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

In the Matter of	)	
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TECHNOLOGICAL ADVISORY COUNCIL	)	**ET Docket No. 16-191**
NOISE FLOOR TECHNICAL INQUIRY	)	
	)	

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

COMMENTS OF THE SOCIETY OF BROADCAST ENGINEERS, INCORPORATED

The Society of Broadcast Engineers, Incorporated (SBE), [1] by counsel and pursuant to the *Public Notice* (the Notice), DA 16-676, released June 15, 2016[2], hereby respectfully submits its comments in response to the wide-ranging series of questions asked in the Notice. These questions, and SBE's responses thereto, are intended to assist the Commission's Technological Advisory Council (TAC) in an investigation of changes and trends to the radio spectrum noise floor; its determination as to whether there is an increasing radio frequency (RF) noise problem; if so, the scope and quantitative evidence of the problem; and finally, how a noise study should be performed by the TAC. For its comments and input to the TAC, and representing the interests of broadcasters and broadcast engineers in this critical investigation, SBE states as follows:

I. Introduction and Background

1. SBE appreciates the leadership on this issue of Dr. Greg Lapin and Lynn Claudy, co-chairs of the TAC Spectrum and Receiver Performance working group. This effort is both long

[1] SBE is the national association of broadcast engineers and technical communications professionals, with more than 5,000 members.

[2] See, *Office of Engineering and Technology Announces Technological Advisory Council (TAC) Noise Floor Technical Inquiry*, released June 15, 2016 in the captioned docket proceeding. These comments are timely filed.

overdue and yet more timely than ever before. The TAC has concisely addressed the conceptual and practical technical issues in the conduct of the study in the Notice. SBE is of the view that its members and SBE chapters throughout the United States can assist in the gathering and submission of data from the field in different broadcast markets and different RF environments, provided, however, that the data gathering and measurements of the noise floor in different environments be done in accordance with consistent methodologies.

2. The need for this current noise study dates at least to the first year of the existence of the TAC. 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 request also noted that the "commercially viable range of radio frequency devices has significantly expanded" and that, although these devices were previously limited to the 30 MHz to 3 GHz range, "communications now utilize spectrum up to and including the oxygen absorption bands to 70 GHz." FCC staff 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

[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.

> 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. [6]

In response to the Commission's 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…[7] Thus, the TAC 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.[8]

3. The TAC cautioned against implementing new spectrum management techniques or services *without first concluding extensive studies of the noise floor*. It stated that there

> …could be a very serious emerging problem caused by the explosive growth of both intentional and unintentional radio sources. The future could be very different from what we might expect from past experience. The key to getting our hands around this issue will be a good set of models for both intentional and unintentional radiators which can then be used to predict the evolution of the noise background…[9]

Further:

> [W]e could potentially be entering a period of rapid degradation of the noise environment. Such degradation would reduce our ability to meet the communications needs of the country. The principal negative impacts are likely to be reductions in the performance or reliability of wireless systems or increases in their costs.[10]

The TAC later noted that, until noise floor information is organized and analyzed, the Commission will not have a firm basis for deciding whether current noise standards are too tight,

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[6] *Id*, at 3.
[7] FCC Technological Advisory Council, Second Meeting Report at 1, 9 (Oct. 28, 1999).
[8] FCC Technological Advisory Council II, Second Meeting Report, at 8-9 (Nov. 23, 2001)
[9] FCC Technological Advisory Council, Third Meeting Report, at 1 (Jan. 3, 2000).
[10] FCC Technological Advisory Council, Fourth Meeting Report, at 23 (Annex 4) (Mar. 24,2000).

too loose, or appropriate.[11] *Yet, sixteen years later, no such study has been conducted*. Now, and for the past several decades, new noise sources are being developed and have been developed and the proliferation of electronic devices continues as fast as the technology and the regulatory processes will allow. Many of these individual sources of RF noise may be consistent with current Commission rules,[12] but in some cases, individually and in the aggregate, they may (and SBE believes that they do) negatively impact the overall electromagnetic noise environment.[13] Because the Commission's resources are woefully inadequate to address RF noise through widespread enforcement of Part 15 and Part 18 rules governing RF emitters after the devices are deployed, the only reasonable means of dealing with them is to enact and enforce, *ex ante*, appropriate rules for RF emitters that are based on actual knowledge of the noise floor and trends over time. The growing number of interference complaints indicates that any increase in noise levels will result in harmful interference, so these rules may need to require a decrease in the permitted limits for emission to balance the aggregate noise potential of a growing number of noise emitting devices.

4. Subsequent to the TAC's meeting reports and initial advice with respect to noise floor evaluation, 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." [14] On November 7, 2002, the SPTF issued a Report recommending sweeping changes in the

[11] FCC Technological Advisory Council, Sixth Meeting Report, at 9 (Sept. 27, 2000) (discussing Abstract presented by George H. Hagn).
[12] This is not generally true with respect to wide-area noise sources such as overhead power lines, RF lighting devices and other Part 15 or 18 devices that interfere substantially with AM and FM radio broadcast reception, international broadcasting reception and television broadcast reception.
[13] FCC Technological Advisory Council, Sixth Meeting Report, at 25 (Sept. 27, 2000) (Annex 4: Abstract of Hagn talk).
[14] Spectrum Policy Task Force Report, ET Docket No. 02-135 (Nov. 7, 2002) ("SPTF Report").

Commission's approach to spectrum management.[15] In particular, the SPTF Report suggested that the Commission adopt a new and untested approach to spectrum management that incorporated an "interference temperature" concept. Basically, the staff proposed to divide each spectrum block horizontally into a licensed portion above a specified signal level and an unlicensed portion below that level. Given the newness of the concept and the dangers of implementing a new scheme of spectrum management, the SPTF identified two prerequisites to the implementation of the interference temperature concept: (1) the compilation of current, comprehensive data regarding the noise floor (including a standard method for measuring the noise floor) and existing spectrum usage; and (2) an evaluation of current and future receiver environments. The SPTF Report, at p.28 stated:

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

5. On July 7, 2003, the TAC convened a public meeting regarding the measurement and management of spectrum interference.[16] The TAC presentations at that meeting again noted that there was no then-current data regarding either the noise floor or current spectrum usage.[17] 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

[15] *Id.*
[16] See, *Technological Advisory Council ("TAC") to Hold Meeting*, Public Notice, DA 03- 1991 (June 17,2003).
[17] TAC, Measurement Technology and Issues, presentation by Robert J. Matheson, NTIA/ITS (July 7, 2003).

be a prerequisite to and a necessary first component of any improved spectrum management plan in a given frequency band. Surprisingly, however, and despite the clear acknowledgement that these studies were necessary, no progress in performing such seems to have been made between May of 1999 and the present time.[18] Yet, the need for a comprehensive evaluation of the ambient noise environment, especially in the medium-frequency (MF), high-frequency (HF), VHF, UHF and low microwave ranges is more compelling all the time.

