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

In the Matter of	)	
	)	
Establishment of an Interference Noise Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands	)	**ET Docket No. 03-237**

To: The Commission

COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, the National Association for Amateur Radio, also known as the American Radio Relay League, Incorporated (ARRL), by counsel, hereby respectfully submits its comments in response to the *Notice of Inquiry and Notice of Proposed Rule Making*, (the Notice) FCC 03-289, 69 Fed. Reg. 2863, *et seq.* released in the captioned docket proceeding November 28, 2003. The Notice asks for comment on a new interference temperature model for quantifying and managing interference. The concept is to shift from regulating transmitters to a paradigm of regulation of the RF environment, which takes into account the interaction between transmitters and receivers. In the interest of the Amateur Radio Service in effective, responsible and efficient spectrum management, ARRL states as follows:

I. Introduction

1. The Commission is interested in the possibility of adding new licensed or unlicensed services in spectrum used by incumbent licensees which can tolerate additional undesired RF energy or noise in the RF environment where that service's receivers operate. If the regulations take into account the effect on receivers of all

undesired energy in a given band at a given time that would affect receiver operation, the theory is that this would allow more efficient deployment of additional "underlay" services in that same band at the same time. The interference temperature limit would act as a "cap" or upper limit on the potential RF energy that could be introduced into the band.

2. The Inquiry portion of the Notice seeks comment on the development and use of an interference temperature metric, and how to manage a transition from the current transmitter based approach for interference management to the RF environment approach. Of course, this would involve planning, study of existing RF noise and interference levels, and other factors that would take a significant amount of time to complete. Nevertheless, the Notice of Proposed Rule Making portion of this proceeding asks what rules should be adopted now which would establish interference temperature limits and procedures for assessing the interference temperature in specific bands used by fixed satellite uplinks and terrestrial fixed point-to-point links. These facilities do not normally occupy Amateur Radio allocations, and as such, the Notice of Proposed Rule Making portion of this proceeding does not directly affect the Amateur Service. Nevertheless, the concerns that ARRL has about the Interference Temperature concept as a model are substantial, and it is strongly urged, for the reasons set forth below, that the Notice of Proposed Rule Making in this proceeding is highly premature and should not go forward.

3. Of the recommendations contained in the Commission's Spectrum Policy Task Force Report, none seemed more controversial than the recommendation to study the possible award of "underlay" rights for the use of already-licensed spectrum based on the

concept of the interference temperature model. The concept is rather simple: If the combined radio frequency (RF) level of existing noise sources in an environment plus that contributed by the low-power devices contemplated by the proposal are less in the aggregate than the interference threshold of the existing receivers of the incumbent licensed radio service in a given bandwidth, there is by definition no interference to existing operations of that licensed radio service. What sounds simple in theory, however, is quite another matter in practice.

4. In the comments filed in response to the Spectrum Policy Task Force Report, those of incumbent licensees in the Broadcast, Amateur, Commercial Wireless, Satellite and Microwave services strongly opposed the concept of underlay rights premised on implementation of an interference temperature metric. Thus, this proceeding scales back the proposal in order to create a "test bed" for the concept. It is asking for proposals to rapidly implement the concept in two bands, the 6525-6700 MHz band used by the Fixed Microwave Service and the Fixed Satellite Service, and a portion of the 12.75-13.25 GHz band used by the Fixed Service, the Fixed Satellite Service, and the Broadcast Auxiliary Service. The Commission estimates that more than 400 million low power unlicensed devices could operate within the two bands without exceeding a reasonable interference temperature.

