

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Revisions to Rules Authorizing the Operation of Low Power Auxiliary Stations in the 698- 806 MHz Band)	WT Docket No. 08-166
)	
)	
Public Interest Spectrum Coalition, Petition for Rulemaking Regarding Low Power Auxiliary Stations, Including Wireless Microphones, and the Digital Television Transition)	WT Docket No. 08-167
)	
)	
Amendment of Parts 15, 74 and 90 of the Commission's Rules Regarding Low Power Auxiliary Stations, Including Wireless Microphones)	ET Docket No. 10-24
)	
)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions)	GN Docket No. 12-268
)	

REPLY COMMENTS OF SHURE INCORPORATED

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SUMMARY

The initial Comments in the Incentive Auctions rulemaking demonstrate that wireless microphones remain a critical production tool essential to commercial and not-for-profit activities in many sectors of American society -- broadcasting, live entertainment, corporate communications, education, worship, government and recreation -- and their ability to operate on clean, interference-free UHF spectrum must be preserved even as the Commission implements incentive auctions and repacking in an effort to expand spectrum available for wireless broadband services.

As a global leader in the design and manufacture of audio electronics, including professional wireless microphone and related products, Shure joins with the other audio technology manufacturers, content and event producers, commercial enterprises, and athletic, educational and religious institutions, in urging the Commission not to roll back important wireless microphone protections in the UHF band developed as a result of the lengthy, multi-stakeholder White Spaces rulemaking.

Manufacturers and users have made the vast majority of investment over the past several decades in the UHF band, which now is the predominant band for such operations worldwide. The unique technical characteristics of UHF spectrum make it particularly suitable for the operation of professional and high quality wireless audio production tools. No party offered evidence or analysis to demonstrate that suitable alternative spectrum is available for professional wireless microphone operations. Similarly, the available spectrum in the lower UHF below channel 21 is insufficient to support wireless microphone user needs today and in the long term.

Numerous parties agreed with Shure that in the face of the reduction of available UHF spectrum, it is more important than ever to retain the two wireless microphone reserve channels. In many markets, these two reserve channels will be an important source of spectrum for licensed users and may constitute the *only* interference-free spectrum available for unlicensed wireless microphone operations and itinerant operations, such as newsgathering teams covering breaking news. In this context, Shure supports the modified band plan proposed by NAB and CTIA as long as reserved channels are retained, recognizing that their specific channel assignments may require modification.

The Comments revealed widespread support for expanding the class of parties eligible for Part74 licenses to better reflect the diverse uses and purposes for wireless microphones today. In particular, the Commission should adopt rules that permit licensing by “professional users” who deploy wireless microphones in a manner similar to broadcast licensees who routinely require spectrum that exceeds the amount available in the reserve channels and require registration in the geolocation database in near real time.

In light of the possible severe reduction of access to clean, interference-free UHF spectrum, Shure and others recommend that wireless microphone users be able to operate in the guard bands. For spectrum in the guard bands in the Commission’s initial band plan proposal or for spectrum in the lower guard band under the modified proposal, Shure recommends that wireless microphones should be able to gain temporary protection from interference for the time and location of use by registering in the database.

Shure joins with the majority of other commenters who agree the Commission should not adopt unnecessary transmission or technical requirements for wireless microphones. Manufacturers are driven by the demands of the marketplace to improve their technology in the

interest of spectral efficiency and significant advancements have been made in the past several years. Both analog and digital technologies are deployed by operators today in accordance with specific use case scenarios, and both technologies exhibit tradeoffs in performance attributes as design decisions are considered.

Shure also joins with other commenters in supporting modest changes to the Commission's rules on co-channel operation, which Shure believes will provide some limited spectrum efficiency gains without creating interference to broadcast television. Shure also asks that the Commission dismiss the recommendation that unlicensed TV band devices be permitted to operate on portions of channels reserved for and in use by wireless microphones. This proposal is a technically unsupported and unsound request that will create intermodulation products and other interference issues, eroding the utility of the channel for reliable wireless microphone operations.

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REPLY COMMENTS OF SHURE INCORPORATED

Shure Incorporated (“Shure”), by its undersigned counsel, hereby submits these Reply Comments in the above-referenced dockets.

I. The Comments Demonstrate the Critical Need to Preserve Access to Clean UHF Spectrum for Wireless Microphones

The Comments revealed strong consensus from equipment manufacturers and users across a wide variety of industries in support of preserving wireless microphone access to clean UHF spectrum even in the context of incentive auctions, repacking, and other changes made to the TV Band to facilitate expanded allocations for licensed wireless broadband services. Many parties echoed Shure’s recommendation that the Commission not roll back important wireless microphone protections developed as a result of the lengthy, multi-stakeholder White Spaces

rulemaking. In addition to two reserve TV channels per market for wireless audio production, the Commission adopted an innovative geolocation database sharing scheme to carefully balance the interests of new spectrum users and incumbents, including wireless microphones. Support for retaining the White Space rules and/or expanding the list of parties eligible to obtain a wireless microphone operator's license came from a broad cross-section of users, including the National Association of Broadcasters ("NAB"),¹ Comcast Corporation and NBCUniversal Media, LLC ("Comcast/NBCUniversal"),² the National Football League ("NFL"),³ The Walt Disney Companies (including ESPN, ABC Network and Walt Disney World),⁴ The Broadway League,⁵ The Recording Academy,⁶ the Grand Ole Opry,⁷ the Metropolitan Opera,⁸ Cirque du Soleil,⁹ the Screen Actors Guild-American Federation of Television and Radio Artists and AFL-CIO,¹⁰ The Performing Arts Wireless Microphones Working Group,¹¹ Lakewood Church (Sr. Pastor Joel Osteen),¹² Willow Creek Church,¹³ the National Systems Contractors Association,¹⁴ Northwestern and Drexel Universities,¹⁵ and over 100 of the nation's top audio service providers,

¹ Comments of the National Association of Broadcasters, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*NAB Comments*").

² Comments of Comcast Corporation and NBCUniversal Media, LLC, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*Comcast/NBCUniversal Comments*").

³ Comments of the National Football League, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*NFL Comments*").

⁴ Comments of the Walt Disney Company, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*Disney Comments*").

⁵ Comment of The Broadway League, Inc., WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*Broadway Comments*").