6. 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 several commenting parties 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.

7. Despite repeated expressions of strong agreement among spectrum management professionals and eminent technicians that RF noise studies are critical to any progressive spectrum management program, no such noise studies have been commenced. Instead, the

[18] Such was not the case earlier. CCIR conducted a major survey of business, residential and rural man-made noise levels in the Continental United States between 1966 and 1971. This study formed the basis of the CCIR model for man-made noise (CCIR Report 258-5). In 1993, measurements of man-made noise levels were made in business areas of Montreal and Ottawa and in residential Ottawa. The results of those measurements tended to show a decrease in noise levels, caused in part by the localized practice of using buried powerlines rather than overhead powerlines.

Commission has since 1999 skipped the urgent step of evaluating the RF environment before repeatedly and constantly making allocation decisions. This, to SBE, leads to potentially arbitratry spectrum allocations decisionmaking.[19] In SBE's view, an RF noise study is a necessary prerequisite to any spectrum allocation decisionmaking going forward (especially in making any provision for unlicensed broadband services; wireless backhaul; and any MSS or new unlicensed technologies); and the study should include actual spectrum measurements of the RF noise/interference floor. In order to obtain quantitative data regarding the noise floor in various environments and trends over time, the TAC should adopt a standard methodology for measuring the noise floor. Further, as was urged more than a decade ago, there should be created a public/private partnership for a long-term noise monitoring network and for the archiving of data, for use by the Commission, NTIA and the public, to facilitate next-generation spectrum management. SBE's ubiquitous membership and its geographically distributed chapters provide opportunities for high-quality data gathering and measurements in all types of environments by technical professionals.

II. Methodology of the TAC Noise Study and Determination of Trends in the Radio Spectrum Noise Floor

8. The Notice, at page 2, asks a series of specific questions related to the conceptualization and methodology of the TAC noise study. SBE's input with respect to these questions follows. First of all, it is beyond question that there is a generalized noise problem (considered from the perspective of the Broadcast Service, especially with respect to the AM broadcast band). There is ample evidence of this. Notably, SBE has recently filed comments in

[19] For example, the Commission is poised now to decide whether or not to permit Globalstar to offer an ancillary terrestrial component to its Mobile Satellite Service system in the band 2473-2495 MHz, overlapping both the Broadcast Auxiliary allocation at 2450-2483.5 MHz and the Part 15 and Part 18 band. Before making an overlay decision in that spectrum it would be most helpful to know the status of the noise floor, which anecdotally SBE can attest is exceptionally high in virtually all broadcast markets.

response to the Commission's *Further Notice of Proposed Rulemaking*, and to the combined *Notice of Inquiry*, FCC 15-142, 30 FCC Rcd 12145, released October 23, 2015 in Docket 13-249 (the "*Further Notice*").[20] The *Further Notice* proposes to implement "further proposals, suggested by commenters in this proceeding, that [the Commission] believe[s] will further enhance the viability of the AM broadcast service." The *Notice of Inquiry* "pose[s] questions regarding further utilization of the AM Expanded Band, as proposed by certain commenters." The *Further Notice* followed up on the *First Report and Order* in that proceeding, which adopted several proposals intended to assist AM broadcasters to better serve the public, thereby advancing the Commission's fundamental goals of localism, competition, and diversity in broadcast media. SBE's comments in that proceeding focused the Commission's attention not on what was proposed or inquired about in the rulemaking or inquiry portions of the *Further Notice*, but rather to raise (as SBE has in the past) an urgent subject that the Commission did not address in the *First Report and Order* in that proceeding and apparently does not intend to consider in the remainder thereof: that of ambient noise in the AM Broadcast band specifically, and in the Medium Frequency (MF) bands generally. Though the Commission made, and is currently examining some additional short-term improvements in AM broadcasting in that docket proceeding, which may be necessary in connection with the short-term needs of AM licensees, those initiatives are not, in SBE's view, going to lead to any meaningful, long-term improvement in MF AM broadcasting. To do that, the Commission is going to have to be willing to implement some difficult regulatory reforms that it has not heretofore addressed, and to commit to a regulatory plan which, over time, will reduce the levels of man-made noise in the MF bands,

[20] The Further Notice is a component of the *First Report and Order, Further Notice of Proposed Rule Making, and Notice of Inquiry* in this proceeding, which was published in the Federal Register January 19, 2016. See, 81 Fed. Reg. 2818 *et seq*. (FCC 15-142, 30 FCC Rcd 12145, released October 23, 2015).

and more broadly in the bands below and above 30 megahertz. A prerequisite to the completion of such a plan is the completion of the proposed TAC noise study.

9. The Commission did not address a significant request made by SBE in its comments[21] filed January 21, 2014 in response to the *Notice of Proposed Rule Making*[22] in the AM improvement proceeding: commencement of an initiative to reduce ambient AM broadcast band noise, by means of Part 15 and Part 18 rule changes and stepped-up enforcement efforts relative to existing rules. The goal is a significant reduction in AM broadcast band spectrum pollution, especially along public rights-of-way and in residential areas, where AM broadcast reception is most urgent. SBE's premise was that there is an ever-worsening noise floor in the AM band in particular and in the MF range in general. It is a big part of what drives listeners away from the band.

10. The Commission has stated very recently in Docket 13-249 its assumption (which in SBE's extensive anecdotal experience has proven correct) that there exists an increasing noise floor in the AM broadcast band between 530 kHz and 1705 kHz.[23] The Commission acknowledged in the 2013 *Notice of Proposed Rule Making* in that proceeding that the high noise levels in the AM band are expected to increase further with the increases in the number of electronic products (and given the aging infrastructure in incidental radiators such as power

[21] SBE's comments in response to the *Notice of Proposed Rule Making* had stated in part as follows:

> At paragraph 5 of the Notice, the Commission states candidly - and SBE suggests absolutely accurately - that 'AM radio is particularly susceptible to interference from electronic devices of all types, including such ubiquitous items as TV sets, vehicle engines, fluorescent lighting, computers, and power lines. The noise on the AM band that is caused by those sources is only expected to increase as electronic devices continue to proliferate.' SBE suggests that this enunciation of the current and predicted future RF environment in the medium-frequency spectrum is overly fatalistic, however. It is SBE's view that the goal of AM revitalization will never be realized in the medium and long term in the face of the headwind of a worsening RF noise environment in the AM broadcast band. Some regulatory relief is absolutely necessary.