II. The Commission Lacks Sufficient Information And Management Tools To Develop or Implement An Interference Temperature Metric

5. The Commission does not presently have sufficient information to implement an interference temperature model for management of any of the radio spectrum. The Notice, at paragraph 4, states that "[a] general implementation of the interference

temperature approach would involve planning, study of existing RF noise and interference levels and other factors, and transition processes that would take a substantial amount of time to complete." ARRL agrees with this wholeheartedly. The Commission's rules for Part 15 unlicensed devices, for example, are wholly inconsistent with creation of an interference temperature metric, since they are premised on point source radiators and not on any understanding of aggregate noise levels or of distributive unlicensed systems. The concept of interference temperature is a holistic concept, not one merely based on receiver immunity or receiver interference thresholds. Holistic spectrum management requires an understanding of the noise environment on a band-by-band, geographic area-by-geographic area basis, and, as the Notice states, a dynamic noise management program that allows monitoring of the noise environment. It is suggested that the Commission presently has virtually none of the information about the noise environment that would be necessary to support any implementation of the interference temperature planning concept now.

6. An example of the problem is the 2400-2483.5 MHz band. The proliferation of unlicensed devices in this band has rendered it all but unusable for licensed services. The aggregate noise levels from Wi-Fi systems in this band have raised the noise floor to levels that are so high that even wideband video systems cannot operate there. Active management of the noise environment implies some control over the operation of unlicensed devices and systems deployed on an underlay basis in the band, regardless of the receiver sensitivity calculations used as a determinant of the threshold for interference in a given band in a given geographic RF environment. The Commission has, under its present Part 15 paradigm, no control whatsoever over the proliferation of RF emitters,

either in terms of the numbers or nature of the systems (i.e. point source or distributive) so it cannot assume that it could regulate the RF environment under an interference temperature model. It certainly could not do so on a dynamic, real-time basis.

7. More fundamentally, the Commission has no reliable data on the RF noise environment now. It has not proceeded with studies, conceptually initiated by the Technological Advisory Council, that would provide information over a medium term, to determine (1) what the nature of current noise levels are in the RF spectrum, and (2) what the trends are due to proliferation of licensed services in certain bands and especially the proliferation of unlicensed devices and systems. There is, in other words, insufficient data to use as a base line to proceed to calculate an interference temperature metric.

8. The Commission's zeal to provide more opportunities for competitive and innovative services and devices for the public through more intensive use of allocated spectrum is both understandable and laudable. ARRL supported the theory in its comments on the Spectrum Task Force Report. Theoretically, an interference metric is a good concept because it is a holistic management technique. It is, however, hardly a new concept. On both an intraservice and interservice basis, calculations of desired-to-undesired signal ratios and signal-to-noise ratios have been calculated and utilized for many years as a means of determining whether newcomers can be accommodated in deployed spectrum.

9. There can be no shortcuts, however, in a conceptual shift to management of the RF environment without disenfranchising incumbent licensees, which themselves provide valuable and sometimes indispensable services to the public.[1] Whether by overlay or

[1] The Commission has, in recent times, publicly characterized interference concerns of incumbent licensed radio services raised in the context of proposals for the addition of overlay and underlay services as

underlay of additional users, the Commission has stumbled repeatedly by attempting shortcuts in the process. The Commission has proposed to allow higher power Part 15 devices in deployed television broadcast allocations without any determination of the effect on new digital receivers or the RF environment of the television broadcast bands, at the same time it is demanding high definition television implementation rapidly. It allowed cellular architecture for commercial mobile service providers on an interleaved basis in public safety wireless allocations without first determining the effect of the changed environment on deployed public safety receivers, with disastrous results. It is now rushing to judgment on a proposal to permit broadband over unshielded power line systems in the high frequency and low-band VHF spectrum without first carefully studying the ability of sensitive and geographically proximate fixed and especially mobile radio systems to tolerate such interference.[2] The point is that the Commission has heretofore not shown itself willing or able to manage the RF environment as proposed. It has neither the management tools under the present paradigm for regulation of unlicensed devices to prevent a cacophony of essentially unregulated competing RF emitters to the detriment of incumbent services, nor the basic knowledge from noise studies necessary as a predicate for the proposed new paradigm. It is suggested that there is a fundamental inconsistency between the concept of unlicensed device deployment under the existing Part 15 rules and the concept of dynamic regulation of the RF environment. Given the

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"NIMBYism" and resistance to change. That is an unfair and wholly unjustified accusation. The entire concept of dynamic RF spectrum management is the determination of compatibility in sharing of allocations. The determination of compatibility in these contexts, which is the precise goal (and potential benefit) of the instant proceeding, is a technical one. The Commission's recent historical trend is to shortcut that process, or avoid it altogether. It is not unreasonable for an incumbent allocated radio service to insist on a full compatibility study prior to allocation decisions being made.

