

Before the
Federal Communications Commission
Washington DC 20554

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

**REPLY COMMENTS OF
SENNHEISER ELECTRONIC CORPORATION**

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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
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Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions)	Docket No. 12-268
)	

**REPLY COMMENTS OF
SENNHEISER ELECTRONIC CORPORATION**

Sennheiser Electronic Corporation files these reply comments in the above-captioned proceedings.¹

About Sennheiser. Sennheiser Electronic Corporation is a wholly-owned subsidiary of Sennheiser electronic GmbH & Co. KG, headquartered in Germany. The parent company is a global leader in microphone technology, RF-wireless and infrared sound transmission,

¹ *The Wireless Telecommunications Bureau and the Office of Engineering and Technology Seek to Update and Refresh Record in the Wireless Microphones Proceeding, WT Docket Nos. 08-166, 08-167, ET Docket No. 10-24, Public Notice, 27 FCC Rcd 12067 (Wireless Telecom. Bur. and Office of Engineering and Technology 2012) (Wireless Microphone Public Notice); Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Docket No. 12-268, Notice of Proposed Rulemaking, 27 FCC Rcd 12357 (2012).*

headphone transducer technology, and active noise cancellation. The U.S. subsidiary, based in Old Lyme, Connecticut, represents Sennheiser products in the United States and distributes a variety of other professional audio lines. Sennheiser is a leading manufacturer of wireless microphones used in the United States.

A. SUMMARY

TV-band wireless microphones are essential to large segments of the U.S. economy—films, television, live and recorded music, live theater, even sports—that that are part of the “core copyright” industries which account for more than \$1 trillion in annual revenues, 6% of GDP, and 5% of private employment in the United States. They play an equally vital role in education, communal worship, and democratic functioning at all levels of government.

Wireless microphones operate in locally vacant TV spectrum, which is likely to become more scarce after the upcoming repacking of TV spectrum. The proponents of unlicensed TV Band Devices (TVBDs), which also use vacant TV channels, have mounted regulatory challenges against wireless microphones in hopes of preserving more spectrum for their own use. Advocates have touted the supposed public interest in TVBDs for over a decade, yet still cannot point to any actual benefits. Their technology has been painfully slow to develop, in part because of the complex technical rules needed to protect other spectrum users. To succeed, TVBDs will have to compete with the vast installed base of inexpensive Wi-Fi equipment.

TVBD supporters reiterate the erroneous claim that wireless microphones use spectrum inefficiently, even while acknowledging dramatic improvements in device density for some applications. Their arguments ignore the demands on spectrum that result from microphones’ high performance requirements. Even so, digital wireless microphones achieve markedly better spectrum efficiency than do TVBDs.

Their continuing importance to commerce, entertainment, and public life mean that wireless microphones still need the two channels presently reserved for their use. The Commission should expand licensing eligibility to include certain users who genuinely need the protection and higher power that licensing offers. And we insist once again that wireless microphones could not perform adequately if required to operate under the same rules as TVBDs.

Broadcast television, UHF broadband services, and TVBDs all serve the *distribution* of content. Wireless microphones help to *create* U.S. news and entertainment content—widely acknowledged as the best in the world and a major U.S. export. As the Commission moves toward an incentive auction and TV repacking, we ask that it keep in mind the importance of wireless microphones to the economy and the culture, and the need for adequate spectrum to support them.

B. WIRELESS MICROPHONES ARE ESSENTIAL TO THE U.S. ECONOMY.

Wireless microphones are integral to major components of United States commerce.² They are fundamental tools in American sports, cultural, artistic, political, civic, academic, community, and spiritual activities.³ They are critical to electronic news gathering and

² See, e.g., comments submitted in GN Docket No. 12-268 and/or WT Docket Nos. 08-166 and 08-167, and ET Docket No. 10-24 by Sennheiser at 4; New York State Broadcasters Association, Inc. at 4-6; The Performing Arts Wireless Microphone Working Group at 5; The Broadway League at 3; Shure Incorporated at 4-6.

