

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

In the Matter of)	
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)	
Amendment of Part 15 of the Commission's)	ET Docket No. 14-165
Rules for Unlicensed Operations in the)	
Television Bands, Repurposed 600 MHz)	
Band, 600 MHz Guard Bands, and Duplex)	
Gap, and Channel 37, and)	
)	
)	
Amendment of Part 74 of the Commission's)	
Rules For Low Power Auxiliary Stations in)	
The Repurposed 600 MHz Band and 600 MHz)	
Duplex Gap)	
)	
Expanding the Economic and Innovation)	GN Docket No. 12-268
Opportunities of Spectrum Through Incentive)	
Auctions)	

REPLY COMMENTS OF SHURE INCORPORATED

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SUMMARY

The wireless microphone community -- users, manufacturers and the millions of people who demand productions of which wireless microphones are an integral part -- face significant disruption and severe harm if the Commission adopts many of the proposals in the NPRM, including proposals that would radically reduce the clean UHF spectrum available for wireless microphone use, impose government-mandated redesign of wireless microphone equipment to incorporate database control, impose restrictive new power limits on unlicensed wireless microphones, and render noncompliant a substantial portion of recently purchased wireless microphone equipment across the country. Other Commenting parties shared Shure's concern that the proposals in the NPRM, if adopted, would not meet the needs of the existing and expanding wireless microphone industry and would disproportionately -- and unnecessarily -- favor white space devices ("WSDs"). The Comments also revealed, however, overreaching attempts by some WSD proponents and the wireless carrier community to oust wireless microphones from UHF frequencies by advocating for further rule amendments that would banish explicitly wireless microphones from UHF frequencies, or effectively make the spectrum environment so hostile, and new requirements so onerous (all under the guise of spectrum efficiency and interference mitigation) as to make it virtually impossible for today's wireless microphone operations to continue.

The Commission must not accept the false choice of dismantling, either knowingly -- or unwittingly -- the existing robust wireless microphone industry, successfully sharing spectrum for over three decades and currently serving the needs of millions, in favor of white space device proponents who seek to gain access to spectrum in the hopes of jumpstarting a new market for devices and services that have yet to materialize even after five years of a favorable regulatory rules. Demand for wireless microphones operating in a professional and semi-professional

context are at an all-time high. Today, they are integral to the U.S.'s global leadership in the creation of content in broadcast, film, music, sports, theater and other content performed live and distributed through broadcast television, cable TV, movies, and via broadband Internet distribution.

Other parties shared Shure's opposition to rule changes that would eliminate essential protections for wireless microphone operations. In particular, rule changes that would:

- eliminate the two wireless microphone reserve channels, thereby eliminating what may be the last post-auction and repack source of interference-free UHF spectrum particularly important for non-registered wireless microphones, without identifying comparable spectrum,
- allow portable WSDs to operate on channels below channel 21, thereby eliminating one of the principal sources of spectrum available for wireless microphones, especially unlicensed wireless microphones,
- permit fixed WSD operations on channels adjacent to broadcast signals, thereby eliminating the other principal sources of spectrum available for wireless microphones, especially unlicensed wireless microphones,
- allow WSDs to operate at increased power (in some cases, substantially increased power) creating a significant disparity that will risk interference to licensed wireless microphones and be unworkable for unlicensed wireless microphones,
- allow WSDs to use significantly increased antenna heights, raising interference risks for both licensed and unlicensed wireless microphones,
- allow fixed WSDs to operate where there are two, rather than three, vacant channels, thereby halving the amount of spectrum that was previously contemplated as a source for wireless microphones, particularly below channel 21,
- force a fundamental redesign of wireless microphone architecture by requiring that they be controlled by a database to operate in guard bands and channels 14-21 thereby rendering obsolete a significant portion of existing wireless microphone equipment while leaving users with no choice for new equipment even if they could muster the funds for new investments,
- impose new, onerous reduced power requirements in the duplex gap which would make wireless microphones vulnerable to interference from WSDs and wireless transmissions in nearby spectrum, and at the extremely low levels proposed by some parties eliminate all utility of the guard band for wireless microphone operations. The

50 mW power limit for unlicensed wireless microphones should be retained including for operations in the guard bands,

- eliminate the existing geolocation database registration system for unlicensed wireless microphones (*i.e.*, those operated by microphone users that do not routinely use 50 or more microphones) thereby closing off any opportunity to protect special events served by microphone users that may not meet the high threshold for license eligibility,
- impose a new fee requirement on wireless microphones for accessing the database, thereby singling out wireless microphones as the only incumbent service subject to a fee and creating new burdens on unlicensed users, and
- impose harsh transition procedures that would force wireless microphone users to discard working equipment (much of which was recently purchased after the 700 MHz transition) long before the end of the equipment's useful life and in a context in which no viable substitute spectrum path has yet emerged.

Other parties also aligned with Shure's support for wireless microphone operations in the duplex gap and guard bands but the Comments confirmed that the 4 MHz proposed for licensed wireless microphone use does not adequately address wireless microphone needs for interference-free spectrum. Accordingly, Shure supports the proposal that the entire duplex gap be dedicated to wireless microphone use particularly if no other clean UHF spectrum is identified. If the Commission retains its 4 MHz/6 MHz apportionment of the duplex gap between wireless microphones and WSDs, it should retain the original 1 MHz/4 MHz/6 MHz band plan that contemplates a 1 MHz buffer between wireless microphones and wireless services.

Channel 37 presents an important spectrum resource and licensed wireless microphones should be able to operate in channel 37 similar to other white space channels except that licensed wireless microphone operators will take additional steps to avoid Wireless Medical Telemetry Service sites and Radio Astronomy facilities identified in the database.

Licensed and unlicensed wireless microphone should be able to operate exclusively in the proposed 3 MHz guard bands adjacent to Channel 37. That spectrum, albeit a modest allocation,

could be a source of much needed exclusive use spectrum for wireless microphones -- particularly important for unlicensed wireless microphones -- that would otherwise lie fallow.

The Commission's proposal to adopt improvements in the database operation garnered much support. The Commission should reject the few suggestions to limit these changes to two "fast polling" channels or provide for lengthy grace periods and should proceed to adopt these improvements immediately. Similarly, most parties recognized that if the Commission relaxes location accuracy requirements it must incorporate corresponding changes to separation distances to protect incumbent services.

Finally, wireless carrier interests assert a risk of interference and argue that wireless microphones should be "migrated" elsewhere without delay or, again, be subject to such onerous technical limitations as to make effective operation impossible. Qualcomm and CTIA both offer technical inputs but their assumptions regarding wireless microphone operations and how they will translate to the duplex gap and/or lower guard band are not born from real-world environments and measurements, and ultimately fail to provide useful data to develop the technical record in the instant proceeding. Shure suggests that the Commission undertake its own testing with the involvement of all stakeholders to better understand coexistence of devices in the UHF band. Other agencies, such as the EU's Electronic Communications Committee, have studied the compatibility of devices in the 600 MHz band with thoughtful consideration of real-world parameters, separation distances, and assumptions about wireless microphone compatibility between wireless microphones and cellular devices.

Shure urges the Commission to proceed cautiously in light of the very significant established wireless microphone industry that is at stake and endeavor to strike a balance that will address wireless microphone and wireless carrier needs while maintaining reasonable opportunity for WSDs.

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REPLY COMMENTS OF SHURE INCORPORATED

Shure Incorporated (“Shure”), by its undersigned counsel, hereby submits these Reply Comments in response to the Notice of Proposed Rulemaking (“NPRM”) in the above-captioned proceeding.¹ The wireless microphone community -- users, manufacturers and the millions of people who demand productions of which wireless microphones are an integral part -- face significant disruption and severe harm if the Commission adopts many of the proposals in the

¹ Amendment of Part 15 of the Commission’s Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, and Amendment of Part 74 of the Commission’s Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap, ET Docket No. 14-165, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, *Notice of Proposed Rulemaking*, FCC 14-144 (rel. Sept. 30, 2014) (“NPRM”).