[22] *Revitalization of the AM Radio Service*, Notice of Proposed Rule Making, 28 FCC Rcd 15221 (2013).

[23] See the *First Report and Order, Further Notice of Proposed Rule Making, and Notice of Inquiry*

lines). However, in the AM improvement proceeding thus far, the Commission has seemed to accept as a "given" that the unquantified ambient noise levels in the AM broadcast band (and therefore in the remainder of the MF spectrum as well) would continue to increase; and that the effects of a deteriorating RF environment in the MF range is something to be responded to on a regulatory basis *without addressing the noise environment itself*. In its October 21, 2015 *Report and Order* in the proceeding, there was a reference to the Commission's proposal to change nighttime and critical hours protection for Class A AM stations. The argument from commenters was that they could provide better service, with more power to "*overcome the local noise floor*," if the protection requirements for Class A stations were relaxed. There was no discussion in that docket, either in filed comments or by the Commission, of the possibility of reducing the noise floor. Relative to this, the Commission stated that: "[i]n this proceeding, spectrum scarcity is not the problem as much as is the need for existing AM stations to overcome *an increasing noise floor* that inhibits local service, both day and night." The discussion was limited to power increases and reduction of protection criteria, rather than the commencement of a discussion about quantifiable reduction of the noise floor. With respect to nighttime root-sum-square (RSS) methodology for AM interference calculations, the Commission said that some commenters urged a return to the 50 percent exclusion method used prior to 1991, which considered only the skywave contributions to RSS calculations of co-channel stations, on the theory that it would enable AM broadcasters to improve their facilities and signals and thus *overcome the "increasing noise floor."* Having acknowledged in the *Notice of Proposed Rule Making* that the high noise levels in the AM band are expected to increase further with the increases in the number of electronic products (and due to aging infrastructure such as, for example, power lines), it is discouraging that in the AM revitalization proceeding, from the outset to the present

time, the Commission seems content to allow the ambient noise levels in the AM broadcast band (and in the remainder of the MF and HF spectrum as well) to continue to increase and to accept the deteriorating RF environment as a "given." It need not be that way going forward.

11. So, there is most certainly a noise floor problem. The magnitude of this problem and the extent of it in the 21st Century is virtually unknown, however, and clearly it will vary according to geographic area, frequency range, and radio service affected. So, the need for this study is most urgent at the present time.[24] The expected major sources of noise that are of concern to radio broadcasters are principally overhead power lines; incidental emitters generally, and especially the growing number of switching-mode power supplies, pulsed DC motors, RF lighting devices, battery chargers, solar power systems, and plasma television receivers. Many devices generate noise that is ultimately radiated, although Commission regulations do address the amount of noise that is conducted onto the AC mains. Although radiation from the AC mains wiring is the mechanism by which most interference is propagated, it is possible for conducted signals to directly impact other equipment also plugged into the AC mains.

12. It is well understood that the Commission has over the past several decades strongly supported unlicensed, low-power RF devices and systems. Unlicensed, low-power technologies are efficient from a regulatory perspective because (1) they do not require licensing and (2) due to either low power or very intermittent duty cycles, those devices that comply with the

[24] The Commission cannot rely on the presence or absence interference complaints as a metric for determining or evaluating the extent of the problem of an increasing noise floor. Non-technical members of the public, such as AM Broadcast listeners, do not complain about interference due to high noise levels. Instead, they simply abandon the medium. Mobile broadband consumers will change geographical location if communications fail in a given area due to RF noise levels. They don't translate to complaints generally. Technically inclined persons such as radio Amateurs and broadcast engineers are more likely to submit interference complaints to the Commission, but the Commission's online complaint filing system candidly informs complainants in most cases that the Commission will not address individual complaints due to resource limitations. Because there is in effect no post-hoc remedy for noise based interference, the complaints, whether or not based on noise floor, diminish over time and are anecdotal in any case. The Commission's interference resolution procedures are historically premised on complaints. In making decisions with respect to RF emitters in the medium frequency and high frequency bands, the Commission relies far too heavily on the unenforced and largely unenforceable non-interference requirement (47 C.F.R. § 15.5) generally applicable to Part 15 unlicensed devices.

Commission's rules are individually not significant contributors to the MF noise environment. However, the Commission apparently does not have a clear understanding of the aggregate effects of Part 15 and Part 18 unlicensed devices. Nor does it have any practical ability to address the interference potential of unlicensed devices, individually or in the aggregate, past the point of sale. The Commission's ability to conduct post-point-of-sale interference remediation is virtually non-existent[25] and its recent, draconian reductions in field staff available to conduct spectrum enforcement have made it clear that there is no chance that enforcement in interference cases involving unlicensed devices is not going to be available in the future either. Therefore, the only source of regulatory reform that has a meaningful chance to positively affect the (now unknown) noise floor over time are the regulations that create obligations on manufacturers and importers and dealers, prior to the point that the consumer or user of the device or system comes into possession of it and before it is deployed.

13. Anecdotal indications, however, are that the noise levels in the AM broadcast band are extremely high. According to LBA Group, a consulting engineering firm,[26]AM reception is highly dependent on the desired signal being typically some 26 dB above the ambient noise level. The AM band, LBA reports, is subject to AM coverage distortion, increasing noise threats, and interference from the proliferation of wireless systems, electronic devices and low frequency radiators that distort AM signals more now than as recently as 10 years ago. The electric power grid has expanded, bringing its own noise contributions from corona, arcing, and other modes.[27]

[25] As but one example, power line interference complaints languish in the Commission's Enforcement Bureau for more than a decade at a time with no enforcement action taken at all. Utilities are typically non-responsive to complaints of interference to Commission licensees in the HF and MF bands, and the Commission has shown no propensity to issue any meaningful sanctions against chronic Part 15 rule violators, including power utilities.

[26] See, LBA Group, Saving The AM Band – Why RF Noise Abatement Is So Important (2014), https://www.lbagroup.com/blog/saving-the-am-band-from-rf-noise/ (Last viewed July 16, 2016).

[27] A good primer on this subject is found at http://www.arrl.org/power-line-noise#top which was prepared by the laboratory staff at ARRL, the national association for Amateur Radio. (Last viewed July 16, 2016).