³ See, e.g., comments submitted in WT Docket Nos. 08-166 and 08-167, and ET Docket No. 10-24, by the John F. Kennedy Center for the Performing Arts at 1-2; Thompson Engineering at 1; The Performing Arts Wireless Microphone Working Group at 5-6; and CBS Corporation, Fox Entertainment Group, Inc., NBCUniversal Media, LLC, The Walt Disney Company, Univision Communications, Inc. (jointly) at 11-12.

production, and to public safety in emergencies.⁴ The records in the captioned proceedings and the earlier “white space” proceeding (ET Docket 04-186) include vast amounts of evidence for the essential role of wireless microphones in the United States’ news, sports, and entertainment industries, and in public debate.⁵

Live music events produced by a single American company generate more than \$2.5 billion in annual revenues.⁶ Broadway productions alone are a \$13 billion industry.⁷ Other performing arts—opera, dance, symphony, and community and regional theater—contribute nearly \$8 billion to the U.S. economy.⁸ The professional spectator sports industry generates more than \$25 billion in consumer spending each year, while broadcast and cable networks spend several billion more annually for rights to the programming.⁹ As Sennheiser noted earlier, the “core copyright” or content production industries in the United States—including TV, film, radio, books, and recorded music—account for more than \$1 trillion in annual revenues, or 6%

⁴ National Association of Broadcasters at 6; New York State Broadcasters Association, Inc. at 4-6 and 12-13; The Walt Disney Company at 41-46.

⁵ Sennheiser at 4; Shure at 4-6; Broadway League at 3; Performing Arts Wireless Microphone Working Group at 5.

⁶ Comments of Live Nation Entertainment, Inc., WT Docket Nos. 08-166 and 08-167, and ET Docket No. 10-24 (March 1, 2010).

⁷ Broadway League at 3.

⁸ Performing Arts Wireless Microphone Working Group at 5 (\$10 billion generated in New York, and another \$3 billion in touring production).

⁹ WR Hambrecht + Co., *The U.S. Professional Sports Market and Franchise Valuation Report 2012*, available at http://www.wrhambrecht.com/pdf/SportsMarketReport_2012.pdf

of GDP, and support more than 5 million domestic jobs: fully 5% of total private industry employment.¹⁰

All of these disparate activities are dependent on the availability of wireless microphones. All rely on the fidelity, reliability, compact size, and low latency afforded by operation in the TV bands.

In addition to this economic activity, each deployment of wireless microphones represents a significant capital expenditure toward purchasing and upgrading equipment.¹¹ If equipment must be replaced or further upgraded due to changes in the Commission's rules, significant economic harm will ensue.¹² Many users are still trying to amortize the expense of equipment purchased to accommodate the Commission's last repacking of the TV spectrum. Some are small entities outside the major economic categories listed above, but which nonetheless must bear the costs to upgrade or replace their systems, whether licensed or unlicensed under waiver: churches, small town governments, high school and community college

¹⁰ Sennheiser at n.5. Just a few days ago, CNN reported that of 236,000 jobs added to the U.S. economy in February, fully 21,000—almost nine percent—were in the film industry. Available at <http://economy.money.cnn.com/2013/03/08/jobs-report-movies/>

¹¹ See, e.g., The Performing Arts Wireless Microphone Working Group at 5 (migration from the 700 MHz band in 2010 required unbudgeted outlays by individual performing arts groups of up to \$100,000 for new equipment); National Football League at 3 (nearly \$9 million spent in transition from analog to digital equipment); Shure at 10-12 (citing, *inter alia*, the experience of a single church which spent over \$100,000 for equipment to move out of the 700 MHz band). Moreover, comments from entities as varied as The Walt Disney Company to The Kennedy Center, and numerous comments in the “white space” proceeding, describe in detail the volume of wireless microphone equipment utilized every day and demonstrate the significant investments made by organizations large and small in every facet of the economy.

¹² Performing Arts Wireless Microphone Working Group at 5 (estimating a minimum of \$17.5 million in expenditures would be required); see also Shure at 6.

theater programs and the like¹³—costs which threaten to devastate small budgets and decimate local religious, cultural, educational, and civic discourse.