NPRM, including proposals that would radically reduce the clean UHF spectrum available for wireless microphone use, impose government-mandated redesign of wireless microphone equipment to incorporate database control, impose restrictive new power limits on unlicensed wireless microphones, and render noncompliant a substantial portion of recently purchased wireless microphone equipment across the country. Other Commenting parties shared Shure's concern that the proposals in the NPRM, if adopted, would not meet the needs of the existing and expanding wireless microphone industry and would disproportionately -- and unnecessarily -- favor white space devices ("WSDs").² The Comments also revealed, however, overreaching attempts by some WSD proponents and the wireless carrier community to oust wireless microphones from UHF frequencies directly or indirectly by burdening wireless microphone operations with onerous and unworkable technical and operational requirements.

It is undisputed that wireless microphones will have less interference-free UHF spectrum in which to operate following the introduction of wireless services in the 600 MHz Band and wireless microphone manufacturers and users will continue to adapt product technologies and applications to meet production demands while new services are introduced into the UHF spectrum. However, it is not acceptable for the Commission to radically alter the regulatory scheme in such a way as to fundamentally undermine wireless microphone designs and deployments and, in turn, disrupt the many sectors that rely on them to produce the nation's news, sports and other broadcast content, live entertainment, business and civic communication, worship services, and convention and hospitality audio-visual services, among others.

² See Comments of Audio-Technica U.S., Inc., ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268, at 7 (filed Feb. 4, 2015) ("*Audio-Technica Comments*") ("[T]he rules as proposed unduly favor WSD operations . . .").

I. The Commission Must Avoid Upending Wireless Microphone Operations and Disrupting the Many Industries that Rely on Wireless Microphones, Harming Users, Manufacturers and the Millions of Americans Who Demand Advanced Audio from Wireless Microphones in a Wide Range of Productions

In the Comments, Shure demonstrated that many of the proposed Part 15 rule changes, if adopted, would simply be inadequate to address the existing important UHF spectrum needs of wireless microphone operations. Most wireless microphone operations and virtually all of professional wireless microphone operations make use of UHF frequencies affected by this proceeding and the spectrum auction.³ Certain proposed rule amendments, if adopted, would be particularly damaging to wireless microphone operations negating much of the equipment that exists today and leaving no viable substitute path for future wireless microphone operations. The National Association of Broadcasters (“NAB”), Sennheiser, Audio-Technica, and CP Communications voiced similar concerns in the Comments.⁴ In stark contrast, Microsoft, certain other white space proponents, as well as some wireless carrier representatives impatient at the prospect of wresting control of UHF frequencies through this proceeding and the Incentive Auction have, accordingly, propounded many arguments detailing how the Commission can

³ See Comments of Sennheiser Electronic Corporation, ET Docket No. 14-165, GN Docket No. 12-268, at 12 (filed Feb. 4, 2015) (“*Sennheiser Comments*”) (“Class A and Class B users will require access to unlicensed UHF TV band spectrum . . .”).

⁴ See, e.g., *Audio-Technica Comments*, at 12 (observing that requiring microphones to adhere to WSD database requirements will render all current products on the market obsolete and impose undue financial burdens on consumers); Comments of CP Communications, LLC, ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268, at 3 (filed Feb. 4, 2015) (“*CP Communications Comments*”) (recognizing that sweeping wireless microphones out of the 600 MHz band and the 500 MHz band or the proposed use of the 600 MHz guard bands and duplex gap will unavoidably result in degradation of audio delivery to public audiences and there is no practical alternative for critical uses); Comments of the National Association of Broadcasters, ET Docket No. 14-165, GN Docket No. 12-268, at 16 (filed Feb. 4, 2015) (“*NAB Comments*”) (noting that inserting TV stations into the duplex gap, especially in major markets, would completely eliminate the only dedicated spectrum for licensed microphones); Comments of the National Association of Broadcasters, ET Docket No. 14-166, GN Docket No. 12-268, at 2-3 (filed Feb. 4, 2015) (observing that decisions by the FCC to eliminate 12 megahertz of reserve channels and its proposed rules for the duplex gap will completely eliminate any reliable reserved spectrum for wireless microphone operations); *Sennheiser Comments*, at 21 (recognizing that the proposal that wireless microphones certified to operate in any portion of the repurposed 600 MHz Band be required to cease operation, even if they can operate in other frequencies, will make equipment useless that would otherwise remain useful for a long time).

amend its rules either to banish explicitly wireless microphones from UHF frequencies, or effectively make the spectrum environment so hostile, and new requirements so onerous (all under the guise of spectrum efficiency and coordination)⁵ as to make it virtually impossible for today's wireless microphone operations to continue. Many of these arguments contain unjustified claims regarding wireless microphone technologies and operations⁶ and conclusory arguments aimed solely at securing control over UHF spectrum as quickly as possible without regard to the significant harm to longstanding incumbent uses and existing needs.

As a threshold matter, Shure cautions that it is inappropriate for the Commission to knowingly -- or unwittingly -- participate in the dismantling of the wireless microphone service. The proposed rule amendments, taken collectively, as well as certain actions recommended in the Comments by white space proponents or carrier representatives⁷ would do just that. Wireless microphones have been critical tools for broadcast and many other productions for over three decades, and today the demand for high quality, sophisticated production values that require wireless microphones is at an all-time high.⁸ Wireless microphones have served and are

⁵ See Comments of CTIA – The Wireless Association, ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268, at 43 (filed Feb. 4, 2015) (“*CTIA Comments*”) (proposing that the FCC should expedite the wireless microphone transition from the 600 MHz band); Comments of Microsoft Corporation, ET Docket No. 14-165, GN Docket No. 12-268, at 34 (filed Feb. 4, 2015) (“*Microsoft Comments*”) (advocating that unlicensed microphones operating in the 600 MHz duplex gap and guard bands should be required to query white space databases and share the bands with white space devices); Comments of Motorola Solutions, Inc., ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268, at 9 (filed Feb. 4, 2015) (“*Motorola Comments*”) (stating that wireless microphone should not be allowed to operate on channels 14-20); Comments of White Space Alliance, ET Docket No. 14-165, GN Docket No. 12-268, at 24 (filed Feb. 4, 2015) (“*WISPA Comments*”) (arguing that microphones entering the 600 MHz band should be required to have a spectral efficiency of at least 4 bits/Hz).

⁶ See, e.g., *Microsoft Comments*, at 10-11 (claiming that digital microphones are more efficient); *Motorola Comments*, at 9 (suggesting that wireless microphone operations in channels 14-20 could threaten public-safety and life-safety communications).

⁷ See, e.g., comments cited *supra* note 5.

⁸ See *Audio-Technica Comments*, at 21 (“The demand for wireless microphones is constantly expanding. It is not uncommon for an event to require more than 100 microphones”); *Sennheiser Comments*, at 2-3 (“The U.S. public expects the very highest standards of production quality As a practical matter, this means ‘CD’ sound quality rather than MP3, with no discernable latency”); *CP Communications Comments*, at 2 (“Wireless has replaced wired microphones in virtually all professional situations”).

successfully serving the ever-expanding demand of millions of Americans for increasingly complex productions. Wireless microphones are integral to the U.S.'s global leadership in the creation of content in broadcast, film, music, sports, theater and other content performed live and distributed through broadcast television, cable TV, movies, and via broadband Internet distribution.⁹

In the Comments, some white space proponents make vocal demands that significant blocks of UHF spectrum be turned over immediately for WSD use and that the FCC radically amend the Part 15 rules to accommodate this incipient service.¹⁰ The Commission must not lose sight of the fact that the “white space industry” has yet to materialize.¹¹ Only 15 fixed white space devices have been certified in the five years since the FCC promulgated the white spaces rules in Part 15.¹² No personal/portable white space devices have achieved certification.¹³ As NAB expressed, unlicensed use is highly speculative and it is uncertain whether a market will develop.¹⁴ The Commission must not accept the false choice of dismantling the existing robust

⁹ See *Sennheiser Comments*, at 2-3 (“Wireless microphones are ubiquitous in all aspects of the entertainment business, in news reporting, in sports, and in U.S. commercial, civic and religious life. . . . These include team sports from local college broadcasts to the Super Bowl, the World Series, the Final Four, and the Stanley Cup; the Democratic and Republican political conventions; post-election national and local coverage; the Oscar, Emmy, and Grammy Awards shows; events such as the Olympics, NASCAR races, the Kentucky Derby, and major golf and tennis tournaments; and on-the-scene news reporting of all kinds, both local and national.”).