⁶ Joint Comments of Wireless Microphone Interests, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24 (filed Jan. 25, 2013) ("*Wireless Microphone Interests Comments*").

⁷ *Id.*

⁸ *Id.*

⁹ *Id.*

¹⁰ *Id.*

¹¹ Comments of the Performing Arts Wireless Microphone Working Group, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268 (filed Jan. 25, 2013) ("*Performing Arts Comments*").

¹² *Wireless Microphone Interests Comments.*

¹³ *Id.*

¹⁴ *Id.*

¹⁵ *Id.*

engineers and frequency coordinators.¹⁶ The Comments revealed the view of corporate America as well. PSAV (serving an extended network of hotels and conference centers), frequency coordinators for the MGM Grand Hotels and the Venetian/the Palazzo (Las Vegas)¹⁷ and Boeing, the world's largest aerospace manufacturer, urged the Commission to protect wireless microphones. Boeing described its training and corporate meetings during which "reliable and high quality wireless microphone operation is simply a necessity."¹⁸ The economic, cultural and social benefits of these industries and organizations are clear and a matter of record and must be accounted for in the crafting of rules for changes to the UHF band.¹⁹

A. The UHF Band Supports the Vast Majority of Wireless Microphone Operations and is Uniquely Suited for This Purpose

UHF spectrum is uniquely suited for wireless audio uses based on its favorable combination of wavelength, low body absorption, shadowing, and low ambient noise.²⁰ In agreement with this principle Sennheiser explained, for example, "[t]he need for unimpaired propagation through the stage sets and performers' bodies sets an upper bound on frequency, while the need for small, inconspicuous antennas sets a lower bound," thereby making

¹⁶ See e.g., *Wireless Microphone Interests Comments*. Despite the challenges raised by the incentive auction proposal, Shure emphasizes that wired audio devices are not a reasonable substitute for wireless audio equipment. The record in ET Docket No. 04-186, WT Docket Nos. 08-166, 167 is replete with discussion of the increasing demand for wireless audio services. One party noted that "one of the most common sources of liability at professional events is injury resulting from an individual tripping over cable." *Disney Comments* at 41. ESPN utilizes wireless microphones "where laying a cable is not possible or practical, or where laying cable may create a safety hazard." *Id.*

¹⁷ *Wireless Microphone Interests Comments*.

¹⁸ Comments of The Boeing Company, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 4 (filed Jan. 25, 2013) ("*Boeing Comments*").

¹⁹ *Broadway Comments* at 3 ("Each year League members provide Broadway productions to more than 30 million people in New York City - a \$10 billion industry - the city's largest tourist attraction, directly employing over 10,000 people and supporting another 80,000 full-time positions including hotel and restaurant workers."); *Performing Arts Comments* at 5 ("Performances by opera and dance companies, symphony orchestras, community theaters, and regional theatres reach a combined audience of 190 million Americans annually and collectively represent an annual \$7.8 billion dollar industry."); See also *Shure Comments*, at n.15.

²⁰ In this and other proceedings, Shure has submitted extensive discussion of the favorable technical attributes of UHF spectrum for wireless microphone operations. See Comments of Shure Incorporated, ET Docket Nos. 04-186, 02-360 (filed Nov. 30, 2004).

“opportunities for migration to other frequencies ... limited.”²¹ The Walt Disney Company also highlighted the need to protect wireless microphone operations in the UHF band “given the unique qualities of UHF spectrum, which enables lower power signals to propagate over large distances and facilitates the use of small antennas with minimal gain.”²²

Given the particular suitability of the UHF spectrum for professional wireless audio, Shure urges the Commission to reject the unsupported calls by the White Space Alliance for a forced transition of the devices to other spectrum.²³ Such arguments merely dredge up proposals previously rejected and dismissed by the Commission²⁴ and ignore the technical requirements for professional-grade wireless audio systems. Also disregarded are the facts that wireless microphones have operated in the TV Band for decades and have a substantial installed base, that UHF spectrum is the global spectrum of choice for wireless microphone operations,²⁵ and that for decades, research and development has been focused on the UHF spectrum resulting in significant long-standing investments in UHF operations by both manufacturers and users in order to deliver the audio quality that modern audiences expect.²⁶ Alternative bands such as 3.5 and 4.9 GHz are purported to be plentiful, available and suitable for the operation of wireless

²¹ Comments of Sennheiser Electronic Corporation, GN Docket No. 12-268, at 9 (filed Jan. 25, 2013) (“*Sennheiser Comments*”).

²² *Disney Comments* at 46.

²³ Comments of WhiteSpace Alliance, GN Docket No. 12-268, at 33-34 (filed Jan. 25, 2013) (“*WhiteSpace Alliance Comments*”).

²⁴ See *Unlicensed Operation in the TV Broadcast Bands, Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807 (2008) (“*2008 White Space Order*”).

²⁵ “Wireless microphones and similar applications such as cordless cameras represent a high social, cultural and economic value in Europe. Such technologies, commonly summarised as PMSE (‘programme-making and special events’), are essential contributors to the production of the rich media content that will be critical to the success of the high speed broadband services to be delivered over fibre networks. In addition, PMSE applications are also supporting musical and theatrical performances, sport, social and cultural events in the professional and non-professional field.” European Commission, *Spectrum for Wireless Events*, http://ec.europa.eu/information_society/policy/ecomms/radio_spectrum/sectorial/shared_use/pmse/index_en.htm (last visited Jan. 15, 2013).

²⁶ See e.g., *NFL Comments* at 3 (noting the “NFL recently spent nearly \$9 million to upgrade its microphones from analog to digital”).

microphones.²⁷ However, as Shure and others have repeatedly explained, while there are some wireless audio devices that can operate in non-UHF bands, the characteristics of these alternative bands force tangible tradeoffs in latency, power, battery life, and range that are unacceptable to today’s professional wireless microphone operators. In that regard, Sennheiser stated that the “low available power and high interference levels for unlicensed operation in [higher frequency] bands leads to unreliable performance, while the narrow bandwidth of most units impairs audio quality.”²⁸ Migrating wireless microphone operations to the adjacent VHF spectrum is also infeasible for most professional applications given the requirement for larger antennas and higher power necessary to overcome higher background noise in that spectrum.²⁹

Furthermore, the higher frequency bands mentioned by some as suitable alternatives for wireless microphones are governed by rules and populated with users that create difficult and in many cases insurmountable technical and regulatory obstacles to supporting the scale of professional wireless microphone operations currently housed in UHF. For example, the 2.4 GHz band already supports a significant amount of unlicensed low power operations including Wi-Fi and related “smart grid” type devices.³⁰ The 3.5 GHz band is currently the subject of a separate Commission rulemaking set to examine a new “small cell” sharing scheme between commercial users and a significant number of existing federal users, which does not contemplate the use of this spectrum by wireless microphones.³¹ The 4.9 GHz band is also subject to an open rulemaking in which some parties, who are simultaneously advocating for a reduction in the amount of available UHF spectrum for wireless microphones, are also advocating for the

²⁷ *WhiteSpace Alliance Comments* at 35.