And, urban areas with increasing industrial activities have further added RF noise to the environment. As a consequence, AM stations have increased power to raise their signal-to-noise ratio in an attempt to preserve their coverage areas, often interfering with other stations. However, there is a limit to power increases, both economically and technically, and those limits are now reached in many cases.[28]

14. The severity of AM reception interference is variable, LBA notes, depending on factors including location, frequency, weather conditions, and other factors. Power line interference may actually decrease in wet weather, or change with varying electric load conditions. Much unintentional interference is local in nature, but the cumulative impact can be extensive. In the case of power line interference, the impact is extreme on automobile radios, whose travel path often parallels electric distribution and transmission lines. In one power line field investigation by LBA, the signal *of a 50,000 watt radio station was found to be unusable only four miles from the transmitter on a car radio*. The signal to noise ratio was measured to be 16 dB, which was 10 dB less than that specified by the Commission for good AM reception. By present Commission standards, the AM station at issue should have a "clean" signal out to almost 100 miles. LBA notes that in the 50 years it has provided AM technical consulting services to US and international broadcast stations, it has witnessed the deterioration in the AM noise environment first hand. The interference limiting impact on a typical AM station coverage was illustrated by LBA in an example. A hypothetical 10,000 watt AM station at 1000 kHz projects a usable signal to 75 miles under noise assumptions of 50 years ago. Many consider that noise levels have risen at least 10 dB, and often much more, in populated areas. That noise increase would shrink coverage to 45 miles: a coverage area decrease of 64%. To overcome this,

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[28] See also Gorka Prieto, Manuel Velez, Amaia Arrinda, Unai Gil, David Guerra and David de la Vega, *External Noise Measurements in the Medium Wave Band* , University of the Basque Country – UPV/EHU (2007).

a power increase of 10 times, to 100,000 watts, would be needed. Even if such an increase were permissible, this would represent a major increase in investment and operating costs, an increase in the station's interference impact to other coverage areas, and an increase in the station's carbon footprint.

15. The Commission does not now have, and has never had a complete understanding of ambient RF noise levels and trends thereof *over time*. Furthermore, the Commission has uneven regulations and policies governing noise-generating intentional, incidental and unintentional radiators; and its enforcement efforts in this context have been and are both impractical and insufficient. The combination of these factors paints a dismal picture for the future of the AM broadcast band; for the survivability of AM stations in the longer term (no matter what short-term fixes are implemented); and for the AM listening public. It is incontrovertible that AM broadcast band interference is not well-documented. Even if AM interference complaints were to be lodged from frustrated listeners, the Commission's Enforcement Bureau has not ever been equipped to deal with them, and it certainly is not now that many of the field offices have been closed and experienced staff relieved of their long-held positions. Adequate staff does not exist, and attrition through restructuring of the field offices has left the Commission's Enforcement Bureau severely understaffed.

16. Nor is interference from Part 15 devices to AM receivers addressed at the manufacturer level. It is the *user* of an unlicensed RF emitter that is required to adhere to the non-interference requirement in the Part 15 rules. That is a regulatory paradigm that has failed in terms of keeping the aggregate level of man-made interference at manageable levels in the AM broadcast band. Part 15 device users are almost inevitably non-technical persons with no interference resolution capabilities and no incentive to assist in resolving the problems, even if

any might happen to be reported to them by an AM listener. Add to that the inherent difficulty in finding the source of RF noise from unlicensed (or licensed) RF devices, and it becomes apparent that RF noise from unlicensed Part 15 devices (and Part 18 Industrial, Scientific and Medical devices) is a large and - in the field - completely unmanageable problem.

17. As to the question which services and products are most significantly affected by ambient RF noise at the present time, SBE can speak with authority only to the Broadcast Service. SBE has regularly received reports of strong interference to the AM broadcast band, and some interference reports involving FM Broadcast and VHF and UHF television broadcast spectrum. So in SBE's experience, the services most significantly affected by ambient RF noise are the AM Broadcast Service (and to perhaps a lesser extent the FM and Television Broadcast services); and reception in the United States of international broadcast stations. There is conducted powerline noise that affects wireline telephone and cable service as well.

18. With respect to the effects of high levels of ambient RF noise on FM listeners and television viewers, Steve Johnston, the Director of Engineering and Operations at Wisconsin Public Radio has studied ambient noise in detail and presented a paper on the impact of ambient noise on FM reception at an NAB broadcast convention several years ago.[29] The paper noted that the nature of FM analog and TV digital reception tends to hide the noise, making it more difficult to attribute interference to man-made (typically Part 15 and Part 18 device) sources than is the case with analog AM reception. However, the higher noise floor has made the range of FM stations effectively shrink. As an example, the paper cites the experience of a listener to a Wisconsin FM station (in a reception area of quite strong desired signal strength) who reported that after many years of solid reception, she could no longer receive the station in her

[29] .See, Johnston, Steve, *Indoor Noise Conditions in the FM Broadcast Band*. http://www.wd8das.net/nab-paper.pdf (last viewed July 16, 2016).

kitchen. When asked if she had any new electronics or appliances, she said she'd added a new microwave oven. An on/off test with the oven resulted in suddenly clear reception, all back to normal, with the oven unplugged. She acquired a replacement oven of the same make and model, and experienced the same problem. When exchanged for a product from a different manufacturer, the problem disappeared. Another case involved an FM listener who placed his cellphone and charger on his bedside table and could no longer hear one of the local FM stations. Moving the charger of the cellphone across the room, away from the bedside radio caused reception to return to normal.

19. The theory of the Johnston paper is that increasing levels of *indoor* noise from modern electronics may be masking weaker FM signals – and probably digital HD Radio and HDTV as well. The ambient noise increase creates the impression that HD Radio and HDTV have difficulty with "building penetration" and that misperception contributes to an otherwise unnecessary effort to increase digital power. The paper reports a variety of measurements with a portable spectrum analyzer and antenna in several urban apartments, suburban houses, and urban offices. All were found to have higher noise levels inside than outdoors on the same property. The paper cites a trend of long-time FM listeners reporting deteriorating reception over time. In the past five years, the paper cites Audience "Listener Logs" showing a 37% increase in email and telephone complaints related to reception. Doubtless, this is due to a deteriorating ambient RF environment, though of course the data is purely anecdotal and begs for a study methodology to quantify the noise increases. The strongest noise sources found inside residences were recently-manufactured switch-mode power supplies used for charging batteries in cellphones and digital cameras. Some made a broad "hash" while others produced a series of noise peaks on discrete frequencies through the band, probably related to the switching frequency. Some HDTV

receivers and DVD players were also very noisy in the FM band, perhaps due to their power supplies as well. Personal computers and digital clocks and telephones were quite noisy in the FM band as well. In urban apartments, ambient noise was found to be much higher than the background level in the parking lots outside. Fewer square feet of space meant the noise sources were more "concentrated" than in single-family residences, which had their own array of noise sources. Within urban office structures, the study found a combination of significant attenuation of the desired FM signals and high undesired noise levels indoors. Specific causes of the noise in this environment were harder to identify, likely because of the number of contributors on various floors and rooms, with reflection and multipath propagation on the noise signals from the metallic structures, all of which tended to "blur" the source.