¹⁰ See, e.g., *Microsoft Comments*, at 1-3 (proposing technical rules that would make at least three commercially usable 600 MHz channels available for WSD use, including unused television channels, lower guard band, duplex gap, and Channel 37 among others); Comments of WiFi Alliance, ET Docket No. 14-165, GN Docket No. 12-268, at i (filed Feb. 4, 2015) (“*WiFi Alliance Comments*”) (supporting proposals to expand television channels available for fixed and personal/portable white space devices and permit operations in the 600 MHz guard bands and duplex gap, on channel 37, and in the repurposed 600 MHz band); *WISPA Comments*, at 3 (supporting “the maximum availability of unlicensed spectrum in licensed bands” along with vacant and unused channels in these bands for WSD use).

¹¹ See Comments of Shure Incorporated, ET Docket No. 14-165, GN Docket No. 12-268, at 9-10 (filed Feb. 4, 2015) (“*Shure Comments*”); *Audio-Technica Comments*, at 16.

¹² The Commission’s database reflects grants for fixed WSDs to Redline Communications, Koos Technical Services, Carlson Wireless Technologies, Meld Technology, Adaptrum, Inc. and 6Harmonics, Inc.

¹³ See *NAB Comments*, at 7 (“[N]o [personal/portable] have yet been approved for public use.”); *Sennheiser Comments*, at 6-7 (“[N]o portable white space devices are in the market.”).

¹⁴ See *NAB Comments*, at 15 (“[I]t is highly speculative . . . to allot duplex gap spectrum exclusively for unlicensed use. To date, it remains unclear whether a market for white space devices will develop . . .”).

wireless microphone industry currently serving the needs of millions in favor of white space device proponents who seek to gain access to spectrum in the hopes of jumpstarting a new market for devices and services.

Shure, Sennheiser, Audio-Technica and others also pointed out that recent FCC actions displacing wireless microphones from the 700 MHz Band relocated a large portion of the country's wireless microphone use to the very UHF frequencies now targeted in the new rules for auction and repurposing, causing significant disruption and expense to wireless microphone users and the industries that rely on them.¹⁵ Principles of reasonable and sound policymaking require that the Commission must take this into account as it considers what changes should be made to the Part 15 and Part 74 rules.¹⁶ The public interest will be harmed if the Commission fails to address the needs of the wireless microphone community and, accordingly, all of the proposed changes in the NPRM and recommendations that arise in the Comments should be evaluated with that objective in mind. The Commission should proceed cautiously and endeavor to strike a balance that will address wireless microphone and wireless carrier needs while maintaining reasonable opportunity for WSDs.¹⁷

¹⁵ See *Audio-Technica Comments*, at 12 (“[M]any [consumers] recently experienced the financial hardship of replacing their wireless equipment as a result of the 700MHz spectrum auction.”); *CP Communications Comments*, at 6 (recognizing that many small business attempting to comply with the rules recently incurred significant expenses moving to the 600 MHz band); Comments of Sennheiser Electronic Corporation, GN Docket Nos. 14-166, 12-268, at 19 (filed Feb. 4, 2015) (emphasizing that these displacements are “creating havoc for the wireless microphone industry” and that “transition from 600 MHz is particularly difficult because many owners only recently invested in new equipment in order to transition off 700 MHz frequencies”); *Shure Comments*, at 6 (noting that wireless microphone users were forced “to discard perfectly operable equipment and reinvest in new equipment” when 700 MHz operations were banned).

¹⁶ “In making public interest determinations which will affect an entire industry, the FCC is responsible for weighing the potential benefits against the detriments of a proposed policy.” *ITT World Commc'ns, Inc. v. F.C.C.*, 725 F.2d 732, 751 (D.C. Cir. 1984).

¹⁷ See *Audio-Technica Comments*, at 16-18 (suggesting that the Commission should proceed cautiously and phase in Part 15 rule changes).

A. Parties with Knowledge of Wireless Microphone Operations Oppose Rule Changes that Would Eliminate Essential Wireless Microphone Protections

In its initial Comments, Shure opposed rule changes that would eliminate essential protections for wireless microphone operations. Specifically, Shure and others opposed rule changes that would:

- eliminate the two wireless microphone reserve channels, thereby eliminating what may be the last post-auction and repack source of interference-free UHF spectrum,
- allow portable WSDs to operate on channels below channel 21, thereby eliminating one of the principal sources of spectrum available for wireless microphones, especially unlicensed wireless microphones,
- permit fixed WSD operations on channels adjacent to broadcast signals, thereby eliminating the other principal sources of spectrum available for wireless microphones, especially unlicensed wireless microphones,
- allow WSDs to operate at increased power (in some cases, substantially increased power) creating a significant disparity that will risk interference to licensed wireless microphones and be unworkable for unlicensed wireless microphones,
- allow WSDs to use significantly increased antenna heights raising interference risks for both licensed and unlicensed wireless microphones,
- allow fixed WSDs to operate where there are two, rather than three, vacant channels, thereby halving the amount of spectrum that was previously contemplated as a source for wireless microphones particularly below channel 21,
- force a fundamental redesign of wireless microphone architecture by requiring that they be controlled by a database to operate in guard bands and channels 14-21 thereby rendering obsolete a very significant portion of existing wireless microphone equipment while leaving users with no choice for new equipment even if they could muster the funds for new investments,
- impose new, onerous reduced power requirements in the duplex gap which would make wireless microphones vulnerable to interference from WSDs and wireless transmissions in nearby spectrum, and at the extremely low levels proposed by some parties eliminate all utility of the guard band for wireless microphone operations,
- eliminate the existing geolocation database registration system for unlicensed wireless microphones (i.e., those operated by microphone users that do not routinely

use 50 or more microphones) thereby closing off any opportunity to protect special events served by microphone users that may not meet the high threshold for license eligibility,

- impose a new fee requirement on wireless microphones for accessing the database, thereby singling out wireless microphones as the only incumbent service subject to a fee and creating new burdens on unlicensed users, and
- impose harsh transition procedures that would force wireless microphone users to discard working equipment (much of which was recently purchased after the 700 MHz transition) long before the end of the equipment's useful life and in a context in which no viable substitute spectrum path has yet emerged.

II. Wireless Microphone Operators Need Access to all Possible UHF Spectrum Options

Wireless microphones have operated successfully in the UHF Band, including 600 MHz frequencies, for more than 30 years. Some wireless microphone operations use other frequencies and efforts to encourage non-professional users into other bands have increased. Nonetheless, professional users -- those that require real-time, high quality, low latency transmissions -- operate principally in UHF frequencies.¹⁸ These services are deeply embedded in productions serving broadcast, filmmaking, sports, music, theater, commercial, religious and education activities. These operators successfully share spectrum with broadcasters and with each other through careful frequency coordination that has enabled decades of successful operation without interference complaint.¹⁹ Wireless microphone technology has continued to advance in spectral efficiency and performance, driving the country's global leadership in content creation particularly in multimedia and entertainment. In light of the reduced future availability of UHF spectrum as a result of the Incentive Auction and repacking, wireless microphone operators will need access to all possible UHF spectrum options, including small slices of spectrum, in order to

¹⁸ See *Sennheiser Comments*, at 12 (“Class A and Class B users will require access to unlicensed UHF TV band spectrum . . .”).