²⁸ *Sennheiser Comments*, at 4.

²⁹ Comments of Shure Incorporated WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 37-8 (filed Jan. 25, 2013) (“*Shure Comments*”).

³⁰ Comments of Public Interest Spectrum Coalition, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 8, 11, and 15 (filed Jan. 25, 2013) (“*PISC Comments*”).

³¹ See Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, *Notice of Proposed Rulemaking and Order*, GN Docket No. 12-354, FCC 12-148 (rel. Dec. 12, 2012).

expanded use of the 4.9 GHz spectrum for unlicensed broadband use in addition to the public safety licensees that already operate in the band.³²

None of the parties urging the Commission to move wireless microphones out of the UHF band offers any evidence or analysis that the referenced spectrum bands are available or suitable for professional wireless audio use, thus, there is little merit to the supposition that wireless microphones can simply migrate to other bands without serious impact to users and their audiences. The absence of suitable alternative equipment aside, the significant costs that wireless microphone users would have to incur to replace their systems is an inappropriate penalty, particularly after bearing the recent expense of the 700 MHz transition.³³

B. The UHF Band is the Global Spectrum Choice for Wireless Microphones

For decades, research and development for professional wireless audio technology has been concentrated in the UHF Band and today state of the art wireless microphone technology relies on UHF spectrum, both in the U.S. and internationally. Nearly all industrialized nations with significant media development allocate operation of wireless microphones to the UHF Band.³⁴ Other countries, such as Japan, not only allow wireless microphone operation in the UHF spectrum, but are moving to open *additional* UHF spectrum for its use.³⁵ The harmonization of the operating spectrum for wireless microphones is a key consideration for equipment manufacturers faced with design investments to serve global markets and for

³² Comments of the Wireless Internet Service Providers Association, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 5-6 (filed Jan. 25, 2013) (“*WISPA Comments*”). Any wireless microphones operating in these bands would be subject to Part 15 regulations including the requirement to accept all interference from other users, rendering that band unsuitable for professional audio needs.

³³ See e.g., *Performing Arts Comments* at 5 (“For many performing arts organizations, this migration out of the 700 MHz band caused an unanticipated expenditure of \$25,000 to \$100,000 for the purchase of sound equipment that would operate in a different area of the broadcast spectrum.”).

³⁴ *Shure Comments* at 14.

³⁵ See “Appeal for Opinion on Ministerial Ordinance and Bulletin Plans relating to Technical Standards, etc. for Mobile Communications Systems Using 700 MHz Band” Press Release, Ministry of Internal Affairs and Communication http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/Releases/Telecommunications/12022904.html (Feb. 29, 2012).

professional touring productions and rental companies that make significant capital investments with an expectation that equipment can be deployed in multiple countries. As the Walt Disney Company points out, since “UHF spectrum has been harmonized globally for wireless microphone use ... should the FCC take action to further mitigate the use of wireless microphones in the UHF band, another harmful effect is that possibility that equipment costs may increase as manufacturers are forced to develop wireless equipment that can only be used in the U.S.”³⁶

C. The Available Spectrum Below Channel 21 is Insufficient to Support Wireless Microphone User Needs

The Wireless Internet Service Providers Association (“WISPA”) and the Public Interest Spectrum Coalition (“PISC”) argue, with little supporting reasoning, that the Commission should limit wireless microphone operations to the portion of UHF spectrum below channel 21.³⁷ Shure strongly opposes this suggestion. Wireless microphones can and do make use of vacant TV channels below channel 21, but these are in no way sufficient to accommodate all wireless microphone operations nationwide. The NFL states in its comments, “spectrum for wireless microphones is growing scarce,” and as a result of this situation, it has “received numerous recent reports of wireless microphone interference during games, rendering coaches unable to communicate plays to their quarterbacks and referees unable to consult one another on calls.”³⁸ The Walt Disney Company informed that Commission that ESPN, in its headquarters in Bristol, Connecticut, can use “245 UHF frequencies over thirty-one channels *in a single day*” and that, in order to cover larger events such as the Presidential Inauguration, its subsidiary ABC “required over 108 MHz total bandwidth over twenty-five UHF television channels to support wireless

³⁶ *Disney Comments* at n.131.

³⁷ *See WISPA Comments* at 19; *PISC Comments* at 32-35.

³⁸ *NFL Comments* at 4.

microphones, IFBs ..., and communications channels.”³⁹ Major broadcast events, music productions, theater, and sports productions often utilize hundreds of wireless microphones,⁴⁰ and if these operations were limited to the spectrum below channel 21, these events would be so significantly impaired that they would become virtually impossible to conduct.⁴¹ In addition, a forced migration to the lower UHF Band would create unnecessary complications to the TV repacking effort following the Incentive Auctions.

II. Shure Supports the NAB/CTIA Modified Band Plan

On January 24, 2013, a group consisting of cellular carriers, semiconductor manufacturers and NAB filed an ex parte letter with the Commission proposing an alternative 600 MHz band plan⁴² that retained a number of core principles from the FCC’s lead plan (*e.g.*, 5 MHz paired block of spectrum), but deviated in recommending that the Commission “adopt a contiguous ‘Down from TV 51’ approach with uplink at the top,” a dramatically narrower “mid-band” or “duplex” gap between the uplink and downlink bands in the 600 MHz band (perhaps as narrow as 10 megahertz), and the elimination of DTV stations from the mid-band gap.⁴³ This alternative plan met with widespread support from broadcast and cellular interests in the comments. Among others, Comcast/NBCUniversal stated that adoption of the Down-from-51 approach would “create a contiguous band of frequencies allocated to television broadcasting, which will ensure continued progress and innovation in broadcasting.”⁴⁴ Verizon Wireless explained that a Down-from-51 approach was “needed to protect 600 MHz mobile broadband

³⁹ *Disney Comments* at 41-42 (italics in original).