20. **A**mateur Radio operators and broadcast engineers are typically able to avoid purchasing Part 15 or Part 18 devices for use in their own homes (though they have no control over their neighbors' purchases of RF noise contributors) and they are skilled in interference resolution. That level of awareness is not present with all or most non-technical broadcast listeners, however. Concern about this problem tends to be focused on the HF and MF band on the theory that ambient RF noise increases are principally a problem for AM broadcasters, radio amateurs and other HF and MF band users. However, the cited paper establishes qualitatively that the problem extends to FM and TV broadcast reception as well. Because, as discussed above, once noise-contributing devices are deployed, the noise environment is determined for years thereafter, the urgency of the TAC study is apparent.

21. The Notice asks, if there is a noise problem created by incidental radiators, what sorts of government, industry and civil society efforts might be brought to bear to ameliorate the noise they produce. With respect to government efforts, control over ambient noise is not in SBE's

view a deregulatory exercise. Some existing regulations should be better enforced, and some new regulations will be required in order to improve ambient noise conditions in the existing AM band. Absent the TAC noise study now proposed, the modification of or creation of new regulations is akin to throwing a dart at a board while blindfolded. It is obvious that any interference management plan for the broadcast bands and the broadcast auxiliary bands has to be based on rules which limit RF noise before it becomes an issue, not *post hoc*, and those rules will have to be enforced. No rules can be enacted without the benefit of some valid noise floor measurements and evaluations over time. As a starting point for a plan by the Commission to gain some control over ambient RF noise levels, some strategies to consider are the following:

A. Radiated emission limits below 30 MHz in FCC Part 15 rules for unintentional emitters (such as, for example, plasma television receivers) should be enacted. There presently are no radiated emission limits below 30 MHz for most unintentional emitters. Only conducted limits exist now. This has become a short-range problem with respect to interference from some emitters, such as cellular telephones (especially in charge mode) and plasma television receivers. Direct radiation from a plasma display can be problematic for AM receivers and difficult to remedy. The Commission should consider establishing limits on the amount of noise that can be *radiated directly* from such devices.

B. Lower limits in Part 15 for LED light bulbs should be enacted which are harmonized with the lower limits for fluorescent bulbs in the current Part 18 rules. Part 18 rules govern fluorescent bulbs. Those Part 18 limits are lower than the Part 15 limits which govern LED bulbs. The Part 15 LED bulbs typically operate at levels 12 dB higher than Part 18 fluorescent bulbs. All of the reasons that caused the Commission to establish reasonably low limits for fluorescent bulbs exist for LED bulbs. There are apparently very few, if any interference reports involving fluorescent bulbs that meet Part 18 consumer limits. There are, however, substantial numbers of complaints of harmful interference to Amateur Radio stations from LED light bulbs on an annual basis. This is a good example of an RF management problem that must be addressed *before* the devices are marketed. There could be dozens, if not hundreds, of RF light bulbs in range of a typical AM broadcast receiver in a typical residential neighborhood. If harmful interference occurs and is reported, there is no practical, *post hoc* solution. Filtering of the bulb is not an option. They couldn't all be found, even if adequate Commission resources were available to investigate such instances. Even if they were to be found, the user of an RF light bulb that contributed to AM receiver interference would not likely be ordered by the Commission to stop using it.

C. Better external labeling on packaging for Part 18 fluorescent bulbs and ballasts should be ordered. Part 18 rules have separate limits for consumer and commercial fluorescent devices. A number of big-box stores and large hardware and consumer retailers, including some well-known

nationwide chains are openly selling commercial fluorescent bulbs and ballasts to residential consumer users. Presently, there is no information on the outside of the packaging for these devices indicating that they are not legal to use in residential environments. These same big box stores are all selling Class A industrial lighting ballasts. There is material in the Office of Engineering and Technology's "Knowledge Database" (KDB) clarifying that such marketing is not legal and that the labeling, or even signage and warning, is not enough. If this policy (it is *not* a specific rule) were to be enforced, the big box store would claim that they can sell commercial environment ballasts because they also sell them to buyers for that market, but the devices are on display and the general public is not informed of the proper environment in which to deploy them.

D. Specific radiated and/or conducted emission limits for incidental emitters such as motors or power lines should be enacted. Under present Commission rules, there are no specific emission limits for incidental emitters such as power lines and non-pulsed motors. There are requirements for manufacturers of incidental emitters to use good engineering practice and a requirement that the operator of an incidental emitter use them in a way that does not cause harmful interference to licensed users of spectrum. Those rules are neither enforced, however, nor practically enforceable. Specific emission limits would set an upper level on the worst of the power-line noise cases and would require manufacturers to pay at least minimal attention to design and utilities to evaluate their entire systems at least sporadically, assuming that they perceive that there is a risk of actual Commission enforcement. Although conducted-emission limits could be established for motors and similar 120- or 240-volt devices, only radiated limits would be practical for medium-voltage or high-voltage power lines.

E. Conducted emission limits on pulse-width motor controllers used in appliances should be enacted. Under Part 15 rules, "digital devices" used in appliances are exempt from specific emission limits. There are instances of interference to AM receivers from pulse-width motor controllers in washing machines, air conditioners and pool pumps. If pulse-width motor controllers are digital devices, then these 500- to 1500-watt digital devices would be exempt. Most digital devices that are used in appliances are very low power display units, microprocessor control circuitry and similar devices which have a much lower interference potential than 1500-watt motor controllers.

F. The Commission should substantially increase, and increase the visibility of, enforcement in power line interference cases. There are literally dozens of complaints from Amateur Radio operators of severe interference from power line noise annually. Power line radiation in the HF and MF Amateur allocations will in most cases directly translate to preclusive noise in the AM broadcast band. The Commission has relied completely on the good faith efforts of electric utilities to resolve these. In a few cases, those efforts have been successful. However, far more often, utilities do not have available to them and are not willing to retain persons skilled in RF interference resolution. They are unwilling to act, and the cases brought to the Commission (usually by Amateur Radio operators, rather than by non-technical AM listeners) are allowed to languish unresolved for years and in some cases more than a decade, without any enforcement action at all. As discussed above, AM radio interference inevitably goes unreported by listeners. A few visible enforcement actions by the Commission would create some incentive on the part of electric utilities industry and perhaps lead to the development of effective industry programs

to address the burgeoning power line interference problem. Deterrence works in regulatory enforcement but the Commission's actions have to be both timely and visible in order to create that effect.