¹⁹ See, e.g., *Sennheiser Comments*, at 7; *Shure Comments*, at 5.

avoid severe disruption of existing operations. NAB, Sennheiser, Audio-Technica, CP Communications and others echoed Shure's view that it is imperative that the Commission preserve sufficient UHF spectrum resources to support wireless microphone operations and that the current proposals do not adequately address this need.²⁰

A. Preservation of Two Reserve Channels for Wireless Microphones Is Even More Critical if the Commission Proceeds with Rule Amendments that Close Other UHF Spectrum Options for Wireless Microphones

Shure urged the Commission to preserve two reserve channels for wireless microphones.²¹ Other parties that understand the demand for and extent of use of wireless microphone also urged the Commission to retain "safe haven" channels.²² These two channels become even more critical in light of certain NPRM proposals combined with others newly raised in the Comments that would effectively eliminate all potential interference-free UHF spectrum for wireless microphone use. In this regard, Shure strongly rejects Microsoft's wholly unfounded claim that "under the Commission's proposed plans for wireless microphone operations in the TV bands, plenty of 600 MHz spectrum remains available for wireless microphone use."²³ While the NPRM identifies opportunities for shared use by unlicensed microphones and white space devices, spectrum free from potential interference by white space devices and LTE out-of-band emissions would be drastically reduced. In addition, if the

²⁰ Although not a part of the *NPRM's* proposals, Shure shares in the support displayed in the comments for identifying the "naturally occurring" white space channel that may develop in many markets as a channel available for wireless microphone operations exclusively. See, e.g., *Sennheiser Comments*, at 8 ("one unassigned, or 'naturally occurring,' UHF television channel be assigned solely for wireless microphone use.").

²¹ Given that the former reserve wireless microphone channels above and possibly below channel 37 will be auctioned to wireless carriers, the two reserve channels could be located elsewhere in the UHF band.

²² See *CP Communications Comments*, at 6 ("CP Communications supports . . . the prohibitions of white space devices from operating on the first 2 vacant TV channels above and below channel 37, assigning 2 separate UHF channel for wireless microphone use and reserving Channel 37 for hyper-critical wireless microphone use."); *Sennheiser Comments*, at 8 ("Class A wireless microphone users should be permitted use of Channel 37, and white space devices should be limited to other spectrum that has been identified for white space device use.").

²³ *Microsoft Comments*, at 29-30.

Commission adopts the proposal to allow portable WSDs to operate below channel 21 and/or fixed WSDs to operate on channels adjacent to channels assigned to television, wireless microphones will have virtually no option to access interference-free channels anywhere in the UHF band, a particularly difficult problem for unlicensed wireless microphones.²⁴

In developing the Part 15 white spaces rules, the Commission recognized that these two reserve channels would create valuable interference-free spectrum for wireless microphones by ensuring that wireless microphone operators only need to coordinate among other wireless microphone operators, a process that has continued successfully for many years. Notwithstanding the millions of important licensed and unlicensed users who rely on the existing reserve channels,²⁵ the Commission has not yet identified any other comparable spectrum where wireless microphone users would have access to interference-free spectrum, a process that will be challenged to meet the aggressive timelines for cessation of current 600 MHz Band operations called for by multiple Commenters. The TV band repacking process further exacerbates the issue, after which many of today's white space channels will be occupied by broadcasters relocated as a result of the auction.

The presence of interfering signals is a problem for wireless microphones that have exacting needs for clear spectrum to drive audio performance and spectral efficiency. Some parties argue that the database registration system will create interference-free spectrum for wireless microphones.²⁶ As a practical matter, this benefit is only available to licensed operators

²⁴ See Letter from Ginny Louloudes et al, Exec. Director, Alliance of Resident Theaters New York to Tom Wheeler et al, Chairman, Federal Communications Commission, at 1 (filed Feb. 3, 2015) (observing that the Commission's proposed rule that would prevent performing arts entities using fewer than 50 wireless devices from participating in the database "would leave our member organizations without any interference protection mechanism").

²⁵ The reserve channels are used extensively by both unlicensed and licensed wireless microphone users and constitute the first choice of channels in any frequency coordination plan.

²⁶ See, e.g., *Microsoft Comments*, at 37.

who, as described above, will have a greatly reduced number of channels available for database registration in the post-repack UHF band. Licensed wireless microphone operators can hope that the multiple databases operate flawlessly and synchronize continuously without error or delay but there is little real world evidence to date of such performance because no portable WSDs have been deployed.²⁷ The databases remain wholly unproven when it comes to managing congested frequencies and personal/portable WSDs. Accordingly, there certainly is no basis for the unquestioned confidence that some parties display in the operation of the databases.²⁸ Shure agrees with the NAB, Audio Technica, and GE Healthcare that the rules should not be amended on the assumption that the databases will effectively prevent interference to incumbent services before the Commission and stakeholders have had a meaningful period of time to assess the performance of the databases and to prompt resolution of flaws and errors that lead to interference to incumbents.²⁹

Users and audiences expect wireless microphones to operate free from interference. Anything less than clear, accurate sound quality with no discernable latency is perceived as a very significant problem that cannot be fixed later (the National Anthem at the Super Bowl cannot be sung again). For these reasons, the value of shared or impaired spectrum without guaranteed interference protection is relatively limited for professional quality applications.

Reserve channels are a critical component of providing this protection for both licensed and unlicensed operations, and are especially important to unlicensed operations that do not have access to the database reservation system without a 30-day advance approval. Lastly, if adopted,

²⁷ See *Audio-Technica Comments*, at 16 (noting there has been relatively little experience with the databases under the congestion conditions expected as a result of repurposing the television bands).

²⁸ See, e.g., *WiFi Alliance Comments*, at 10 (asserting extensive experience and high degree of confidence with databases).

²⁹ See *Audio-Technica Comments*, at 17-18; Comments of GE Healthcare, ET Docket No. 14-165, GN Docket No. 12-268, at 3 (filed Feb. 4, 2015); *NAB Comments*, at 11-14.

the NPRM proposal to eliminate the unlicensed registration system would foreclose availability of any reliable interference-free spectrum for unlicensed users, who comprise a majority of the installed base today.

B. The 4 MHz in the Duplex Gap Proposed for Licensed Wireless Microphones Does Not Adequately Address Wireless Microphone Needs for Interference-Free Spectrum

The Commission proposes “shared” spectrum for WSD and wireless microphones in the guard bands including duplex gap, the “naturally occurring” white space channel that may be present in a market, and in any white spaces that remain after repacking. However, it must be acknowledged that wireless microphone operations will be subject to interference in virtually all of these frequencies.³⁰ Licensed microphones operating in the 4 MHz in the duplex gap will contend with emissions from both WSDs as well as LTE devices. As proposed, all but the 4 MHz in the duplex gap and the 3 MHz buffers in the lower guard band and channel 37 guard band (should it be necessary) will be shared with fixed and portable WSDs.

In that context, Shure expressed support for the proposal in the duplex gap that would ensure that licensed wireless microphones would have dedicated spectrum in which to operate. However, Shure agrees with Sennheiser that the 4 MHz identified in the duplex gap is insufficient to support existing licensed wireless microphone services in the absence of other spectrum options. Shure accordingly supports the recommendation of NAB that the duplex gap be dedicated to wireless microphones, particularly if no other clean UHF spectrum is identified for wireless microphones. Shure notes that wireless microphones, because of their lower power, unique operational characteristics, temporal operation, and likely body absorption, are able to

³⁰ See *Audio-Technica Comments*, at 10 (“[T]he portion of the duplex gap proposed for licensed wireless operations is not clean spectrum.”).

operate in spectrum more effectively than other services such as WSDs without affecting nearby services. To the extent that the Commission adopts ETSI OOB standards, which Shure has recommended for some time, the tighter mask will further ensure that even more efficient use of the spectrum will be made by wireless microphones without affecting adjacent services.³¹ Further protection to adjacent services could be achieved by adoption of the ETSI spurious emissions limit of -54 dBm/100 kHz outside the mask (+/- 1 MHz from the center frequency).