⁴⁰ *See Shure Comments* at 13-14.

⁴¹ *See Disney Comments* at 44 (notes that frequency coordination of wireless microphones “is particularly difficult when covering news events in major urban areas, such as Washington, D.C., Los Angeles, New York or Chicago”).

⁴² *See Ex Parte Letter of AT&T, Inc., Intel Corporation, National Association of Broadcasters, Qualcomm, T-Mobile and Verizon Wireless, GN Docket No. 12-268* (filed Jan. 24, 2013) (“*Alt Band Plan Proposal*”).

⁴³ *Alt Band Plan Proposal* at 1.

⁴⁴ *Comcast/NBCUniversal Comments* at 20.

providers and television broadcasters from mutual interference, and to ensure that service providers and vendors can efficiently incorporate the 600 MHz band into wireless devices and networks.”⁴⁵

Shure lends its conditional support to the Down-from-51 plan in these reply comments. Shure agrees that creating a contiguous block of 600 MHz spectrum starting at channel 51 has significant advantages for the broadcast and cellular communities. We also agree that eliminating the wide mid-band gap proposed in the Commission’s lead plan will likely make the design and manufacture of cellular devices less complicated, and will protect both broadcasters and cellular networks from interference.⁴⁶

While Shure supports the Down-from-51 band plan, there are special concerns for wireless microphones. First, if sufficient spectrum is voluntarily contributed by the broadcasters, the Down-from-51 plan may consume the dedicated wireless microphone reserve channel created by the FCC above Channel 37. To the extent that this occurs, Shure urges the Commission to ensure that there is a second reserve channel created below Channel 37 to offset the loss of clean spectrum for wireless microphones. Second, the narrower mid-band gap proposed in the Down-from-51 plan will not provide a suitable spectrum environment for professional wireless microphones that require reliable clean spectrum due to the out-of-band emissions (“OOBE”) from the immediately adjacent 600 MHz uplink band (although it is possible that this band would have utility for nonprofessional users). The guard band immediately below the downlink band, however, should present a significantly cleaner

⁴⁵ Comments of Verizon Wireless, GN Docket No. 12-268, at 5 (filed Jan. 25, 2013).

⁴⁶ In particular, removing DTV stations from the mid-band gap creates greater separation between the relocating incumbent broadcasters and proposed 600 MHz handset uplink signals, the latter of which are both capable of creating interference into DTV receivers and also susceptible to interference from DTV stations.

environment, and wireless microphones should be given priority in those frequencies (enabled by the geolocation database).

III. The Two Wireless Microphone Reserve Channels Provide Essential Capacity and Should be Retained

The comments showed a strong consensus among wireless microphone stakeholders that the two reserve channels are critical to wireless microphone operations and must be retained. As Shure stated in its comments that the “demand for clean interference-free spectrum continues to skyrocket, and many wireless microphone users will rely solely on the existence of the reserve channels to ensure that they can operate their audio systems.”⁴⁷ Important content producers such as the NAB and the NFL also voiced strong opposition to the proposed elimination of the two wireless microphone reserve channels,⁴⁸ the need for which is clearly demonstrated by the record in this proceeding as well as that developed in the White Spaces proceeding.⁴⁹ The Commission’s decision to establish these channels is based on many years of study regarding wireless microphone functionality and development that remains valid despite plans for increased allocations for wireless broadband services in the TV Band.

The Commission has already recognized that the two reserve channels are the only means by which wireless microphone users can be certain to have interference-free spectrum available for unlicensed wireless microphone use and itinerant operations.⁵⁰ The importance of the reserve channels to *licensed* users, as well, cannot be underestimated, as their utility extends beyond

⁴⁷ *Shure Comments* at 16.

⁴⁸ *See NAB Comments* at 5-10 and *NFL Comments* at 4-6.

⁴⁹ *See Unlicensed Operation in the TV Broadcast Bands, Second Memorandum Opinion and Order, 25 FCC Rcd 18661, at ¶ 29 (rel. 2010) (“White Space Recon Order”).* (“We continue to recognize that wireless microphones are currently used in many different venues where people gather for events large and small and many consumers and businesses have come to rely on these devices.”).

⁵⁰ *See 2008 White Space Order* at ¶ 157 (“[T]he number of UHF channels available will be more restricted in markets where there are PLMRS/CMRS operations in addition to TV and other authorized uses. We will therefore reserve two channels where TVBDs will not be permitted in each of the markets where PLMRS/CMRS operations are present in order to preserve spectrum for wireless microphone operation.”).

itinerant use and into the foundation of studio facility frequency planning. NAB points out that wireless microphone usage is “essential for newsroom, newsgathering, and other operations” and the reserve channels “are needed to ensure that essential wireless microphone operations can perform without interference from unlicensed devices.”⁵¹ For breaking news, these channels are indispensable to electronic news gathering (“ENG”) operations which “by their nature occur at locations and on channels impossible to identify very far in advance” thus making it impossible to register for protection in the database.⁵²

Both the NFL and the Walt Disney Company stated that it is “imperative” that the Commission protect the reserve channels since they are necessary to meet the growing demand for spectrum and any reduction in the amount of available spectrum will result in the degradation of a multitude of productions and events.⁵³ For live theater, the Broadway League also supports the retention of the two reserve channels highlighting that their elimination “would have the greatest impact on smaller wireless microphone users and would result in more requests for database registration.”⁵⁴ Likewise, the Performing Arts Wireless Microphone Working Group expressed that most “professional performing arts organizations across the country ... operate with fewer than 16 wireless devices and they need the protection of the two safe-haven channels.”⁵⁵

No party offered evidence that the two reserve channels are any less necessary today than they were a short while ago when the Commission created them. In fact, the comments make clear that the two reserve channels will be even more important in an environment where wireless microphones will have access to less UHF spectrum as a result of the auctions and

⁵¹ *NAB Comments* at 6.

⁵² *Id.* at 7.

⁵³ *Id.* at 45-46

⁵⁴ *Broadway Comments* at 2.