An informed public relies on news gathering and production, which in turn rely heavily on the use of wireless microphones. Coverage of the recent Presidential inauguration by a single network (ABC) required 78 UHF frequencies over 25 channels.¹⁴ The congestion of vast numbers of domestic and international news outlets required intensive coordination and innovative frequency re-use. TV, cable, and radio news producers depend on wireless microphones every day in every market for on-the-spot reporting of live news events from the field to the studio, and to produce newscasts and other public affairs programs.¹⁵ The delivery of responsive local news, public affairs, and information has long been a tenet of the Commission's media public interest analysis. Wireless microphones make possible the timely coverage of news and public affairs.

The Commission has acknowledged “the significance of wireless microphones in providing quality audio technology for performances and programs in theaters, classrooms, lecture halls, houses of worship, stadiums, and other venues.”¹⁶ It cannot ignore the potential consequences to the U.S. economy and to American cultural, religious, and civic life should changes in the rules degrade the interference protections afforded to wireless microphones.

¹³ Shure at 5-6, n.11-14 (citing numerous comments in ET Docket No. 04-186); *see also* Thompson Engineering at 1.

¹⁴ The Walt Disney Company at 44.

¹⁵ CBS Corporations, Fox Entertainment Group, Inc., NBCUniversal Media, LLC, The Walt Disney Company, and Univision Communications, Inc. (jointly) at 11.

¹⁶ *Low Power Auxiliary Stations in the 698-806 MHz Band*, Report and Order and Further Notice of Proposed Rulemaking, 25 FCC Rcd 643 at ¶ 87 (2010).

C. THE COMMISSION SHOULD NOT FAVOR TV BAND DEVICES OVER WIRELESS MICROPHONES.

Wireless microphones and TVBDs both operate in locally vacant TV spectrum. The prospect of that spectrum shrinking, due to the upcoming incentive auction and TV repacking, has led TVBD proponents to take an aggressive stance in staking out the vacant channels that might remain. Indeed, the only serious opposition to wireless microphones in these proceedings comes from TVBD advocates.

The TVBD challenges to wireless microphones rest on two false premises: that TVBDs serve a greater public interest; and that wireless microphones are spectrally inefficient. These two canards underlie all of the open issues, including the expansion of licensing eligibility and the maintenance of reserved channels for wireless microphones. We take up in turn the public interest and spectrum efficiency questions, before addressing the specific issues they affect.

1. TVBDs have not lived up to proponents' promises as to public interest.

TVBDs seemed like a good idea when first proposed, now more than ten years ago.¹⁷ Back then most homes still had analog TVs. The spectrum allocated for television covered 68 channels, or 408 MHz. The channel separation and “UHF taboo” rules ensured a plethora of vacant channels in every market. TVBDs promised to put that empty spectrum to good use. Then came the digital TV transition. More than a quarter of the TV spectrum—18 channels, a total of 108 MHz—became reallocated to other purposes. The Commission was able to pack digital TV stations more closely than their analog predecessors, further reducing the count of open channels. Much of the TVBD spectrum vanished. Soon, the planned incentive auction and the additional repacking to follow will further diminish vacant TV spectrum.

¹⁷ *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Inquiry, 17 FCC Rcd 25632 (2002).

Over the same period, the evolving TVBD technology needed to protect other spectrum users became increasingly intricate—perhaps more so than the Commission originally anticipated. The technical rules for these devices are among the most complex anywhere in the FCC rulebook.¹⁸ Only five distinct devices have been certified. They are seeing little use; TVBD service has yet to reach public awareness.

Advocates doubtless will respond that widespread TVBD service was approved only last December.¹⁹ That is not a good answer. The TVBD technical rules were adopted more than four years ago after a lengthy deliberation,²⁰ reached essentially their current form thirty months ago,²¹ and were last tweaked almost a year ago.²² No further reconsideration is pending. Manufacturers have had plenty of time to get products ready for market. Few have done so. Compare this weak response to events following the Commission’s 2002 adoption of digital modulation rules, which authorized the Wi-Fi “g” standard.²³ Within weeks of the rule’s taking

¹⁸ See 47 C.F.R. § 15.707-13.