Wireless service has not been subject to rigorous out-of-band emission limits (and Shure urges the Commission to consider such limits in this proceeding) and as a result some of the duplex gap spectrum will suffer from LTE interference. Interference into the wireless microphone band will inhibit the number of microphones that will be able to make simultaneous use of the spectrum.³² For that reason, if the Commission decides to adopt its 4 MHz/6 MHz apportionment of duplex gap spectrum between wireless microphones and unlicensed devices, and determines that a 1 MHz buffer is required to protect wireless downlink, Shure supports the Commission's original proposal to place the 1 MHz buffer between wireless microphones and wireless services and opposes suggestions to move the buffer between WSDs and wireless uplinks.³³ As proposed in the NPRM, that buffer will serve to abate interference from LTE in the licensed wireless microphone band. Notwithstanding LTE emissions, the Commission should permit wireless microphones -- an industry that has successfully shared spectrum for more than three decades and which continues to innovate technology to operate in congested environments -- to operate in the duplex gap and apply any available and future technical

³¹ See *Audio-Technica Comments*, at 10-11.

³² See *Sennheiser Comments*, at 9 (“[L]imited bandwidth, coupled with the likelihood of a high noise floor and out-of-band emissions from adjacent wireless services, will diminish likely use [of a single 4 MHz block for licensed microphones].”).

³³ See *Microsoft Comments*, at 12 (proposing the 1 MHz buffer be moved to the top of the duplex gap); *Google Comments*, at 17 (preferring a “4/6/1” band plan over a “1/4/6” band plan).

solutions to interference protection that can be developed to make efficient use of that spectrum.³⁴

Shure also opposes CTIA's view that the 4 MHz wireless microphone section in the duplex gap should be eliminated in favor of a single 6 MHz band to be shared between WSDs and wireless microphones with a 5 MHz buffer between such operations and wireless services.³⁵ Wireless microphones require interference-free UHF spectrum and the proposed 4 MHz band for licensed microphones is already inadequate to meet existing needs. Wireless microphone users operating in the duplex gap will already have to contend with LTE emissions from wireless services in adjacent spectrum. Designating a 6 MHz *shared* band would worsen this situation and should not be adopted.

Similarly, Shure opposes the suggestion of Motorola and the WiFi Alliance that wireless microphone spectrum in the duplex gap should be limited to 3 MHz to enable a second 1 MHz guard band at the upper end of the gap between the WSD transmit and base station receive band.³⁶ This proposal would eliminate much needed spectrum for wireless microphones and in any event there is no need for an additional guard band.

Microsoft asserts that the Commission should limit eligibility to operate in the duplex gap to ENG licensed users only and that all ENG microphones operating in the duplex gap must use digital only equipment.³⁷ Microsoft professes that these rule changes are necessary to promote efficient use of duplex gap spectrum and facilitate sharing between licensed ENG microphone

³⁴ NAB suggests that the Commission should dedicate the middle portion of the duplex gap to licensed wireless microphones and include reasonable guard bands on either side of that allocation to protect mobile receivers and base stations. *See NAB Comments*, at 15-16.

³⁵ *CTIA Comments*, at 19.

³⁶ *See Motorola Comments*, at 9; *WiFi Alliance Comments*, at 26-27.

³⁷ *See Microsoft Comments*, at 11.

users and unlicensed wireless microphones and WSDs.³⁸ The Commission should not adopt Microsoft's suggested requirements. In asserting this view, Microsoft relies on factually incorrect information that "only six or eight analog microphones using 200 kHz channels can operate in 6 MHz of spectrum." Today, professional analog wireless microphones are capable of more than doubling this figure and, under similar performance metrics, digital wireless microphones achieve a simultaneously compatible channel count that is roughly equivalent. Analog systems can often perform better in the face of interference, while digital systems can adjust performance metrics such as range to increase compatibility. These performance tradeoffs are important considerations for operators deploying wireless microphones under variable conditions, which is very often the case in activities such as newsgathering. It is therefore impractical and inappropriate to mandate the use of only digital technology within this user community.

The Commission has assiduously avoided rules that dictate specific technology choices -- a principle that the WSD community should greatly appreciate and strive to preserve -- with the recognition that technology choices are best left to the actual stakeholders who are better informed and closest to the technical options, limitations, and advancements. Wireless microphone operators will be highly motivated to use the duplex gap spectrum as efficiently as possible and artificial constraints in FCC rules would only inhibit their ability to meet production needs appropriate for the particular circumstances without any countervailing benefit.

Finally, the Commission should also reject the suggestion by CEA that wireless microphones should not be operating in the duplex gap or lower guard band at all.³⁹ CEA claims

³⁸ *See id.*

³⁹ Comments of Consumer Electronics Association, ET Docket No. 14-165, GN Docket No. 12-268, at 6 (filed Feb. 4, 2015) ("*CEA Comments*").

that cellular carriers cannot be protected from interference from a wireless microphone operating in the guard band or duplex gap. CEA's lack of support for this statement suggests that CEA's claim is more of a reflection of the interest of its WSD constituency in seeing wireless microphones banned from UHF frequencies.

C. The Commission Should Not Permit Portable WSD Operation Below Channel 21 or Fixed WSD Operation in Adjacent Channels

The Commission proposes to allow portable white space devices access to channels below channel 21 and to allow fixed white space devices to operate on channels adjacent to DTV. Shure and others opposed these proposals because, together with the proposed elimination of the wireless microphone reserve channels, they would completely eliminate all "safe haven" UHF wireless microphone channels. The current combination of measures were a part of a careful balance that the Commission struck in developing the white space rules to address the needs of wireless microphones while enabling new WSDs to share the UHF spectrum. In the Commission's words in adopting these measures, "wireless microphones will have access to those channels where WSDs are not allowed to operate."⁴⁰ Consistent with this proclamation, when the Commission banned wireless microphone from the 700 MHz spectrum, wireless microphone users were encouraged to transition operations to available frequencies under channel 21.⁴¹ Today there is a significant inventory investment of new wireless microphone

⁴⁰ Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807, ¶ 200 (Nov. 14, 2008).

⁴¹ The Commission said "[w]ireless microphones will be protected in a variety of ways. The locations where wireless microphones are used, such as entertainment venues and for sporting events, can be registered in the database and will be protected as for other services. In addition, channels from 2 – 20 will be restricted to fixed devices, and we anticipate that many of these channels will remain available for wireless microphones that operate on an itinerant basis. In addition, in 13 major markets where certain channels between 14 and 20 are used for land mobile operations, we will leave 2 channels between 21 and 51 free of new unlicensed devices and therefore available for wireless microphones." *Id.* at ¶ 1.

equipment operating in frequencies below channel 21, driven by the publication of the Commission's final white spaces rules and 700 MHz cutoff date.⁴²

For both licensed and unlicensed wireless microphone users, the loss of the 700 MHz band and prospect of WSDs in the remaining TV band raised the importance of UHF channels 14-20 due to their assurance of interference-free operation, based on the promise of a future absence of portable WSDs altogether and fixed WSDs on adjacent channels. With the proposed elimination of the two wireless microphone reserve channels, wireless microphone operations would suffer a twofold reduction and virtual elimination of reliable, interference-free spectrum in which to operate.⁴³ In the context where the Commission has not yet identified a comparable spectrum arrangement for wireless microphones, eliminating the prohibitions on WSD adjacent channel operation and portable device operation below channel 21 would deliver a crippling blow to the country's wireless microphone operations and negate the value of significant recent equipment investments by users in a variety of business, cultural, and academic sectors.

⁴² Following these announcements, Shure saw the sales of wireless microphones operating below channel 21 increase by a factor of four.

⁴³ Although Shure supports efforts to identify spectrum outside the UHF that may be useful for wireless microphones, those efforts may provide some spectrum relief to wireless microphones but identifying such spectrum, adopting rules, implementing transition of existing government and other users or sharing mechanisms can take multiple years. Those efforts are at the very beginning part of a contested multi-year regulatory process and no equipment development will begin, assuming the rules for such newly identified spectrum encourage manufacturers to make necessary investments, until that process is complete. As such, the prospect of making available additional spectrum resources to wireless microphones is only a potential long term solution.