⁵⁵ *Performing Arts Comments* at 4.

repacking. The Commission should therefore maintain its allocation of two reserve channels for professional audio production to support both licensed and unlicensed operations.

IV. The Comments Showed the Compelling Need to Expand Part 74 Licensing Eligibility

Shure has proposed a reasonable and neutral expansion of Part 74 licensing for wireless microphones. Specifically, Shure recommends that the Commission authorize licenses for all professional uses of wireless microphones, which would include the range of operators that require high quality and reliable wireless service beyond what is available using the two reserve channels.⁵⁶ Professional uses would include only those events where wireless microphones are an integral part of the production and the inability to use interference-free wireless microphones would impair or substantially undermine the event.⁵⁷ The Wireless Microphone Interests group urged the Commission to take this step: “[u]nder existing rules, large categories of important professional users including music concerts, Broadway theaters, the Kennedy Center, the theaters in the Las Vegas entertainment district, corporate productions and large houses of worship” are not currently eligible for licenses.⁵⁸ Shure contends that its approach is preferable to defining a new class of eligible parties by seating or building size. Its proposed eligibility approach more closely aligns licensing with those users who need it -- professional users who have exhausted the clean spectrum available in the two reserve channels, regardless of context.

As a practical matter, the outdated eligibility requirements impose unjustified and burdensome requirements on professional wireless microphone users who do not hold a license. The current rules require unlicensed wireless microphone users to wait 30 days and possibly more after registering for an event to obtain actual authority to request channels that require

⁵⁶ See *Shure Comments* at 21.

⁵⁷ See *id.* at 21-22.

⁵⁸ *Wireless Microphone Interests Comments* at 3.

protection in one or more of the approved geolocation databases.⁵⁹ This 30 day comment and notice period greatly diminishes the utility of the geolocation databases for touring productions, live events crews, venue operators, and other professional wireless microphone users who do not have a license but who need flexible authority to support a large wireless-intensive production. Parties with real-world expertise in frequency coordination for major productions described in the comments the practical need to be able to access the database in near real time to reflect the many frequency coordination decisions that must be made leading up to the event and even on the day of the event to adjust to unpredictable local conditions. Instructive comments were filed on this point by a group of over 100 well-known users and highly regarded frequency coordinators, including multiple Grammy award winning sound engineers and other audio professionals with responsibility for supporting high profile, complex wireless-intensive productions such as the Olympics, the Latin Grammy Awards, the Country Music Awards, the Rose Bowl, Microsoft corporate meetings, Radio City Music Hall, Cirque du Soleil, houses of worship, convention centers and hotels. Speaking of the Commission’s 30-day advance filing requirement, that group said:

“Many events are not planned or planned with sufficient finality 30-days in advance and professional frequency coordinators often discover unforeseen changes at the time of the event ... [such as] added performance dates, location changes within large venue complexes, size and scale increases to accommodate program changes and overlapping events within close proximity...”⁶⁰

Collectively representing the nation’s top echelon of expertise in wireless audio production and engineering, these experts stated unequivocally that unlicensed professional wireless microphone users in these situations “cannot obtain adequate protection through the Commission’s 30 day

⁵⁹ See 2008 White Space Order at ¶ 260.

⁶⁰ *Wireless Microphone Interests Comments* at 4-5.

advance request requirement and such requirements stand as an unreasonable barrier to the successful production of many professional events.”⁶¹

Similarly, The Broadway League, Inc. also commented that “[o]nly after on-site coordination will a touring-company know whether it will need to register in the database for protection on additional channels. There simply is no opportunity for a thirty-day notice and comment procedure.”⁶²

“Even productions that are planned for long runs in a single theatre would have problems with the thirty-day advance notice. Many of these productions use the services and rental equipment of audio engineering contractors who will not begin work – and especially will not purchase new equipment – until they have a contract with the producer along with a deposit. These are details that must be left to the final days of pre-production. Thus, by the time the audio engineers create their microphone plan for the production and survey the spectrum at the site, there is, again, no opportunity for a thirty-day comment window.”⁶³

Audio Technica supports Shure’s proposal to expand licensing to professional users and agrees the “Commission should not just consider the size of an organization or type of application as these limited criteria could deny protection for many legitimate and established wireless microphone uses.”⁶⁴ Other groups’ recommendations for license expansion are more limited to specific users or type of venue. For example,

- Robert Bosch LLC recommends the expansion of Part 74 licensing to nuclear power plant facilities on a secondary basis to broadcasters and with prior frequency coordination.⁶⁵
- The NFL “urges the Commission to allow sports leagues to become licensed wireless microphone operators and receive protection from interference through a centralized database.”⁶⁶

⁶¹ *Id.* at 5.

⁶² *Id.* at 4 (“[the advance 30-day notice process is] not a viable option for many professional users. Frequency planning is a complex and dynamic task that often requires flexibility leading up to the event or even at the event.”) *See also Broadway Comments* at 7.

⁶³ *Broadway Comments* at 7-8.

⁶⁴ *Audio Technica Comments* at 20.

⁶⁵ Comments of Robert Bosch LLC, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 18 (filed Jan. 25, 2013).

- The Broadway League recommends the expansion of low power auxiliary station licenses to its member and “other similarly situated, professionally staffed performance venues, producers, audio engineers and sound designers.”⁶⁷
- Boeing recommends the inclusion of “large professional conference centers and corporate campuses” as “eligible operators” of Part 74 licenses.⁶⁸

While Shure fully supports the inclusion of these users as eligible licensees under the “professional users” umbrella, it urges the Commission not to expand licensing by adding overly narrow new categories of uses. This type of licensing regime would not wholly encompass the diverse array of groups who utilize wireless microphones, nor would it account for evolving and changing uses of wireless microphones in the future. Shure is also concerned that licensing based on type of user (i.e., theater, house of worship, sports league) or use could establish a slippery slope whereby the Commission would have to delve into improper and unnecessary content regulation to determine if any specific entity should be granted a license for a specific use. Instead, it should look to a neutral and all-inclusive category of users that encompasses all of the vital uses for wireless microphones, but is restricted only to those users who need to expand spectrum access to support their productions and who are knowledgeable about the FCC’s rules, frequency coordination, and other attributes of professional users.⁶⁹ Any applicant for a wireless microphone license would need to certify that it would be used for professional wireless microphone operations. Given the significant history of wireless microphone operations coexisting with other incumbents in the UHF band based on skilled frequency management undertaken by professionals including audio engineers, frequency coordinators, and sound designers for auditoriums, theaters, corporate campuses, convention centers, arenas, theme parks,

⁶⁶ *NFL Comments* at 2.