¹⁹ *Office of Engineering and Technology Authorizes TV White Space Database Administrators to Provide Service to Unlicensed Devices Operating on Unused TV Spectrum in the East Coast Region*, ET Docket No. 04-186, Public Notice, 27 FCC Rcd 15099 (2012). Nationwide operation was approved on March 1, 2013. *Office of Engineering and Technology Authorizes TV White Space Database Administrators to Provide Service to Unlicensed Devices Operating on Unused TV Spectrum Nationwide*, ET Docket No. 04-186, Public Notice, DA 13-324 (released March 1, 2013).

²⁰ *Unlicensed Operation in the TV Broadcast Bands*, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008).

²¹ *Unlicensed Operation in the TV Broadcast Bands*, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 (2010).

²² *Unlicensed Operation in the TV Broadcast Bands*, Third Memorandum Opinion and Order, 27 FCC Rcd 3692 (2012) (relaxing out-of-band emission limits and antenna height limits for fixed TVBDs; slightly adjusting occupied bandwidth and power spectral density).

²³ *Amendment of Part 15 of the Commission's Rules Regarding Spread Spectrum Devices*, Second Report and Order, 17 FCC Rcd 10755 (2002).

effect, consumer electronics stores featured enormous displays of the newly authorized equipment. A look around the local *Best Buy* offers a good reading as to which consumer technologies manufacturers think will be viable. TVBDs are nowhere in sight.

TVBD supporter Public Interest Spectrum Coalition (PISC) rhapsodizes on the benefits of the “unlicensed economy.”²⁴ Sennheiser fully agrees with PISC on the potential public interest benefits in unlicensed spectrum. Yet PISC’s numerous examples cite only applications at 900 MHz and 2.4 GHz. Even PISC is unable to find a single instance of current benefits from TVBDs. Although always good fodder for PowerPoint, the technology still shows little sign of maturing into actual hardware in widespread use. The coming incentive auction and its aftermath will further discourage TVBD deployment.

Fixed TVBDs face obstacles different from those impeding personal/portable devices. Fixed TVBDs have more obvious money-making applications, such as consumer broadband delivery. They do not need widespread acceptance to be useful, in contrast to personal/portable devices, which may not be worth the cost to consumers until there is an ecosystem of access points (or the equivalent); but that installed base is unlikely to appear until a sufficient uptake of personal/portable devices occurs. Fixed TVBDs can also be technically simpler than personal/portable devices, as they do not need geolocation capability. But they will have to compete against a well-established product base of low-cost, high-performing fixed technology at 2.4 and 5 GHz—which the Commission has recently proposed to expand.²⁵ Fixed TVBDs have yet to prove they can make inroads into this market.

²⁴ Public Interest Spectrum Coalition at 8-17.

²⁵ *Unlicensed National Information Infrastructure Devices in the 5 GHz Band*, ET Docket No. 13-49, Notice of Proposed Rulemaking, FCC 13-22 (released Feb. 20, 2013).

A failure of TVBDs to flourish should not be taken as a black mark against either its advocates or the Commission. Part of the Commission’s mandate is to foster new technologies.²⁶ Almost by definition, this pursuit entails backing some technologies that fail. Other recent non-starters for which the Commission had high hopes include, for example, communications ultra-wideband devices and retail Internet via broadband-over-power-line.²⁷ If every FCC-approved technology succeeded, that would suggest the Commission is being too conservative in its rulemaking. Successful innovation always entails risk, a fact well known both to the Commission and to the companies that originally developed and promoted TVBD technology.

If history were different—if the Commission were to first consider TVBDs today—we doubt they would be approved. The amount of spectrum available for TVBDS has fallen sharply, and their technical rules may be too complex for inexpensive mass-market deployment. What seemed like a good idea ten years ago looks far less promising today.