Further, the Commission should reject the suggestion of Motorola Solutions that wireless microphones should no longer be permitted to operate in channels 14-20 based on the risk of interference to other services.⁴⁴ That claim is specious on its face -- wireless microphones can and have operated successfully in frequencies under channel 21 for many years, co-existing without complaint with CMRS and PLMS in channels 14-20.⁴⁵

D. Wireless Microphones Should be Able to Operate in Channel 37 Under Specific Conditions and the Guard Band Spectrum in Channels 36 and 38

Licensed wireless microphones should be able to operate in channel 37 like other white space channels but with the condition that they will consult the database to avoid WMTS and RAS and register their operations. Operation of licensed wireless microphone users on this basis will protect WMTS and RAS from interference and guarantee timely resolution of any interference issues. Licensed wireless microphone operators are accustomed to careful frequency coordination among multiple services. As a part of that process, licensed wireless microphone users routinely consult the information in the geolocation databases (and other sources) to determine the presence and location of other users with priority rights including TV, PLMRS, and CMRS. As discussed below, wireless microphones have a long successful history of coexisting with other services without interference complaint. Registered operators will similarly account for WMTS and RAS facilities in future coordinations.⁴⁶

Wireless microphones -- licensed and unlicensed -- should be able to operate in the proposed 3 MHz guard bands adjacent to channel 37 should they be required (reserving a 100

⁴⁴ See *Motorola Comments*, at 9.

⁴⁵ See *Sennheiser Comments*, at 14 (observing that both “licensed and unlicensed wireless microphones operate on these channels currently, and there is no reason to now prohibit such operations by unlicensed wireless microphones”).

⁴⁶ Given that no wireless microphone equipment currently on the market permits operation on channel 37, there is an opportunity to take additional precautions to protect WMTS and RAS facilities by applying specialized sales policies, labeling and user instructions to wireless microphones that are sold or modified to operate on channel 37.

kHz buffer to protect wireless services.) That spectrum, albeit a modest allocation, could be a source of much needed exclusive use spectrum for wireless microphones (particularly important for unlicensed wireless microphones) and that would otherwise lie fallow.

Wireless microphones above and below it will not cause interference to WMTS or RAS operations in channel 37. Wireless microphones have operated in channels nearby and adjacent to channel 37 for years and intensively so since the FCC's 2010 ruling identifying two reserve channels for wireless microphone operation located in the unassigned channels closest to channel 37.⁴⁷ Shure is unaware of a single incidence of possible interference to channel 37 WMTS or RAS operations. Based on this record alone, the Commission should not accept the request of the National Radio Astronomy Observatory for a rule banning wireless microphones from operating in or near channel 37.⁴⁸ Shure attributes this excellent record of operation on adjacent channels to several factors. As a general rule, wireless microphone applications do not overlap with WMTS or RAS operations. Intensive wireless microphone use tends to be located in dense population centers away from RAS facilities. Wireless microphone use is typically indoors, in studios, theaters, concert halls, convention centers or other performance areas and commercial buildings. Wireless microphones operate at very low powers. Even the highest powered microphone operating at 250 mW pursuant to Part 74, is comparatively low. Wireless microphone operators have a decades-long and successful history of coordinating frequency use not only with other wireless microphones in the same spectrum but other uses in the same or nearby spectrum including TV, WMTS, RAS, public safety, CMRS and others. These users rely

⁴⁷ See 47 C.F.R. § 15.712(f)(2); Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices below 900 MHz and in the 3 GHz Band, *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661, ¶ 126 (Sept. 23, 2010).

⁴⁸ Comments of National Radio Astronomy Observatory, ET Docket No. 14-165, GN Docket No. 12-268, at 6 (filed Nov. 21, 2014).

on a set of sophisticated coordination tools including frequency scanners and analyzers, software analysis tools, and up to date location specific databases available and utilized daily by professional and semiprofessional wireless microphone operators to find clear channels and avoid interference to other devices and services.⁴⁹ Finally, widespread adoption of the tighter ETSI emission mask will enable wireless microphones to operate closer to the band edges with little risk to services in adjacent frequencies.

Given the very extensive, real world experience with wireless microphone operations on channels 36 and 38, the Commission should reject Microsoft's effort to designate channels 36 and 38 as shared WSD channels.⁵⁰ (The Commission should also reject Microsoft's urging to relax the emission limits for Channels 36 through 38 to facilitate WSD operations on Channel 37 and, if anything, those limits should be tightened.⁵¹) Microsoft asserts that unlicensed wireless microphones will share the two vacant channels above and below Channel 37 with WSDs. However, this attempt to convince the Commission that "plenty of 600 MHz spectrum" will remain available for wireless microphones post-auction is flawed because a successful auction will not leave any vacant channels above Channel 37.

⁴⁹ See *Sennheiser Comments*, at 16.

⁵⁰ See *Microsoft Comments*, at 29-31.

⁵¹ See *Microsoft Comments*, at 31-32. Microsoft offers no technical explanation that would justify the requested change. Given the need to facilitate the coexistence of multiple services in the increasingly congested UHF band, the Commission should endeavor to tighten -- not relax -- emission limits applicable to the devices operating in the UHF band, including WSDs and LTE devices. For this reason, Shure has supported adoption of the ETSI emission mask.

III. Some Proposed Technical and Operational Rules Would Severely Harm Wireless Microphone Operations and Should Not be Adopted

A. Imposing Database Control Requirements on Wireless Microphones Is Unnecessary and Would Severely Harm Manufacturers and Content Creators

Some parties urge the Commission to impose a database control requirement on wireless microphones.⁵² Shure strongly opposes such a requirement and other parties agree.⁵³ Shure strongly disagrees with the view of the WiFi Alliance that such a requirement would facilitate use of wireless microphones in the guard bands or 600 MHz frequencies.⁵⁴ Indeed, imposing such a requirement would cause severe harm to the wireless microphone community.

As Shure outlined in its Comments, wireless microphones differ from WSDs and have never been designed to be controlled by a database function. Such a change would involve significant re-engineering, greater complexity, added cost, and would effectively obsolete all existing wireless microphone equipment in the market today. Wireless microphone users, including the many who recently purchased equipment to replace 700 MHz equipment, would lose significant investment.

Further, such a requirement would serve no purpose. Wireless microphones do not need a database control mechanism to operate successfully in a shared spectrum environment as has been amply demonstrated by more than three decades of sharing spectrum with TV, PLMRS, CMRS, etc. with no known complaints. Wireless microphone operators rely on a variety of tools to frequency coordinate including use of up to date information in manufacturer and other

⁵² See, e.g., *Microsoft Comments*, at 36; *WiFi Alliance Comments*, at i.

⁵³ See *CP Communications Comments*, at 4, 6-7; *Audio-Technica Comments*, at 12-13; *Sennheiser Comments*, at 15-17.

⁵⁴ See *WiFi Alliance Comments*, at 38-40.

databases.⁵⁵ Moreover, such a requirement would deter wireless microphone operations in the guard bands, including duplex gap,⁵⁶ and in whatever spectrum such requirement would apply.

With respect to operations in the guard bands, some parties argue that the Spectrum Act mandates database control of devices operating in guard band spectrum.⁵⁷ Microsoft claims that the Act mandates database control but should the FCC decide to accord different treatment to wireless microphones (apparently in blatant disregard to the mandate it espouses), WSDs should be treated the same.⁵⁸ Microsoft's view has no merit. The Spectrum Act leaves the Commission ample discretion to apply its broad terms as it sees fit and does not require automatic database control.⁵⁹ Nor is the Commission obliged to treat WSDs for this purpose the same as wireless microphones. As discussed above, wireless microphones are not the same as WSDs, are used in wholly different applications, have never been subject to database control, and have an extensive frequency coordination tradition and infrastructure that has supported decades long experience in successfully co-existing with other spectrum users. There is certainly no legislative mandate or reason that the Commission must treat WSDs and wireless microphones the same in fashioning a database requirement.

B. Wireless Microphones Operating in the Guard Bands Should be Subject to No Less Than a 50 mW Power Limit

In the Comments, Shure demonstrated that the proposed 20 mW power limit for unlicensed wireless microphones is not viable particularly as compared to the proposed 40 mW

⁵⁵ See *Sennheiser Comments*, at 10.