⁶⁷ *Broadway Comments* at 4.

⁶⁸ *Boeing Comments* at 5.

⁶⁹ *Shure Comments* at 21-23.

and other professional production environments, there is no public interest reason to deny licensing to these users.

V. Wireless Microphones Should be Permitted to Register for Protected Operations in the Guard Bands

Shure proposed that wireless microphones, registered in the database, be allowed to operate on a priority basis in the guard bands.⁷⁰ The severe spectrum constraints on wireless microphones, especially in “urbanized areas in major markets” where “there may be little or no White Space spectrum available now” will be significantly exasperated by the incentive auction and resulting repacking of television stations. The Commission must act to ensure continued access to essential spectrum for professional audio equipment under these future conditions by prioritizing use of the guard band spectrum by wireless microphones through database registration in order to alleviate some of the spectrum congestion that will result from this process.⁷¹ NAB also supports this approach, asserting that it “sees no reason why the Commission could not designate and reserve the guard bands for licensed wireless microphones.”⁷²

While the comments in the incentive auction proceeding set forth a variety of proposals regarding the band plan, including an alternative band plan supported by numerous parties, no one disputes that the guard bands must be put in place and would provide an opportunity for other uses. In addition, Congress gave the Commission discretion to determine the necessary size of the guard bands and determine the best use of this spectrum.⁷³ Given the essential need for wireless microphones, Shure joins with Sennheiser in calling on the Commission to allow

⁷⁰ See *id.* at 21-23.

⁷¹ See *id.* at 17.

⁷² *NAB Comments* at 6.

⁷³ See Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6407(c), 126 Stat. 156 (2012).

registered wireless microphones to operate in the guard bands with protection from interference from other unlicensed devices.⁷⁴ In the context of the modified band plan proposed by NAB and CTIA,⁷⁵ Shure suggests that wireless microphones have access to both the lower guard band (adjacent to the LTE downlink) and the mid-band gap (between uplink and downlink) although Shure expects that only the lower guard band would be suitably clean for many professional wireless microphone operations, based on OOB characteristics of LTE systems. Shure supports the application of White Space rules to govern the lower guard band, including database registrations for wireless microphones.

VI. The Commission Should Not Mandate Digital Transmission for Wireless Microphones and Should Refrain from Imposing Technology Mandates that Would Stall Innovation, Impair Advancements in Wireless Microphone Performance, and Interfere with Market Forces

A. The Commission Should Not Mandate Digital Transmission for Wireless Microphones

The FCC should not require wireless microphones to use digital transmission at this time. There are several important reasons why this would be inappropriate. Digital wireless microphones are a relatively recent innovation, and digital technology is still evolving rapidly. There are significant tradeoffs between analog and digital wireless microphone systems. For example, digital systems have significantly more throughput delay (latency) than analog systems. This is an important consideration for certain applications such as live sound reinforcement and In Ear Monitoring (“IEM”) systems. Digital systems also tend to exhibit an all-or-nothing transmission characteristic -- sometimes referred to as the “cliff effect” -- that can be disconcerting to performers and presenters. Currently, professional users are deploying both analog and digital technologies according to the requirements of the production.

⁷⁴ See, e.g., *Sennheiser Comments* at 5-6.

⁷⁵ See *Alt Band Plan Proposal*.

While a majority of commenters avoided advocating for a particular transmission technology for wireless microphones, or correctly explained that both analog and digital technologies have strengths and weaknesses,⁷⁶ a minority suggested that a mandatory transition to digital technology is justified and preferred. Specifically, the White Space Alliance (“WSA”) recommended that “all wireless microphones should be required by a date certain to switch to more spectrally efficient modulation,”⁷⁷ and asserted that frequency reuse will improve “with a digital microphone transition.”⁷⁸ WISPA stated that with respect to digital wireless microphones it “favors any bandwidth requirement and transition plan that promotes more efficient use of the TV band spectrum in the shortest reasonable time period.”⁷⁹

Shure is keenly interested in technologies that enable wireless microphones to use spectrum efficiently, and has invested heavily in the development of those technologies. However, the fact is that for similar audio quality and transmission range, currently available high end analog and digital wireless microphone systems exhibit comparable spectral efficiencies. For either type, this figure can be increased significantly by reducing the power to a very low level at the expense of reduced working range. The most important factor limiting spectral efficiency is Intermodulation Distortion (“IMD”), a phenomenon that applies equally to both analog and digital wireless systems. At very low power levels, IMD products can be ignored, allowing virtually all frequencies within a TV channel to be utilized as long as the channel is free of co-channel interference and spill-over interference from transmissions in other channels. As discussed at length in Shure’s Comments, currently available analog and digital

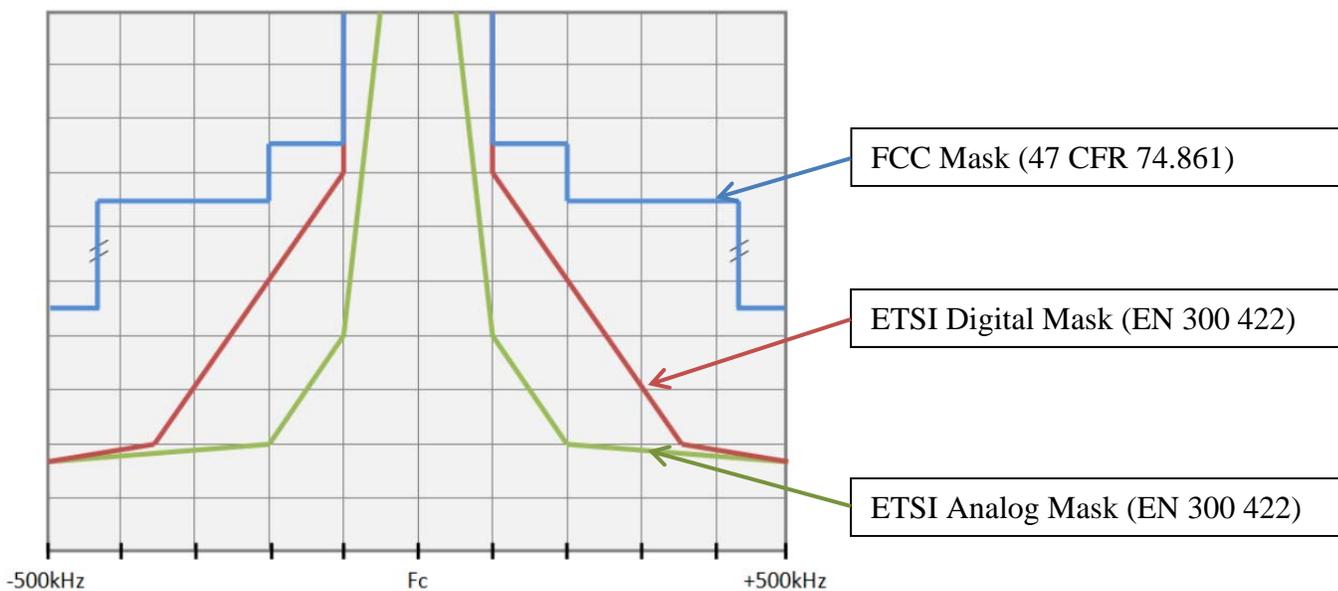
⁷⁶ See, e.g., *Sennheiser Comments* at 5-6.