[2] Particularly telling in this example are the proffered substitutes for prior investigation of the effect of the proposed changed RF environment from the Commission's proposal. Instead of determining what the proper RF environment should be after deployment of BPL systems, the Commission suggests that the affected radio service merely orient its antennas away from the source of the interference.

Part 15 rules as presently configured, there is no control that can be asserted over the RF environment sufficient to support an interference temperature metric, even if receiver immunity is developed (as per ET Docket 03-65) as an element of the management tools.

10. The management tools necessary as components of an interference temperature metric include, as discussed above, a firm baseline understanding of the ambient noise levels in a wide variety of environments in a wide variety of frequency bands. These include rural, exurban, suburban, urban and metropolitan land use environments, given the substantial differences in relative densities of RF devices in each. It would also include data, to be developed over substantial periods of time, of trends in ambient noise in those same environments in those same frequency bands. It would include calculations and experimentation with the aggregate effects of additional RF systems and devices that might be added on an underlay basis to allocated bands, and a relative evaluation of the receiver immunities of incumbent licensees on a service-by-service basis. It also requires study of the differences in interference potential to receivers in incumbent services based on distributive RF systems, such as unlicensed wireless broadband access systems and carrier-current systems, versus the interference potential of individual point source radiators. None of this information is now available to the Commission. Yet the Notice of Proposed Rule Making portion of this proceeding is on the table now. ARRL suggests that the order of things is improper. It seems that the Commission is looking to expand an unmanaged and unmanageable system of unlicensed devices, over which there is no practical control after the point of sale, by the use of a paradigm that assumes that the RF environment can be controlled, taking into account that environment from the perspective of the victim receiver. If the RF environment is not

manageable as the result of the proliferation of unlicensed devices in many portions of the spectrum, the interference temperature metric would appear doomed to failure.[3]

III. An Interference Temperature Metric May Be Workable In The Long Term In Some Contexts But Not Others

11. Assuming that an interference temperature metric for spectrum management can be adopted on a forward looking basis, and that the information discussed above is obtained, the Commission proposes at paragraph 7 of the Notice to use real-time measurement of actual spectrum use and adapt the responses of transmitters and receivers to those measurements. It is difficult to perform this function in the abstract, given the variety of receivers in various bands, which are dictated largely by the function to be performed by the incumbent service. Of particular concern to the Amateur and Amateur-Satellite Services (and to such services as Radioastronomy) are the extremely weak received signal levels and low interference threshold of receivers normally used in communications and research in those services. While an interference metric might fit in microwave bands allocated to the fixed services, due to the narrow antenna beamwidths, high received signal levels and opportunities for frequency re-use in those services, such measurements are largely irrelevant in the Amateur Services operating at HF, and for mobile services using unpredictable paths at unpredictable times, including amateur microwave operation, which is itinerant and which regularly incorporates the use of extremely weak received signals over unpredictable paths.

[3] The Commission notes, at paragraph 11 of the Notice, that, for an interference temperature limit to function effectively on an adaptive or real-time basis, a system would be needed to measure the interference temperature in the band and communicate that information to devices subject to the limit, and a response process would also be needed to restrict the operation of devices so as to maintain the interference temperature at or below the level of the limit. This would occur ideally within each individual device itself, assessing both the interference temperature at its location and make a transmit or no transmit decision based on that temperature and the device's own contribution of RF energy at a particular time.