⁵⁶ See *Audio-Technica Comments*, at 11-12.

⁵⁷ See *Microsoft Comments*, at 36-38.

⁵⁸ *Id.*

⁵⁹ See *Sennheiser Comments*, at 15-16.

power limit for WSDs or the 100 mW power limit proposed by some parties for WSDs⁶⁰ operating in the 6 MHz segment in the duplex gap and guard bands.⁶¹ Shure recommended that the rules retain the existing 50 mW power limit for unlicensed wireless microphone operations⁶² and others agree. The proposed 20 mW limit is too low and will in fact inhibit coexistence between microphones and WSDs by compromising wireless microphone performance. Some parties suggest that the 20 mW proposed limit is warranted because the “aggregate power” of wireless microphones will cause interference to other services.⁶³ However, as pointed out, this theoretical conclusion is not the result of actual measurement in a typical wireless microphone use case. In particular, this “aggregation” theory ignores the fact that microphones are typically spread out, therefore it is highly unlikely that a cluster of them would be operated close to any one handset.

Some parties suggest that wireless microphones be subject to even lower limits. For example, Motorola claims that wireless microphones should be subject to a power limit of 10 mW or less.⁶⁴ Motorola claims without foundation that such a reduced limit is necessary to address the disparity with WSDs. Motorola’s proposal would cripple wireless microphone operations, is not warranted because no disparity with WSDs exists, and should not be adopted. CTIA advocates an even more extreme position. CTIA urges the Commission to adopt a wireless microphone power limit less than 1 mW.⁶⁵ Such a limit is wholly unworkable and

⁶⁰ See *Microsoft Comments*, at 5, 14 (suggesting the Commission should permit WSDs to operate at powers up to 100 mW in the guard bands, and the duplex gap).

⁶¹ *NPRM*, at ¶ 96.

⁶² 47 CFR § 15.717(b); *Audio-Technica Comments*, at 9-11; *Sennheiser Comments*, at 18.

⁶³ See *CEA Comments*, at 5; Comments of the National Academy of Sciences’ Committee on Radio Frequencies, ET Docket No. 165, GN Docket No. 12-268, at 11 (filed Feb. 4, 2015) (“[U]p to 5 wireless microphones could be operated simultaneously in adjacent channels.”).

⁶⁴ See *Motorola Comments*, at 9.

⁶⁵ *CTIA Comments*, at 18.

would be tantamount to banning wireless microphones from operating in the 600 MHz spectrum or other UHF frequencies.

When considering power limits for wireless microphones in the guard bands, the Commission must consider that if a new, dramatically reduced power limit is adopted, many wireless microphone users once again would be forced to retire a significant amount of operating equipment unnecessarily. This arbitrary reduced limit would further create “niche” requirements with limited utility in a small sliver of spectrum that will make it uneconomical and impracticable for wireless microphone manufacturers to invest in producing equipment designed to operate only in the duplex gap and guard bands.

IV. The Commission Should Reject Proposals to Limit Improvements in Database Recheck Procedures

Many parties agreed with Shure that the Commission should adopt its proposal to improve the database procedures by requiring more frequent rechecks and exchange of information between databases.⁶⁶ It was widely recognized that the proposed improvements would promote greater spectrum utilization and lower the risk of interference. Some parties, however, urge the Commission to forego improvement entirely⁶⁷ or limit improvements in database recheck procedures. Google proposes that two “fast polling” channels be created around channel 37;⁶⁸ and WSD operations in all other channels would be subject to the existing 24 hour recheck procedures.⁶⁹ Google asserts that the two “fast polling” channels plus the 4 MHz in the duplex gap will together provide “more spectrum for breaking news coverage than is

⁶⁶ See, e.g., *Motorola Comments*, at 2; *NAB Comments*, at 13; *Sennheiser Comments*, at 20.

⁶⁷ Comments of MELD Technology, Inc., ET Docket No. 14-165, GN Docket No. 12-268, at 2-3 (filed Feb. 2, 2015) (“*MeldTech Comments*”).

⁶⁸ See *Google Comments*, at 47.

⁶⁹ See *id.* at 7.

available under the Commission’s existing rules.”⁷⁰ Shure disagrees with this statement. It is highly unlikely that channels above and below channel 37 will be available for anything other than wireless service after the auction. The 4 MHz wireless microphone section of the duplex gap is likely to be subject to OOBE interference from WSDs and wireless carrier services in nearby spectrum. The WiFi Alliance argues that the database recheck procedures should be relaxed generally including to allow WSDs to hold channels for significant periods of time in the event that a licensed wireless microphone requests use of that channel.⁷¹ Shure also opposes this suggestion as well as Spectrum Bridge’s suggestion that an additional 20 minute grace period be added to accommodate network outages.⁷² As more use is proposed for the UHF Band, the database procedures should be *tightened* not relaxed in order to facilitate more devices sharing spectrum without interference.

A. Relaxation in Location Accuracy Must be Accompanied by Adjustments in Separation Distances

Many parties shared Shure’s view that any relaxation of the location accuracy for personal/portable WSDs from 50 meters must be accompanied by adjustments in separation distance to address the heightened potential interference to wireless microphones.⁷³ To address this problem, Shure recommends that the Commission require WSDs to be programmed to notify the database of its location accuracy and if it is less accurate than +/-50M, for example, the protection zone for wireless microphones must be increased proportionally. Shure notes that Google suggested that the rules allow for location determination to occur by means of “other

⁷⁰ *Id.* at 50.

⁷¹ *See Wi-Fi Alliance Comments*, at 41-42.

⁷² *See Comments of Spectrum Bridge, Inc.*, ET Docket No. 14-165, GN Docket No. 12-268, at 7 (filed Feb. 2, 2015) (“*Spectrum Bridge Comments*”).

⁷³ *See Spectrum Bridge Comments*, at 6; *Comments of Dynamic Spectrum Alliance*, ET Docket No. 14-165, GN Docket No. 12-268, at 12 (filed Feb. 4, 2015) (“*Dynamic Spectrum Alliance Comments*”).

location determination technology” rather than through use of GPS or local determination.⁷⁴ Given the importance of location accuracy to interference avoidance, the Commission should refrain from adopting vague standards in the rules that could lead to a significant increase in the risk of interference.⁷⁵ A better course would be to proceed by individual waiver request subject to public notice and comment if a WSD operator or manufacturer proposes to rely on “alternative means” not contemplated in the rules.

In a related discussion, Shure disagrees with MeldTech’s request that WSD operators be permitted to use stored GPS data or to supplement data in the case of indoor operations.⁷⁶ Shure is concerned that this approach has a high risk of error and potential abuse and that such a rule amendment is unwise with respect to mass market consumer devices like WSDs. A WSD user could store data in a device and use it anywhere without regard to other users of the spectrum. Further, the device could be moved to another location without appropriate location information updates.

V. The Commission Should Reject Overreaching Recommendations that Would Effectively Shut Down Wireless Microphone Operations in UHF Frequencies Either Through Elimination of Spectrum Options, Imposition of Unworkable Technical Requirements or Disproportionately Favoring Other Spectrum Users

Apparently sensing an unprecedented opportunity to displace a longtime incumbent user of UHF spectrum thereby securing significant spectrum for their own future development, WSD proponents urge the Commission to adopt a litany of rule amendments that would favor WSDs without policy or technical justification and regardless of the impact on existing wireless

⁷⁴ See *Google Comments*, at 43.

⁷⁵ In this regard, Shure disagrees with the statement of the Dynamic Spectrum Alliance that “such accuracy . . . is not required to protect other operation in the television bands.” *Dynamic Spectrum Alliance Comments*, at 12.