⁷⁷ *White Space Alliance Comments* at 33.

⁷⁸ *Id.* at 34.

⁷⁹ Comments of Wireless Internet Service Provider Association, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268, at 20 (filed Jan. 23, 2013) (“*WISPA Comments*”).

microphones have similar emission masks and occupy approximately the same bandwidth.⁸⁰ The extreme performance demands placed on professional digital wireless microphones (<5 msec latency, >100dB audio dynamic range, 100+ meter operating range, *etc.*) simply do not facilitate the efficiencies that WSA and WISPA suggest. In fact, the digital wireless microphone emission mask recently implemented by the European Telecommunications Standards Institute (“ETSI”) is actually significantly wider than the mask applied to analog microphones. **Figure 1.0** below illustrates the distinctions between the FCC’s current wireless microphone emission mask (which does not distinguish between digital and analog systems), ETSI’s recently implemented digital mask, and ETSI’s narrower and spectrally more efficient analog mask.⁸¹



Finally, the vast majority of wireless microphones in use today are analog, and manufacturers and users have made significant investments in such systems and expect to be able to recover those investments. Moreover, as Shure has previously advised the Commission,

⁸⁰ See *Shure Comments* at 27-31.

⁸¹ See ETSI EN 300 422, Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement (2008).

professional wireless microphones are ruggedized devices designed for a decade or more of continuous use without more than routine maintenance.⁸² As a result, end users consider professional wireless microphones a long-term investment that is generally depreciated gradually.

The wireless microphone industry is well motivated to adopt spectrally efficient transmission technologies in order to satisfy the ever-increasing demand for more wireless audio channels. Therefore, the Commission should avoid mandating the use of a particular technology that could soon become obsolete. Furthermore, given the enormous installed user base of analog wireless microphones, the Commission should avoid mandating the use of digital transmission at this time.

B. The Comments Support Modest Changes in Operational Rules that Would Permit Greater Co-Channel Operation Between Microphone Users and TV Broadcasters

Shure agrees that limited but meaningful spectrum efficiency gains can be accomplished by a modest reduction in the required separation distance between co-channel wireless microphones and broadcast television stations, which is currently fixed at 113 kilometers in the Commission's rules but can be reduced without creating interference based on the actual coverage area of the television broadcasting stations. Shure also concurs that the evaluation of the factors necessary to determine appropriate separation distances between fixed broadcast stations and wireless microphones (broadcast station transmit power, antenna patterns, and terrain) can be automated and reflected in the available online channel lists for wireless microphones provided by the White Space geolocation databases.

Support for reducing the separation distance between co-channel wireless microphones and broadcast stations came from a diverse group of commenters. For example:

⁸² See, e.g., Comments of Shure Incorporated, ET Docket No. 04-186 at 5-8 (filed Nov. 30, 2004).

- Google/Microsoft urged the Commission to “call for data about [co-channel wireless microphone] operations and, given the lack of interference issues, legitimize the vast majority of them.”⁸³
- The Boeing Company explained that it supported “the Commission’s proposal to reduce the 113 kilometer separation distance between unlicensed wireless microphone operations and co-channel UHF stations.”⁸⁴ Boeing elaborated that “such a reduction could make available significantly more spectrum for use by unlicensed wireless microphones and would promote spectrum efficiency by allowing use of these frequencies by wireless microphones in locations where it otherwise might lie fallow.”⁸⁵
- Sennheiser Electronic Corporation proposed that “wireless microphones be allowed to operate at locations where a co-channel TV signal is below a specified threshold [between -100 to -80dBm over 200kHz]. If a wireless microphone is to be operated indoors, as most are, the measurement can be taken indoors, giving the microphone system the benefit of any wall attenuation.”⁸⁶

Given the significant support for decreasing the separation distance between co-channel wireless microphones and broadcast stations, Shure urges the Commission to continue investigating the specific parameters that facilitate reduced separation while ensuring that broadcast signals are not adversely affected.

There are certain high-profile, large-scale events that involve the simultaneous operation of hundreds of wireless microphones, in-ear monitors and wireless audio devices (*e.g.*, political conventions) that simply cannot be accommodated in presently available unoccupied VHF and UHF spectrum, and the potential loss of 600 MHz spectrum for microphone use will make the production of these events even more challenging. The Commission has historically facilitated the production and broadcast of these events by making additional spectrum, including occupied VHF and UHF channels, available for wireless microphones pursuant to experimental special

⁸³ See Joint Comments of Google, Inc. & Microsoft Corporate, GN Docket No. 12-268 at 54 (filed Jan. 23, 2013) (“*Google/MSFT Joint Comments*”).

⁸⁴ See *Boeing Comments* at 4.

⁸⁵ See *id.* at 4-5.