12. There are so many variables at issue in assessing the RF environment in a given band, at a given location, and at a given time, and there are so many variables in spectrum use by certain services that it is difficult to envision a real-time RF environmental assessment process (especially one within a given device), that would work at all effectively, especially with respect to unlicensed devices and systems. Where would the assessment of the RF environment take place? Above the device or below the device? At what distance from a receiver would the measurement be taken? How would that distance be determined by the subject RF contributing device? What would be used for an antenna and RF sensing system in calculating the RF environment? How would the portability of the device be affected? The concept as discussed at paragraphs 11 through 14 of the Notice appears impractical. Another alternative discussed by the Notice is a more complicated, perhaps centralized, grid-based or system-based monitoring system external to the RF devices that could cause all such devices to cease transmitting in certain circumstances where the interference temperature was exceeded. Again, given the number of variables in determining the normal service contour of the incumbent radio station, avoiding reduction of a given station's service contour is difficult to conceptualize. Mobile stations pose one set of imponderables to the metric, and services such as the Amateur Services, where there are combinations of mobile and itinerant operation and service areas that are extremely large. In the case of HF and satellite services, these span the globe and the space segment. In the case of weak-signal terrestrial Amateur HF, VHF, UHF and microwave operations, the service areas are hundreds or thousands of miles, and the interference threshold of the receivers is extremely low.

13. Any interference temperature metric would have to incorporate real-time adjustment that would preclude or modify operation where the environment exceeds the temperature for that band segment, at a given time and at a given location. The challenges in (1) making the RF environmental assessments, and (2) making those real-time adjustments in view of the RF environmental assessments, inevitably makes the concept a complex and expensive one at the present time. Even if the Commission had the ability to manage the RF environment under its unlicensed device regulatory scheme, and possessed the information necessary in order to accurately assess and determine the interference temperature of any band in any location and relative to the variety of incumbents, the cost of the system is going to be high. Yet, at paragraph 19 of the Notice, the Commission notes that it is not possible to even test the interference temperature metric in an unoccupied band due to cost factors for consumer devices:

> As technology advances to higher and higher frequencies, investments in infrastructure communications, such as point-to-point systems, point-to-multipoint systems and satellite systems, have to keep ahead of the low-cost technology that is the back-bone of consumer electronics. As a result there are no unoccupied frequency bands within the range of frequencies where low-cost consumer applications can be easily manufactured.

If cost for unlicensed consumer devices is an issue in determining a test bed frequency band for development of an interference temperature metric, it is difficult to rationalize the Commission's insistence that consumer electronics manufacturers establish monitoring systems that can sufficiently evaluate the ambient RF environment and maintain, in the aggregate, RF levels below a predetermined interference temperature for a given band relative to specific receiver requirements of incumbent services in that band.

14. As noted above, if there is to be a test bed for the interference temperature metric (and ARRL believes that such is premature and ill-advised), it should be confined to a band or subband, (or bands or subbands) above 1000 MHz in which there are only fixed service or fixed-satellite incumbents. That provides the simplest RF environment in which to determine and measure interference temperature.

15. The Notice, at paragraph 21, asks what factors should be considered in setting interference temperature limits. Among the factors suggested are the extent of current band use; the types of services being offered; the types of licensees (i.e. public safety); the criticality of services; the state of development of technology; and the propagation characteristics of the band. These suggestions are, frankly, startling. None, save for the last, has any relevance whatsoever to calculation of the RF environment, the interference threshold of incumbent service receivers, or the ability of underlay services to maintain operation below a calculated interference threshold for a given band in a given area. Instead, these are standard qualitative issues used in making allocation decisions under the current paradigm. Does the Commission really intend to qualitatively evaluate in the context of establishing an interference temperature metric how "critical" an incumbent licensed service is by comparison to a newcomer, which would operate on an underlay basis? If so, then why bother with considering interference temperature at all? Those factors are assessments made under the current paradigm of spectrum allocations domestically. The Commission's premise in this proceeding is not to prioritize radio services in the normal course, but to accommodate additional uses in bands utilized by incumbents. That is a technical evaluative process. The relative merits of a radio service, the criticality of its service, and the quantity of incumbent service use are irrelevant to the

concept. The propagation characteristics of communications conducted by stations in incumbent services, by comparison, are highly relevant, as are the determination of service areas of incumbents, the emission mode(s), the bandwidth of signals, the receiver sensitivities, the types of antennas, gain, directionality, and typical receive signal levels. This requires some predictability, of course, based initially perhaps on hypothetical reference circuits for various services in addition to calculations based on actual stations and systems.