Wireless microphones, in contrast, deliver a lot for the spectrum they use. In New York City alone, the NBC Today show generates \$1 million of taxable revenue each day. Broadway shows generate millions every night.²⁸ David Letterman, Jimmy Fallon, Dr. Oz, Saturday Night Live, Beacon Theater, Madison Square Garden ... all in just a few square miles. TVBDs remain,

²⁶ 47 U.S.C. § 303(g) (“[The Commission shall]— ... Study new uses for radio, provide for experimental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest ...”). *See also* 47 U.S.C. § 157 (a) (“It shall be the policy of the United States to encourage the provision of new technologies and services to the public. ...”).

²⁷ There are a few ultra-wideband communications niche devices—including wireless microphones—but nothing like the ubiquitous roll-out the original proponents expected. (The non-communications ultra-wideband market for imaging, radar, and location, however, is doing well.) Broadband-over-power-line is used for internal utility communications, but its role as the “third wire” into the nation’s homes failed to materialize.

²⁸ Broadway League at 3.

as they have for ten years, a work in progress, while the public interest in wireless microphones is beyond serious dispute.

2. *Wireless microphones have adequate and improving spectrum efficiency.*

Opponents are unanimous in their inaccurate portrayal of wireless microphones as spectrally inefficient. Many cite a Commission passage that no longer reflects modern microphone technology.²⁹ Some point to a “high density” Shure wireless microphone product that can manage up to 47 units within a 6 MHz channel,³⁰ although at reduced audio quality and limited range. (Sennheiser also offers a high density digital microphone, but opted to retain maximum audio quality by using fewer microphones per channel.)

Several comments echo the fallacy that analog wireless microphones can improve their spectrum efficiency merely by switching to digital modulation.³¹ Our first-round comments explained why this is wrong. An *uncompressed* digital signal occupies about the same radio bandwidth as an analog signal capable of comparable sound quality.³² A *compressed* signal can

²⁹ E.g. Microsoft Corp. at 2, citing *Wireless Microphone Public Notice* at 6 (“[W]ith the use of these analog wireless microphones, only between 1.2 and 1.6 megahertz of the 6 megahertz TV channel may be used while the remainder is effectively left fallow. This constitutes very inefficient use of valuable spectrum.”) Modern versions of both analog and digital microphones make better use of spectrum than this passage suggests.

³⁰ E.g., IEEE 802 at 2.

³¹ E.g., Wireless Internet Service Providers Association at 20-21. Even the Commission edged close to this view: “[M]ost other radio communications services have shifted from analog to digital technology to improve spectrum efficiency and resistance to interference.” *Wireless Microphone Public Notice* at 6.

³² See Sennheiser in WT Docket No. 08-166 *et al.* at 9-12.

squeeze into less bandwidth, but invariably at the cost of reduced audio quality, increased latency, or both.³³

A brief foray into elementary information theory will help to clarify the matter. Engineers in the mid-twentieth century derived the mathematical principles that govern the transmission of information over an imperfect channel. Consider these six properties of a digital wireless microphone (or any other radio communications device):³⁴

- transmitter power (emitted from the antenna);
- range;
- tolerance for radio-frequency noise;
- data rate (throughput in bits/second);
- bit error rate (fraction of bits wrongly received);
- occupied radio bandwidth (in hertz).

When a system operates near its limit, any of these properties can be improved, at least in principle, *but only at the expense of others*. Reduction of radio bandwidth, for example, requires raising the transmitter power, reducing the operating range, reducing the noise tolerance, reducing the throughput data rate, and/or accepting more errors. These limitations are fundamental to the nature of information itself, much as the conservation of energy is fundamental to physics. In the same way that conservation of energy rules out a useful perpetual-motion machine, information theory rules out a useful wireless microphone that operates in a reduced radio bandwidth without sacrificing other qualities.

³³ “Latency” is the time delay incurred in processing the audio signal. Any significant delay in a wireless microphone system becomes intolerable to the performer. The practical upper limit is less than ten thousandths of a second through the entire system, from the microphone transducer all the way back to the monitor.

³⁴ The list is not unique; certain other formulations are equally valid.