⁸⁶ See *Sennheiser Comments* at 11.

temporary authority (“STA”).⁸⁷ Given that future large-scale events will likely involve increasing numbers of wireless microphones and complementary audio devices and significantly less available unoccupied VHF and UHF spectrum, the Commission can anticipate more frequent requests for STA. Shure recommends that the Commission review the STA application process with the objective of streamlining and speeding up the approval process, and enabling the producers/RF coordinators of such events to input frequencies authorized pursuant to STA into the White Space geolocation databases.⁸⁸

C. The Commission Should Disregard Calls For Dramatically Reducing Wireless Microphone Occupied Bandwidth

Several commenters, including Shure, discussed the research and development efforts underway to improve the spectral efficiency of wireless microphones.⁸⁹ With a notable exception, these comments were tempered and acknowledged that the unique performance characteristics of professional wireless microphones make dramatic short-term improvements in spectral efficiency unrealistic. Spectrum Bridge, Inc. (“SpectrumBridge”), however, argued that wireless microphone manufacturers “should be encouraged to use available technologies to reduce [occupied bandwidth] to 50 KHz.”⁹⁰

SpectrumBridge provided no technical analysis for its narrowbanding recommendation and did not elaborate on the “available technologies” its comments reference. Extremely high audio quality and low latency are important to professional wireless microphone users, and at

⁸⁷ See, e.g., Grant of Waiver of Separation Requirements of 47 CFR Sec. 74.802 and Special Temporary Authorizations for National Political Conventions, DA 04-1494 (rel. May 26, 2004).

⁸⁸ The Commission recently completed streamlining Part 5 Experimental License rules to facilitate more effective. See Promoting Expanded Opportunities for Radio Experimentation and Market Trials under Part 5 of the Commission’s Rules and Streamlining Other Related Rules, *Report and Order*, FCC 13-15, ET Docket No. 10-236 (rel. Jan. 31, 2013).

⁸⁹ See, e.g., *Sennheiser Comments* at 8.

⁹⁰ *SpectrumBridge Comments* at 3-4.

present an occupied bandwidth of approximately 200 kHz in accordance with the mask in ETSI EN 300 422 is required to meet user quality expectations.⁹¹

As discussed in greater detail above and in Shure Comments, wireless microphone manufacturers have made important gains in spectral efficiency for both digital and analog systems.⁹² In the future, it may be possible to achieve further improvements. However, the narrowbanding proposed by SpectrumBridge is not currently practical without compromising audio quality. Moreover, as previously discussed, reductions in occupied bandwidth are not the most likely path for improving wireless microphone efficiency. Instead, reducing IMD interference is more likely to bring significant improvements in spectrum efficiency.

Accordingly, the Commission should dismiss unsupported recommendations to radically reduce wireless microphone occupied bandwidth. The wireless microphone industry has and will continue to develop advancements in spectrum efficiency in response to increased demand from users to operate more wireless systems simultaneously. Shure suggests, and other parties agree, that the Commission should refrain from unnecessary regulation and let market forces continue to push technology innovation in this area.

VII. Certain Changes Proposed in the Comments to Improve the Database Registration Process Should be Adopted

Consistent with Shure's recommendations, several commenters proposed changes to improve the functionality of the White Spaces geolocation databases, which are now being implemented. The recommendations include modest fine tuning to optimize the databases' ability to assign frequencies to protect incumbent spectrum users and rapidly assign frequencies

⁹¹ As noted in Shure's Comments, a modest reduction in occupied bandwidth below 200 kHz is possible. *See Shure Comments* at 32-33.

⁹² *See id.*

to unlicensed device operators. Shure encourages the Commission to implement these recommendations.

VIII. Technically Unsound Recommendations Concerning Fractional Channel Registrations for Wireless Microphones Should be Dismissed

Shure opposes the unsupported and technically flawed recommendations made by WISPA and PISC that would result in protecting wireless microphones only on a specific 200 kHz sliver of VHF or UHF spectrum. Specifically, WISPA argued that wireless microphones should “not be permitted to register an entire six megahertz channel,” but “only a narrow sub-channel of 200 kHz of spectrum.”⁹³ PISC recommended wireless microphones be “required to register and request an assignment of microphone sub-channels whenever the non-TVWS channels available at their location are inadequate for a particular event or need.”⁹⁴

Unlicensed device advocates have made this unsound argument for “fractional registrations” before, and the Commission has wisely chosen to disregard it.⁹⁵ Neither WISPA nor PISC has presented new or compelling scientific data to support the recycled argument for allowing unlicensed devices to operate within a TV channel already in use by wireless microphones. There are, however, numerous reasons to dismiss the proposal. Specifically:

- Professional wireless microphones require known, clean spectrum. Frequency coordinators conduct site surveys days or weeks before events to ensure they understand the ambient RF levels on channels contemplated for wireless microphones and complementary low-power broadcast auxiliary transmitters. The introduction of unlicensed TV band devices in channels already occupied by wireless microphones would result in an unpredictable and constantly changing RF environment unsuitable for high-profile microphone operations.

⁹³ WISPA Comments at 19.

⁹⁴ Comments of Public Interest Spectrum Coalition, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, GN Docket No. 12-268 at 42 (filed Jan. 23, 2013) (“PISC Comments”).

⁹⁵ See, e.g., Ex Parte Presentation of Microsoft Corporation, ET Docket No. 04-186 at 1-2 (filed Sep. 16, 2010) (asserting without any technical support that “recent work by Microsoft Research demonstrate[ed] that white space devices are capable of operating on the same channel as narrowband wireless microphones without causing harmful interference.”).

- Placing wireless microphones and unlicensed TV band devices co-channel in fractional registrations would greatly increase the likelihood of interference related to intermodulation (“IMD”) product, which occurs when multiple signals from different sources in close proximity combine to produce unwanted new signals, as well as creating interference related to out-of-band emissions from nearby TV band devices.
- Finally, permitting TV band devices to operate in fractional channels may hinder advances in wireless microphone spectral efficiency. High-density wireless microphone systems require a significantly lower noise floor than conventional wireless microphones to facilitate tighter spacing while minimizing IMD. Fractional registrations would be incompatible with the operation of high-density wireless microphone systems, resulting in wireless microphone operators spreading microphones over more channels instead of less.

VIII. Conclusion

For the foregoing reasons, Shure respectfully urges the Commission to retain the two wireless microphone reserve channels, expand Part 74 license eligibility and permit wireless microphones to operate using the geolocation database in the guard band. In addition, Shure asks the Commission not adopt any mandatory transition from analog to digital wireless microphone technology and to allow the marketplace to drive improvement and implementation of new and efficient technologies.

Respectfully submitted,

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