As an overall suggestion, in every case, some level of enforcement is necessary prior to the point of sale of consumer or industrial devices, and at the utility level in power line cases, in order to create a deterrence effect. The Commission has failed to assess visible, timely and meaningful sanctions in cases that can't be resolved cooperatively. These include, for example, dozens of cases involving non-compliant and uncooperative power line noise contributors. Where a power utility is unresponsive, or if (as is often the case) the utility lacks technical staff or consultants capable of remedying the ascertained interference caused by the subject power line(s) and is unwilling to retain such, then timely and meaningful sanctions brought by the Commission against the recalcitrant power utility are necessary. By contrast, festering, unresolved interference problems and the virtual absence of the allocation of any Commission enforcement resources to egregious power line and other major Part 15 interference cases bode ill for control of ambient noise levels in urban and suburban areas. The deterioration of overhead power lines, and the current proliferation of municipal installations of LED lighting systems with streetlights and traffic lights along and on public rights-of-way stand to substantially increase the levels of RF noise in these environments in the near term. No enforcement coupled with no educational outreach to users and consumers, be they municipal governments, utilities, individuals or other entities is an abandonment of the Commission's mandate and irresponsible spectrum management and stewardship.

22. SBE would be pleased to work with the TAC or the Commission to establish an informal interference resolution process with respect to noise-related interference cases. SBE members and chapters are capable of accurate identification of a correct interference source in a

given local area and could assist in a cooperative effort to quickly evaluate and resolve an interference problem directly with the involved operator of the noise source without involving the Commission. Such a program could involve industry groups representing noise interference victim radio services, but there would have to be willingness on the part of the Commission to take action where the cooperative effort fails. Key to any such program is effective, timely and visible enforcement of rules when unresolved interference is not addressed by the responsible operator of the offending device, system or noise contributor. It is critical that visible, timely and appropriate enforcement measures be taken in at least a few cases, not only to resolve the most difficult compliance cases but to provide a deterrence effect that will encourage voluntary compliance by other Part 15 users. The Commission and the TAC should engage industry groups to participate in these types of cooperative programs, and ask the manufacturers of Part 15 devices and systems to proactively work with users of radio spectrum to cooperatively identify noise sources and to take appropriate remedial actions where needed.

23. As noted above, municipalities are now purchasing RF lighting devices, most undoubtedly completely unaware of the interference potential of LED lighting devices that might be deployed ubiquitously throughout municipalities, creating grids of high noise levels, completely unaware of the Section 15.5 rule calling for the operator of an interference-causing RF device to cease operating the device if interference to authorized services develops. Additional public notices and a few well-placed, well-publicized and timely enforcement actions in egregious cases[30] will create some needed deterrence to the marketing and sale of non-compliant, unlicensed RF devices. Industry contributions to the management of RF noise are

[30] It is notable that there has not been even one Notice of Apparent Liability issued with respect to interference from incidental or unintentional radiators, notwithstanding the presence of long-pending complaints and well-documented cases. On information and belief, the former Washington state field office had prepared a Notice of Apparent Liability recently in a fully investigated case involving deployment of an RF lighting device, but the Enforcement Bureau in Washington inexplicably refused to issue it.

ongoing. For example, IEEE has under development a recommended practices and procedures standard for power line interference resolution. The Commission should encourage power companies to use that standard in maintaining their overhead power lines and the standard could be incorporated by reference in the Commission's Part 15 rules when available.

24. Question 2 of the Notice asks where, spectrally, spatially and temporally the noise problem exists. For incidental and unintentional emitters, noise is typically stronger at lower frequencies. At MF, for example, noise from motors, power lines, switching power supplies and video terminals is generally much stronger on the lower part of the spectrum. This significantly impacts the AM broadcast band, as well as HF international broadcast reception. SBE has also received reports of interference to VHF and UHF spectrum from incidental emitters such as power lines and unintentional emitters such as LED bulbs and LED billboards. There are strong enough radiated RF emissions from incidental radiators to cause interference in the VHF, UHF and microwave bands to licensed radio services in most environments.

25. Spatially, noise is present in indoor and outdoor environments. Each environment has its own set of sources and problems. Indoors, the biggest factor in the impact of man-made noise is the physical proximity of noise sources and affected victim devices.[31] The proximity of indoor noise sources can and does impact broadcast radio reception, over-the-air television, and the use of other wireless devices such as mobile broadband and WiFi. Similar interference instances to broadcast receivers from consumer electronics in homes, from both indoor and outdoor sources, occur all the time. Outdoors, AM broadcast reception is hampered, if not precluded in many cases by overhead power lines which radiate along miles of roadways parallel to vehicular travel

[31] A single RF lighting device in a residential area can cause interference at distances from the emitter up to 500 feet or more.

and by RF lighting devices including the now-proliferating "grow lights" which cause high levels of RF noise at MF and HF throughout entire residential communities.[32]

26. Urban environments, where there are large numbers of devices with radiated or conducted emissions and lower desired-to-undesired signal ratios pose a compellingly adverse problem with RF noise. Broadcast receivers, both in homes and in vehicles, are most often located in suburban areas where this problem is similar.[33] It is noted that in past evaluations of man-made noise, different types of environments were considered. For example, in Recommendation ITU-R P.372-8 (most recent version 2015), radio noise was evaluated and quantified in business, residential, rural, quiet rural and Galactic noise only environments. It is important to have meaningful correlations between quantitative measurements of ambient noise and the geographic environment where those measurements are taken.

27. With the proliferation of new types of noisy electronic devices, radio reception in cities has become almost impossible, although cities have never been a pristine radio environment. Rural settings are quieter, of course, simply due to the smaller number and wider physical separation of noise sources. Even in rural settings, though, noise can be significant from power-line sources, from farming equipment and, in areas where greenhouse farming may be ongoing, new types of high-powered lighting controllers are being used. A number of

[32] Measurements of the interference contours of "grow lights", commonly imported from China and other offshore manufacturing sites have been made at up to a mile radius from a single emitter in a single residence.