Many of the characteristics listed above are outside the microphone manufacturer's control. Transmitter power is limited by battery life (and the Commission's rules). Needed range is set by the layout of the performance venue. Needed noise tolerance depends on the local radio-frequency environment. Data rate depends mathematically on the audio quality required (subject to compression; see below).³⁵ The acceptable error rate likewise depends on quality requirements. Radio bandwidth, as we have seen, depends on all the others.

We spelled this out in our first-round comments, but it bears repeating here: other services that gained spectrum efficiency when converting to digital modulation (such as cell phones and broadcast TV) did not achieve those gains from digitization as such, but from implementing compression. The two are often confused because digitization is a prerequisite to efficient compression. But the processes are distinct. And even compression does not provide an end-run around information theory. Compression reduces the bit rate, but it also impairs audio quality or adds latency.

The above analysis helps to explain the limitations of the high-density microphones much touted in the comments. These products cannot magically circumvent fundamental principles. In high-density mode, they switch to reduced power and a low-bandwidth modulation that is more susceptible to radio-frequency noise. The more extreme densities also necessitate impairing audio quality. These devices have adequate performance for some applications, particularly at very short range. But they are not a universal solution for all wireless microphone spectrum issues.

Finally, amid the sustained TVBD critique of wireless microphones' spectrum efficiency, we see no evidence that TVBDs will do any better. Two TVBD standards are under

³⁵ The mathematical relationship between audio quality and data rate for a typical case is set out in Sennheiser in WT Docket No. 08-166 *et al.* at 10.

development: IEEE 802.22, primarily for long-range fixed applications such as broadband delivery, and IEEE 802.11af for both mobile and shorter-range fixed applications.³⁶ Their *maximum* data rates are, respectively, 22.69 Mbps and 12 Mbps over a 6 MHz channel. These amount to 3.8 bits/second/hertz and 2 bits/second/hertz. Sennheiser digital microphones use a more efficient modulation, achieving just under 6 bits/second/hertz. Moreover, other IEEE 802 protocols automatically downshift the data rate (and impair spectrum efficiency) under adverse spectrum conditions, such as device congestion. If 802.22 and 802.11af devices do the same, as we expect, then even the relatively modest maximum rates will often be out of reach. Because Sennheiser microphones do not reduce their data rate, their spectrum efficiency remains superior to that of TVBDs under all conditions.³⁷

Some TVBD advocates complain that wireless microphone technologies have been “stagnant for decades,”³⁸ and that current Commission rules “encourage inefficient spectrum use.”³⁹ Patent falsehoods like these can take on the status of “facts” through sheer repetition. We do not dispute that wireless microphones, like all radio-based technologies, must continue to work on minimizing their use of shared spectrum resources. The industry is actively doing so. TVBDs supporters should comment on current wireless microphone technologies, not those from

³⁶ Demian Lekomtcev and Roman Maršálek, “Comparison of 802.11af and 802.22 standards—physical layer and cognitive functionality,” *ELECTROREVUE*, Vol. 3, No. 2 at 14 (table) (June 2012), available at <http://www.elektrorevue.cz/en/articles/analogue-technics/0/comparison-of-802-11af-and-802-22-standards---physical-layer-and-cognitive-functionality/>

³⁷ Unlike many other radio-based devices, wireless microphones use spectrum efficiently over time as well as over frequency. Most operate for an hour or two at most, and then vacate the frequency, leaving it free for other users. The duty cycle, measured over a week or so, seldom exceeds a few percent.

³⁸ Microsoft at 2.

³⁹ Public Interest Spectrum Coalition at 37.

the past. and should look to improving their own spectrum efficiencies before publicly criticizing others’.

D. OTHER ISSUES.

1. The Commission should continue to reserve two UHF channels for wireless microphones.

The opposition to maintaining reserved channels for wireless microphones rests mostly on the notions addressed above: that TVBDs would put the spectrum to a better purpose;⁴⁰ and that reserved channels perpetuate the use of supposedly inefficient technologies.⁴¹ We showed in Part B above that wireless microphones contribute in important ways to the U.S. economy, culture, and public life. We showed in Part C that opponents’ claims of spectrum inefficiency are wrong. Two reserved channels are insufficient by far to support needed wireless microphone operations, and are the very least the Commission should consider.⁴²

PISC exaggerates the amounts of spectrum wireless microphones have available.⁴³ PISC takes New York City as its example—but New York City is highly atypical as to both TV station congestion and the local demand for wireless microphones. Moreover, we think PISC erred in its channel counts; see Appendix A for details. PISC also implies that channels below 21 are available to wireless microphones. Yet thirteen major metropolitan areas have access to some of this spectrum for public safety communications; they include some cities having high levels of

⁴⁰ Google & Microsoft at 51.