16. For the same reasons, the Commission should not differentiate between receivers used by primary or secondary allocated incumbent services. Both are entitled to protection from interference from newcomer underlay services, especially where the newcomer is an unlicensed RF device. Where there are differences in interference protection between the primary and secondary service, the lower interference threshold should be adopted. As to what entities should participate in the process of determining interference temperature limits, this appears a good subject for negotiated proceedings, where all affected parties participate through technical representatives. The incumbent services are in the best position to present data concerning receivers and operating characteristics of their own stations and systems. This is a dynamic process, since the interference temperature limits will change with improvements in technology. The timing of review of the limits is variable, depending on changes in the RF environment in a particular band. Dynamic monitoring of the RF environment obviates the need to regularly review the interference temperature metric for a particular band in a particular geographic area. The incumbent services have some effect on the timing of such review as well. A relatively stable environment, such as the radio broadcast bands, might be

reviewed, for example, every five years as a general benchmark. Other environments, where change is occurring, such as in the 800 MHz band, might be reviewed more often.

17. Monitoring systems for managing the RF environment and controlling underlay devices so as to remain below the ascertained interference temperature are difficult to implement such that they serve the intended function. ARRL is not optimistic about the success of the monitoring systems, or sensory or control equipment discussed in the Notice. The RF environment should, in any case, be monitored separately by band or even subband, depending on incumbent use; by geographic area type; and the cost of such systems should be borne by the underlay service, or by the manufacturer of the devices to be deployed there, if unlicensed devices. The response of such sampling monitoring systems should be to disable the underlay devices, in the aggregate, in the event that the interference temperature is exceeded in a given band in a given area, without participation of the incumbent licensed service. This is the simplest, and presumably the most efficient and prompt means of protecting licensed incumbent services against harmful interference. The system must be transparent to the licensed service users. Again, this is a tall order. Again, in ARRL's view, the Commission does not presently have enough data or the regulatory framework to implement such a concept or to manage the RF environment in most frequency bands below 25 GHz as would be necessary in order to implement such a concept.

18. The Commission asks how to define the noise floor and whether there are considerations that would justify using slightly different definitions for different bands or services. It also asks for data concerning noise floor measurements and research on levels of the noise floor over time and in geographic areas. This is precisely the information that

is lacking at the present time. ARRL is conducting noise studies in different geographic environments, and this subject was a topic of some discussion by the Technological Advisory Council sponsored by the Commission, on which ARRL is represented. It is submitted that objective, formal studies be commissioned and evaluated on an open, cooperative basis so as to make some determinations that can be used as a predicate for the establishment of an interference temperature metric in the future. The Notice, at paragraph 26, acknowledges that this is a substantial, time consuming and resource intensive undertaking. It asks for suggestions on collecting this information on a timely, cost effective basis or to develop acceptable estimates. While computer models can provide some basis for estimating noise floor information in various geographic environments, and while the effect on propagation can be to some extent predicted using propagation prediction software (ARRL has done some of this modeling to date in individual instances), there are no shortcuts, and actual measurements are unavoidable over time in order to make accurate interference threshold determinations and therefore interference temperature calculations.

19. At paragraph 28 of the Notice, the Commission asks the ultimate question, one without an answer at present. The Notice claims that, since interference can be characterized as an emission from a transmitter that impedes reception of a desired signal to a given recipient, but that it is only harmful if it rises to a certain level, how much interference can be tolerated before it is considered harmful? As discussed above, with respect to the Amateur Service, the answer is variable depending on which of the wide variety of operating modes and frequency bands are at issue. In the HF spectrum, and in the weak-signal segments of the various Amateur allocations at VHF, UHF and in the