[33] The problem of consumer devices interfering with each other is one that is not fully addressed through the rules on limits and device-operator responsibilities. The limits are set rather high by radio protection standards, and although the current limits do a reasonable job of protecting from interference from "the house next door" in a residential area, they do a poor job of protecting against interference within a single residence by devices owned and operated by residents of that home. They are no more effective at protecting against interference in indoor settings like apartment buildings, where all electrical wiring is common, separated electrically only by breaker panels and metering that are not intended to filter noise conducted onto one apartment's wiring from another apartment unit. The wiring and the devices themselves radiate at MF, HF, VHF and above.

interference reports have been reported to the Commission, and at least one citation has been issued.

28. The third series of questions in the Notice ask generally about quantitative evidence of the overall increase in the total integrated noise floor across various segments of the radio frequency spectrum. This is a difficult question. Much of the current knowledge of the levels of man-made noise is derived from studies done in the 1970s, and the raw data, test conditions and test methodology from those studies may not be documented anywhere. From all indications, the measurements were made using calibrated receivers and a vertical antenna, in a number of indoor and outdoor environments, in the industrial, urban, rural and remote areas outlined in the published ITU-R Recommendation P.372.[34] The anecdotal evidence of rising noise levels is compelling, and it is incontrovertible that there are far more numerous potential noise sources now than there were in the 1970s, when the most of the definitive measurements of man-made noise were initially performed. The results of these studies, and some subsequent work, was compiled by the ITU-R and published in the P.372 Recommendation. P.372 has been revised over the years, as the result of the evaluation of new studies that were not as thorough as some of the work done to support earlier versions. In general terms, these newer studies did not contain sufficient evidence to warrant a significant change in the levels of man-made noise described in the Recommendation, although the frequency range was extended and additional information about atmospheric noise was included.

29. The Notice asks how the integrated levels of man-made noise may have changed. Older studies looked at median values of man-made noise, but did not analyze the ways in which it varied by frequency. In many of the older studies, there were few criteria given for the selection of locations to make measurements, and a relatively small number of sample locations

[34] The most recent version of this document is P.372-12, 07/2015.

for each type of environment were chosen. It is hard to determine after the fact how representational they were of the environments of the time, or to correlate those selections with different permutations that could have been chosen. This makes it difficult to correlate one study to another. To obtain sufficient sensitivity to enable measurements to be made of lower-levels of noise, small calibrated test antennas cannot be used. The measurements that were made were typically done on HF with vertical antennas, and on VHF and above with small Yagi antennas. Although this does allow sensitivity, the actual antenna gain and antenna factor of a vertical antenna will vary with the characteristics of the ground over which it is used, and there is little evidence about how these variations were accounted for in the initial testing. Also, a vertical antenna will have a full response to only vertically polarized signals, further complicating the analysis of actual results.

30. In various prior studies, different detectors may have been used, and certainly different bandwidths, often requiring corrections for bandwidth, to standardize the measurements against the bandwidths used in various standards. This correction, however, would be different for different types of noise and signals, and there is no easy way to determine just what types of signals were being measured, and thus what correction factors would be appropriate. Other factors can very much impact the levels of man-made noise. These include time-of-day variations; skywave propagation; lighting noise; and even variations over the 11-year sunspot cycles. All of the above factors make the correlation between various prior studies rather difficult. SBE is aware of the work of the IEEE EMC Society in the area of man-made noise. IEEE is in the process of revising IEEE Std. 473, a standard on site surveys which does include test methodology for the measurements of signals and noise at test sites and at locations of equipment. The development of consensus standards may be the most effective and accurate

way to resolve questions about what constitutes noise, how it should be measured and how the different test methodologies used over years' time can be correlated to each other.

31. Broadcast receivers vary in sensitivity with different bandwidths, antenna efficiency and emissions. As such, any increase in noise will have a potentially significant impact on radiocommunications. In many cases, even a modest increase can preclude digital television or radio reception. The convention of having spectrum changes result in more than a 1 dB increase in interference is a reasonable standard to continue to apply.

32. Question 4 of the Notice asks how a noise floor study should be performed. There are several major factors that should be studied. The first is how noise varies with time. The prerequisite for this question is to determine whether *man-made* noise levels are changing on a long-term basis. To answer this question in the near term, older noise studies will need to be analyzed, and new studies will need to be performed over a period of years. The focus of the noise study should be an accurate determination of what noise levels exist in as wide a range of indoor and outdoor environments as possible. It should, to the extent possible, determine what types of noise are being found: broadband, non-specific noise; broad noise spectral peaks; broadband digital noise; and noise occurring on discrete frequencies.

33. The methods to be used and the measurement of noise is another key question. Historically, quasi-peak measurements of noise have been done. A quasi-peak detector was originally chosen, with time constants selected to be a reasonable match to a human ear's perception of pulse noise to an amplitude-modulated signal. Although this test method should be retained in order to maintain correlation with historical data, especially relative to the AM Broadcast band, the study should not be limited to the use of quasi-peak measurements. Most radio communication today is not full-carrier, double-sideband amplitude modulation, so the

initial reasons for the limiting the choice of detector no longer exist. FM signals are more immune to impulse noise. For digital signals, with respect to the vast majority of modern communications methods, if a digital signal is not error corrected, a single impulse can wipe out bits that will not be recovered. This would indicate that a peak detection method would be more useful. For error-corrected signals, a single impulse would be ignored, so an average power or RMS detection would be more useful. This should be decided by industry consensus, through standardization of methodologies.

34. The question of measurement bandwidth is also important. The CISPR bandwidths used for most EMC measurements are typically wider than the communications channels used by radio services. This usually means that any measurement of "noise" will encompass a number of communications channels that are in use by that service, and so this measurement will often include one or more signals that are not noise at all, but are signals of the desired, licensed radio service. Some noise studies have used narrower measurement bandwidths, but this can only be extrapolated accurately to a wider bandwidth if the nature of the noise signal is known, and steps are taken to exclude intentional, licensed signals from a measurement of noise. Many radios and test instruments today are capable of capturing a large amount of digital data in a real stream of actual signals, so software digital processing techniques may be able to sort out some of these issues. To do so will require consensus on just what needs to be measured and recorded, necessitating consensus standardization.

35. The Notice asks for the spatial and temporal scales at which noise should be measured. To the extent that data can be evaluated, the more spatial locations, the better. Although a reasonable sample can be developed to measure noise in various environments (such as industrial, residential, etc.) there may be reasons to have a less coarse determination of noise

sources. It may be useful to see how noise varies within a neighborhood, for example, or to see how noise varies along power lines.[35] Measuring to a fine spatial scale may allow the average power of noise radiated in a given unit area to be used to perform skywave predictions of noise at HF, to cite another example. So, a combination of sampling of environments, and more rigorous spatial testing to develop data for further analysis could work together to form a complete noise-study program.

