exceptional events, such as meteor showers, F2-layer openings that occur a few times every eleven years, trans-equatorial VHF openings above 144 MHz, and even occasional satellite orbital passes. The stated principle, therefore, really has no application to a radio service such as the Amateur Service, which has components of an experimental radio service and which exploits the exceptional in radio propagation. It is clear what the principle espouses: the Commission should not write rules that will protect a radio service all of the time against all types of interference. That is an acceptable principle. The Amateur Service does expect and plan for occasional service degradation due to the inevitable vagaries of radio propagation throughout the spectrum. But regular occurrences of interference are not acceptable generally. Commission rules are properly based on avoidance of regular occurrences of interference. The vagueness of

this principle is not helpful, however. There is no definition of "occasional" interference provided and the breadth of the concept is difficult to ascertain without one.[39]

53. Analyzing this and the prior principles is made difficult as well by the failure of the TAC to inform the reader whether the reference is to interference to the service as a whole, or whether the concept applies to individual stations. The issue is not purely academic. For example, Section 2.1 of the Commission's rules defines harmful interference in terms of services, as does the ITU Radio Regulation definition (i.e. Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations). The somewhat different and less inclusive Part 15 [40] definition, however defines Harmful Interference as "Any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with this chapter." It is not clear whether any "occasional" incident of interference (as the term is used in the principle) to an individual station could be harmful interference. If so, the principle is invalid as a generalization.

54. The stated principle is not true under all circumstances in any case: a radio Amateur who deploys a point-to-point microwave control link that is highly engineered over an appropriate path for the frequency band used shouldn't have to plan for occasional service interruptions or degradation. Rules should not be created to protect all users in all cases, and the occasional degradation or interruption of the service on a transient basis is to be expected in most

[39] It is notable also that "exceptional events" can be geographic rather than temporal. As an example, there are very few wind profiler radars operating in the 449 MHz band. However, where they are located, they are incompatible with co-channel Amateur Radio repeaters. It is entirely proper and necessary for the Commission to create rules and policies that will deal with the admittedly rare instances of geographic incompatibility of licensed radio services.
[40] 47 C.F.R. § 15.3(m).

cases (e.g. the HF and MF spectrum allocations), but where a competently engineered system is created for purposes of minimizing unpredictability, that expectation should not be vitiated. Again, radio Amateurs will not accept Part 15 device-generated unpredictability in the use of allocated spectrum.

55. The fourth Principle is that "Receivers are responsible for mitigating interference outside their assigned channels." This is a receiver performance consideration and it does not address out-of-band emissions. It assumes that there is a properly operating transmitter on a fundamental transmit frequency. In this case, the statement is true. Amateur Radio receivers are in general state of the art. There is no need to regulate them, and the statement can be considered accurate with respect to Amateur Radio receivers, though the reference should be with respect to "assigned bands" rather than "assigned channels" since there are, with but one exception, no specific assigned or allocated channels in the Amateur Service.

56. The fifth Principle is that "Systems are expected to use techniques at all layers of the stack to mitigate degradation from interference." This is an overstatement if it is to be used as a basis for a regulatory requirement. However, it is true if it is a statement that each service must add filters, use passband tuning, etc. or incorporate other *reasonable* circuitry in order to limit the effects of interference. It is not reasonable, however, to ask for changes in spectrum use in order to utilize allocated spectrum successfully. As discussed above, there is no justification for the oft-repeated suggestion that Amateur Service stations, in order to avoid interference from power lines, PLC systems, or point-source radiators must aim directional antennas away from sources of interference. That is an unreasonable and unacceptable method of interference mitigation.[41] Amateur radio is intended to use a wide variety of operating modes, so this

[41] There are often interference mitigation techniques to be used in individual cases if an Amateur Radio licensee is given the flexibility to implement one, however. Were the Commission to firmly entitle all licensees to install and

principle should be applied only to the extent possible, and as appropriate, given the operating mode being used.

57. The sixth principle is that "Transmitters are responsible for minimizing the amount of their transmitted energy that appears outside their assigned frequencies and licensed areas." This is a true statement. Transmitters in licensed services are responsible for out-of-band and spurious emissions. This is distinct however from the obligation of Part 15 device or system operators, who are responsible for *all* interference from their operation, devices and systems, whether in-band or out-of-band emissions. Nothing in this principle should be relied upon as a basis for relaxing or reducing standards that are already prescribed by existing rules. Section 2.102(f) of the Commission's Rules [47 C.F.R. § 2.102(f)], for example, 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 rule is taken almost verbatim from the international Radio Regulations. RR 4.5 states as follows: "The frequency assigned to a station of a given service shall be separated from the limits of the band allocated to this service in such a way that, taking account of the frequency band assigned to a station, no harmful interference is caused to services to which frequency bands immediately adjoining are allocated." The obligation to protect adjacent band services from harmful interference is not therefore based solely on domestic decision making. It is also an international treaty obligation, binding on the Commission.