microwave region used by convention for narrowband, weak received signal levels, the level of interfering signal that would have to be considered harmful is extremely low. That which is considered harmful, however, in bands shared with government services and used by radio amateurs for spread-spectrum communications, or for error-correcting data or FM repeater operation would be considerably higher. There is no single answer to the question. A standard response, if there was to be one, to the issue of what increase in the noise floor might be acceptable is that signal level which, in the aggregate, increases the noise floor by not more than 1 dB in most cases and 0.5 dB for public safety services. These figures are the result of interference to receiver noise ratios of -6 dB and -10 dB, respectively, which are widely recognized within the ITU Radiocommunication Sector as applicable to detailed sharing analyses.[4] It may also be necessary to specify the maximum percentage of time that the criteria may be exceeded considering all noise sources, such as 1 percent of the time for particular services. There is, in ARRL's view, no present means of quantifying what level of RF signal constitutes harmful interference or what constitutes a "safe harbor", other than the foregoing. ARRL agrees that some quantification is necessary in order to establish an interference temperature model, but the data that the Commission lacks, discussed above, is part of each calculation for each band, in each geographic area, and perhaps during different time periods, taking into account the various different radio services in each band. There is no generalization possible in this context. It is ARRL's view that there are modest increases in the noise floor that can be assumed to generally not cause interference, but those numbers will change depending on the band and the geographic area under study.

[4] See Rec. ITU-R F.758-3, for example.

IV. Conclusions

20. ARRL recognizes that the Inquiry portion of the Notice in this proceeding seeks specific data and some specific numbers in order to allow the Commission to proceed quickly to develop an interference temperature metric. This is not possible in ARRL's view at the present time. ARRL would prefer it be otherwise; it is supportive of receiver performance specifications and supportive of an interference temperature metric for determining what additional services or devices might be considered compatible to be added to bands used by incumbent services. The Commission should preserve the concept of interference temperature as a holistic method of dynamic management of the RF spectrum. Had such a concept been developed fifteen years ago, bands which are now considered "junk bands" due to the proliferation of unregulated and unmanageable unlicensed devices and which are now less useful to radio amateurs than they once were might have been better configured so as to be more efficiently and fairly deployed for all. However, the concept is not yet mature, and there are no shortcuts in the preparations necessary to implement it.

21. It is necessary first to conduct noise studies in various bands to determine ambient noise levels and trends. This must be done on a localized basis, taking into account differences in geographic environments and different bands. There must also be a comprehensive evaluation of the differences in receiver sensitivities and emission modes used by different services in those different bands. It is also necessary to create a new management paradigm for unlicensed services, since there is no possibility of management of the RF environment without some substantial change in regulation of unlicensed devices. For example, there must be additional obligations placed on

manufacturers of RF devices to implement RF environmental assessment systems so as to dynamically maintain the RF environment in a given band in a given geographic area below the ascertained interference temperature for that band and geographic environment.

22. Just as the concept of license auctions does not suit all radio services, such as the Amateur Service and non-commercial broadcast facilities, the concept of an interference temperature does not suit all bands or all incumbent users. Bands used for radioastronomy and certain bands, including the entirety of the HF spectrum, are ill-suited for any additional underlay services premised on calculation of interference temperature. The variability of HF skywave propagation and the extreme sensitivity of certain Amateur radio and all radioastronomy receivers and systems, and the very low received signal levels, make the calculation of an interference temperature metric impractical for these bands. On the other hand, the concept might, with the appropriate ascertained data, work well in other Amateur allocations where the receivers and the emissions used have a higher interference threshold.

23. Overall, there are other methods of improving spectrum efficiency in the short term that have greater potential than adoption of an interference temperature metric. The use of dynamic frequency selection by cognitive radios in certain bands seems a more mature concept for the short term. ARRL suggests that the Commission commence the information gathering that is necessary for the development of an interference temperature metric, and further develop the concept, before attempting to implement it in any current allocations in the near term. If it is to be implemented, the “test bed”

allocations to be used should be limited to exclusive fixed service microwave stations only.

Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio respectfully requests that the Commission proceed with establishment of an interference temperature metric only to the extent consistent with the foregoing comments, and not otherwise.

Respectfully submitted,

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