36. The Notice asks whether monitoring instrumentation should be capable of determining the directions of the noise sources, and if so, how those data would be used. It is unclear why this is necessary with respect to interference to a broadcast receiver. If directional over-the-air television receive antennas are receiving noise, there is no way to re-orient the antenna away from the desired transmitted signal and therefore no reason to think that noise from different directions would affect how that receiver performs.

37. As to an optimal height above ground for measurements, it is understood that noise levels vary significantly with height above ground. Broadcast receive antennas are located at various distances above ground level, so this factor is not of great consequence. Industry standards typically set measurements of emissions at a height of 1 or 2 meters for measurements of signals below 30 MHz and 1 to 4 meters, in one meter steps, for frequencies above that. For a measurement of noise in the field, measurements at various heights above ground may be the only way that a study can reasonably be conducted. However, it is more important to perform measurements according to existing standards, because it is the only accurate way to compare different studies. It should be possible to establish some correlation between low-height measurements and noise levels at greater heights through modeling.

[35] This is a subject about which the Commission has no useful information . Signal decay along power lines is an important element of a noise study.

38. There are wide differences in the amount of man-made noise in different time, location and frequency domains, and in order to have firm knowledge of the number of measurements that would be statistically sufficient, one would need to conduct a very large number of measurements in order to ascertain the range of expected data, of possible data and of the number of outlier measurements showing results significantly better or worse than the mean or median values. Other questions that will need to be answered include the problem of non-compliant devices, and how levels of noise that clearly represent a non-compliant device should be considered in evaluating man-made noise. Many of the high-powered lighting devices being used for indoor horticulture and farming are have conducted emissions that are very far above the permitted levels. Non-compliant devices will significantly skew any averaged or integrated calculations of man-made noise. They should ideally be excluded, although it is not usually possible or practical to identify a non-compliant device when making field measurements of noise.

39. The Notice asks whether measurements from uncalibrated, or minimally calibrated, devices can be combined. Measurements with calibrated test equipment represent an ideal, although test equipment is usually not as sensitive as real receivers and antennas, so even this has limitations. The 1970s studies, for example, used a vertical antenna for some of the measurements below 30 MHz, with the gain and antenna factors calculated from the theoretical gain of the antenna and typical ground losses. Relatively few entities have the necessary equipment to make calibrated measurements of field strength across a wide frequency range. If the bar is set so high that only fully calibrated equipment can be used, there will be in all likelihood a dearth of measurements done. Although the accuracy is somewhat lower with tests not necessitating calibrated equipment (especially antennas), there is a lot of data that can be

gathered if the ability to use peak- or average-detecting spectrum analyzers and actual antennas instead of calibrated one is used in field-strength studies. At some loss in accuracy, one can make assumptions about bandwidth extrapolation of the measurement receiver to the bandwidths used in CISPR or ANSI C63.4 standard measurements. There are still some caveats with respect to the antenna factor, because the gain of a directive receive antenna may be known, but that gain is correct only for specific azimuth and elevation angles. More data is always useful, and if carefully constructed, "uncalibrated" measurements can be made in a way that can be extrapolated reasonably well to calibrated measurements.

40. As to the possibility of "crowd sourcing" a noise study, this is proving to be a valuable and valid engineering technique, if the caveats are identified and there is some oversight over the techniques, the actual measurements and the determination of results. This can be made somewhat more accurate if there is a single procedure published describing what minimum system and equipment requirements must be met, information about what locations should be used and clear instructions on how to determine antenna gain, losses and how to differentiate between signal and noise.

41. The amount of data that must be collected in order to reach a conclusion will depend on the nature of the data. Noise levels are expected to vary significantly with location, frequency and time and until the range of possible results is known, and statistical analysis done on actual data, the number of measurements needed to have a desired level of certainty is not known. A better approach could be to keep a running tab on the statistical factors, so that the reliability of measurements can be tracked as they occur. Because measurements must be made in a wide variety of environments, and across many different time frames, to completely assess the impact of propagation on noise levels, the amount of data collected will be large over time. Clearly,

conclusions can be reached at a number of steps in the process, if the statistical analysis of accuracy is included in the results.

42. Distinguishing noise from signals is complicated where there are spectrum ovelays of licensed services or licensed and unlicensed services, as there are increasingly in broadcast auxiliary spectrum. However, there are modulation techniques that result in a desired signal that is very noiselike in nature (e.g. spread-spectrum signals) and it may be difficult to always differentiate desired signals from noise. If the purpose of these studies is to determine the levels of man-made noise and how they vary with time, it is important that desired and licensed signals be not mis-measured as noise. This is another area where industry standards could be developed to outline how to make noise studies using calibrated equipment, uncalibrated but accurate receivers and how to analyze data, report data and differentiate noise from desired signals.

43. There is no threshold level below which measurements should be ignored, although any measurement campaign will have a threshold below which measurements cannot be made. Some of the measurements made will show a very low value of noise, and those should not be ignored, but included in the tabulations so that median and mean values can be determined. It is quite sufficient to report that a particular level was below that noise floor, ie. "Less than -10 dBuV/m", but the results should be included in any noise studies.

III. Conclusions

46. This noise study has been necessary for well more than two decades. The Commission critically needs at least preliminary results from this study in order to make time-critical spectrum management decisions. Spectrum planning cannot objectively be done without this noise information and it is unfortunate that the initiative has been delayed this long. SBE and its members and chapters are able to be of use in gathering data for the noise study, premised

upon the prerequisite need to develop a standardized and valid methodology for conducting the study. It is hoped that these comments will provide input into the formulation of that standardized methodology. SBE should be considered a willing resource in the TAC effort and we hope to contribute substantially to the effort. We also hope that these comments will serve as a catalyst for a re-evaluation of the policies of spectrum enforcement and sanctions against operators of incidental and unintentional radiators which are causing long-term interference problems, such as power lines. The unwillingness of the Commission to issue meaningful sanctions has led to the virtual absence of any incentive by power utilities to comply with the Commission's Part 15 non-interference obligations.

Therefore, the foregoing considered, SBE encourages the TAC in its effort and is hopeful that the noise study will provide for the first time a useful, objective basis for spectrum overlays and other allocation decisions in the future. SBE further requests that the TAC focus its attention on a plan to reduce RF noise in at least the medium-wave band. There are other steps that will inevitably improve AM broadcasting, but SBE considers the issues to be addressed by the TAC to be the most urgent of these.

Respectfully submitted,
THE SOCIETY OF BROADCAST ENGINEERS, INC.

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