⁷⁶ *MeldTech Comments*, at 2.

microphone users.⁷⁷ Some WSD proponents propose additional onerous requirements that would, if adopted, essentially obsolete every wireless microphone in the market, and create a hostile environment for wireless microphones to discourage further manufacture of any devices in the UHF band. Wireless carrier representatives pay little attention to the need to address the requirements of an existing, robust service operating for decades in the UHF band and serving the important and growing demands of many key sectors. The Commission should reject overreaching recommendations that would effectively shut down wireless microphone operations in UHF frequencies either through elimination of spectrum options, imposition of unworkable technical requirements or disproportionate favoring of other spectrum users.

A. The Commission Should Reject Efforts to Dramatically Revise Part 15 WSD Power Limits and Other Operating Parameters to Favor WSDs at the Expense of Wireless Microphones

Several WSD interests have come forth in the comments and demanded that the Commission adopt excessive power increases, significant spectrum set asides for WSD operations, and other technical or operating parameters that disproportionately favor WSDs at the expense of wireless microphones. Microsoft, for example, asserts that 18 MHz (three 6 MHz channels) of UHF spectrum in every U.S. market be set aside for exclusive use of WSDs. Microsoft adds this demand to its call for rule changes that would give portable WSDs unprecedented access to spectrum below channel 21 and fixed and portable WSDs access to adjacent channels, shared spectrum at highly favorable power differentials in the guard bands and channel 37, significantly increased powers and antenna heights in rural areas, relaxed

⁷⁷ See, e.g., *WiFi Alliance Comments*, at 10 (proposing WSDs be allotted to operate in channels 14-20); *id.* at 15-16 (endorsing an increase in power limits and antenna heights in rural areas); *id.* at 25-26 (supporting division of the duplex gap); *WISPA Comments*, at 23 (condoning removal of “stringent band emission limits on white space devices” to make channels 35 – 39 useable by WSDs); *id.* at 24 (proposing that new microphones entering channel 37 have a spectral efficiency of at least 4 bits/Hz).

emission criteria for WSDs, and relaxed geolocation accuracy requirements for portable WSDs, among other preferential rules. Motorola Solutions supports many of the same changes and adds that the Commission should create two classes of transmit spectral masks for WSDs, one a relaxed transmit mask approximating a simple low power DTV transmitter mask and two a spectral mask reflecting popular advance communication standards such as 3GPP LTE.⁷⁸ Shure opposes this change as it would significantly increase the potential for interference to wireless microphones in operation in adjacent and nearby frequencies.

Spectrum Bridge proposes that the WSD emission mask be relaxed provided that the database adjust separation distances. This would be accomplished by basing the “apparent” output power of the device, for separation purposes, on adjacent channel emissions. For each 1 dB increase in adjacent channel emissions, the device would be treated as operating at a power level of 1 dB higher when determining separation distances.⁷⁹ This approach may be able to adequately protect wireless microphones registered in the database but it would not protect unregistered wireless microphones and would lead to much higher interference levels in bands shared by wireless microphones and WSDs. The Commission should not adopt this proposal.

The WiFi Alliance also espouses a one-sided view and essentially advocates for every rule change that could possibly benefit WSDs regardless of need or impact on existing industry. Shure urges the Commission to disregard these extreme views and proceed cautiously. Every proposed change should be considered carefully to assess the likely impact on an important existing service, keeping in mind that the WSD market has not materialized despite five years of

⁷⁸ *Motorola Comments*, at 6-7.

⁷⁹ *Spectrum Bridge Comments*, at 5.

a favorable regulatory environment, and with close consideration of the credibility of the technical justification offered.

B. The Commission Should Reject Carrier Efforts to Ban Wireless Microphone From 600 MHz Spectrum

Wireless carrier representatives for their part essentially argue that wireless microphones will cause so much interference to wireless devices that they cannot coexist in the guard bands and must be “migrated” elsewhere without delay or, again, be subject to such onerous technical limitations as to make effective operation impossible.

However, technical inputs from cellular interests regarding wireless microphone operations in the 600 MHz Band duplex gap and lower guard band are inconsistent and do not offer meaningful data to evaluate real-world wireless microphone operations in these bands.

Qualcomm and CTIA both offer technical assumptions regarding wireless microphone operations and how they will translate to the duplex gap and/or lower guard band, but their respective assumptions – are not born from real-world environments and measurements, and ultimately fail to provide useful data to develop the technical record in the instant proceeding. Assumptions regarding body absorption, simulated wireless microphone test signals, lack of information regarding filtering of the signal, and lack of information regarding LTE handset models and selection are among the concerns with both the Qualcomm and CTIA tests.

Significant discrepancies also exist in the test parameters and assumptions made by Qualcomm and CTIA that cannot be reconciled. Table 1.0 below provides a comparison.

CTIA	Qualcomm
TX antenna gain and UE antenna gain of 0 dB	No spec for TX antenna gain; UE ant. gain -7 dB
TX device antenna (body) loss of 3 dB	No spec for TX body loss – assumed 0 dB
UE antenna (body) loss of 3 dB	No spec for UE body loss – assumed 0 dB
Polarization and other losses of 3 dB	No spec for polarization losses – assumed 0 dB
Path loss of 29 dB at 1 meter	Path loss of 29 dB at 1 meter
Total losses of 38 dB (including path loss)	Total losses of 36 dB (including path loss)
Product variation of 3 dB	Product variation of 3 dB
Propagation model assumed: Free Space	Propagation model assumed: Free Space
WM interference at 1 meter at UE = -25 dBm	WM interference at 1m at UE = -23 dBm
WM RX Blocking at -51.5 dBm (measured)	WM RX Blocking at -65 dBm (measured)
Allowable WM XMIT PWR in DX Gap of -13.5 dBm*	Allowable WM XMIT PWER in DX Gap of -32 dBm*
WM Interference radius at 20 mW of 21.4m*	WM Interference radius at 20 mW of 69 meters*
*1 MHz Buffer in Duplex Gap (page 18)	*1 MHz Buffer in Duplex Gap (page 9)
Interference from UE to WSD radius unspecified	Interference from UE to WSD at up to 140m
Product variation is not included in TX allowable power	Product variation is included in TX allowable power
Oobe limit of -89 dBm/100 kHz proposed	Oobe limit not specified; -65 dBm/100 kHz calculated

Table 1.0

For these reasons, and to the extent that such analysis will be pivotal to determining final rules for operations in the duplex gap and guard bands, Shure strongly proposes that the Commission conduct its own testing – with the involvement of interested parties -- to better understand the interactions between devices and to create a reasonable assessment of harmful interference in the future shared UHF Band.

Duplex gap operations have been studied extensively prior to authorizing wireless microphone operations in LTE guard band spectrum in the European Union by the Electronic Communications Committee (“ECC”), and the critical need for this spectrum in the post-auction TV band environment necessitates an equivalent level of due diligence in this proceeding.⁸⁰ In anticipation of conducting its own 600 MHz Band compatibility testing, Shure believes that the FCC may find certain aspects of the ECC’s evaluation on the compatibility of wireless microphones in 700 MHz Band duplex gap band frequencies informative. In particular, the ECC

⁸⁰ See Electronic Communications Committee, Adjacent Band Compatibility Between MFCN and PMSE Audio Applications in the 700 MHz Frequency Band, ECC Report 221 (approved Sept. 2014), available at <http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP221.PDF> (“ECC Report 221”).

spent significant time and energy exploring the real-world operating parameters and interactions between handheld cellular devices and wireless microphones. For example, the ECC spent significant effort studying body loss for both handheld and body worn wireless microphones.⁸¹ The ECC also carefully evaluated real-world separation distances between wireless microphones and cellular devices.⁸² Shure found the ECC's study to be thoughtful and representative of real-world parameters and assumptions for wireless microphone operations.

Respectfully submitted,

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⁸¹ See *ECC Report 221*, at 35-36. The ECC determined that average body loss for handheld microphones was 8 dB, and body worn microphones experienced on average 18 dB of body loss. Both Qualcomm and CTIA studies assumed 0 dB of body loss.

⁸² See *ECC Report 221*, at 21-22, 29-30. The ECC determined that wireless microphones were normally operated no closer than 15 meters to cellular devices, whereas Qualcomm and CTIA assumed one (1) meter of separation between a wireless microphone and cellular device.