58. The seventh Principle is that "Services under FCC jurisdiction are expected to disclose the relevant standards, guidelines and operating characteristics of their systems to the Commission if they expect protection from harmful interference." This is not universally correct,

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maintain an effective and functional directional antenna, for example, then it might fairly be deemed unreasonable for an Amateur licensee to complain of interference received via an omnidirectional antenna when a directional antenna might minimize interference in a particular case.

and it is not suitable as a premise for entitlement of Amateur Radio Service stations to interference protection. Amateur licensees are expected to, and regularly do adapt all new emissions and operations to amateur use as an experimental radio service premised upon their technical self-training. Amateur operations are in a constant state of evolution and flux, as is evidenced by recent startling growth in use of narrowband data emissions in the HF Amateur allocations and the deployment of them in emergency and disaster relief communications. While ARRL has developed (and periodically updates) hypothetical reference circuits, they are, given the nature of the Amateur Radio Service, purely anecdotal. Amateurs deploy some systems like repeaters and digital networks, but the typical Amateur station is an individual, stand-alone station.[42] ARRL does document some performance specifications; ARRL has a plethora of technical reporting publications. But it is not able to document all systems and technical and operating characteristics. And even if that were possible, there are differences in station interference parameters depending on geographic and RF environmental characteristics. This principle presupposes a far greater degree of standardization than exists in the Amateur Service, so its applicability is not at all universal.

59. The eighth Principle is that "The Commission may apply Interference Limits to quantify rights of protection from harmful interference." This is a very broad acceptance of harm claim thresholds without exception. As discussed extensively hereinabove, it is an overbroad statement. It is not applicable to the Amateur Service. Nor is it applicable to Part 15 devices and systems. Even if HCTs were found to be applicable to the vast array of Amateur Service operating parameters, it is not clear from this principle or others whether, if a receiver or system does not or cannot meet the HCT, there would be no interference protection in a given case, or

[42] Indeed, it is this independence from system integration that hardens the Amateur Service in times of natural disasters, allowing the stations to be of unique value "when all else fails" in disaster recovery.

no frequency allocation made for the Service at all. What is this principle a metric for? The fact is that Harmful Interference is a qualitative determination based on policy decisions, not easily quantified. This principle, as stated, presumes an intention to protect only the most robust systems from interference. Services using sensitive receivers are prejudiced. Is there assumed a value based metric, assessing relative value to the public of the service provided by the interferer, and that provided by the service in which the victim receiver operates when an HCT is determined?

60. There is, in general, an inability of Amateur Service licensees to make measurements to determine whether field strength levels are exceeded. If Amateur licensees are not capable of conducting those measurements, then other services which have non-technical operators will not be able to do so either. HCTs may be useful in the creation of service regulations, but they are not helpful in interference resolution in individual cases. In individual cases, if there is harmful interference, it should be addressed. Whether or not there are HCT limits established, if Harmful Interference occurs, it still should be addressed. Establishment of HCTs applicable to Amateur stations would fail to protect amateur experimental work, because it is impractical to make field strength determinations before a claim of harmful interference can be made. The equipment is expensive; it must be calibrated; and the calculations are difficult.

61. Finally, Principle nine states that "A quantitative analysis of interactions between services shall be required before the Commission can make decisions regarding levels of protection." If this principle can be restated to say that spectrum overlays and adjacent band allocations must be determined to be compatible with incumbent licensees before spectrum sharing or other allocations decisions can be made, then ARRL is in agreement with it. ARRL has asserted for many years that the Commission, before it can make a new allocation, must

conduct a technical compatibility analysis. Too often, the Commission has made allocation decisions, especially with respect to unlicensed services and broadband services, based on perceived social value of a new service rather than on technical compatibility studies or the effect on incumbent licensees and services. This is untenable any longer, if indeed it ever was proper spectrum management to begin with.

VI. Conclusions.

62. In the main, the TAC proposed spectrum management policies and principles are not new concepts. They are in some cases proposals that the Commission has made before and heard from the public about before. Concepts such as interference temperature, receiver immunity and harm claim thresholds should be utilized in spectrum management policy where it makes technical sense to do so, but as can be seen from the comments hereinabove, it is highly inappropriate to generalize about their use in all radio services; especially those in which application of the concepts would limit or compromise the communications services to be provided. In the main, the spectrum allocation principles suggested by the TAC include overgeneralizations, and that should be avoided in any future reliance on them. However, the TAC is very much on the right track with certain concepts such as receiver immunity standards for certain radio services and especially for consumer electronics, and the initiation of necessary and urgent programs such as interference hunting teams, to supplement the Commission's meager enforcement resources. ARRL is in a unique position to assist in the development of the latter program and we look forward to doing so. Overall, however, adoption of any next-generation spectrum management techniques as recommended in this proceeding and in the TAC papers presuppose the existence of a knowledge database regarding ambient noise levels in certain environments. Sadly, that information does not exist and it won't any time soon, because

the Commission, for whatever reason, has taken the TAC off of the noise study project proposed in 2016. That, in ARRL's view, is a big mistake. No system of spectrum management incorporating HCTs, interference thresholds and receiver immunity levels can be accurately implemented without the data that would have been provided by the noise study. That study is more important now than ever before, and it is increasingly urgent as a prerequisite for any new spectrum management policies. The Commission should place the cart back behind the horse where it belongs.

Therefore, the foregoing considered, ARRL, the national association for Amateur Radio hereby respectfully requests that the Commission implement new spectrum management policies and adopt principles underlying the same only in accordance with the recommendations and comments set forth hereinabove.

Respectfully submitted,

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