⁴¹ Microsoft at 10.

⁴² See The Walt Disney Company at 45-47; Society of Broadcast Engineers at 12; Shure at 15-16.

⁴³ Public Interest Spectrum Coalition at 33-37.

demand for wireless microphone use, such as New York City and Los Angeles.⁴⁴ Fixed TVBDs also have access to these channels (except channels 3 and 4).⁴⁵ These have an EIRP power limit fully 40 times higher than personal/portable devices.⁴⁶ Moreover, due to constraints on antenna length, wireless microphones in practical applications cannot use channels 2-6. If fixed TVBDs were to succeed, as PISC expects, and populate the available spectrum below channel 21, they would have considerable negative impact on wireless microphones.

One comment suggests that registration can substitute for reserved channels.⁴⁷ This is not in accordance with practical reality. The Commission has imposed limitations on the kinds of events that qualify for registration.⁴⁸ Not all events that realistically need protection will meet the requirements. Moreover, unlicensed wireless microphones must register with the database 30 days in advance,⁴⁹ while the need for protection often arises on much shorter notice. Even if the Commission shortened the 30-day period, its rules still permit a fixed or Mode II personal/portable TVBD that is unable to reach the database to continue operating until 11:59 p.m. of the following day.⁵⁰ This potentially allows a device almost 48 hours of “blind” operation with no guidance from the database. A user would have to register at least 48 hours in advance to be sure

⁴⁴ 47 C.F.R. § 90.303(b).

⁴⁵ 47 C.F.R. § 15.707. Channels 3 and 4 are used by consumer TV interface devices.

⁴⁶ 47 C.F.R. §§ 15.709(a)(1)-(2) (1 W output power plus 6 dBi antenna gain yields 4 W EIRP for fixed TVBDs *versus* 0.1 W EIRP for personal/portable TVBDs).

⁴⁷ Anant Sahai at 3-4.

⁴⁸ *Office of Engineering and Technology and Wireless Telecommunications Bureau Announce Nationwide Launch of Unlicensed Wireless Microphone Registration System*, ET Docket No. 04-186, Public Notice, 27 FCC Rcd 15102 (2012).

⁴⁹ 47 C.F.R. § 15.713(h)(9).

⁵⁰ 47 C.F.R. § 15.711(b)(3)(iii).

of protection—and even that is too long for some applications. News operations, for example, sometimes have to use wireless microphones on just a few minutes notice. Reserved channels can fill these needs; registration cannot.

2. *The Commission should expand licensing for wireless microphones.*

The opponents of expanded licensing seek to warehouse spectrum for TVBDs. Some rely on false charges of spectrum inefficiency.⁵¹ None confronts the issue that expanded licensing will address: namely, that wireless microphones are the only technology capable of meeting the needs of many users not presently eligible under Part 74.⁵² The waiver that allows unlicensed operation at low power will help to meet some of this demand, and should be promptly adopted into the Commission's rules.⁵³ But there remain some venues too large to be served under the waiver, ineligible under Part 74, and yet self-evidently in need of the best possible wireless microphone technology. We offered examples in our first-round comments: outdoor concerts such as those at New York's Central Park, theaters, concert halls, stadiums, auditoriums, business facilities (as used for large shareholder meetings and new-product launches), the federal, state, and local government events that make democracy work, convention centers, lecture halls, and other places of exhibition, entertainment, or public gathering.⁵⁴ We ask the Commission to adjust the eligibility rules to conform to the needs of the public.

⁵¹ E.g., Microsoft at 6-8, Wi-Fi Alliance at 2-3.

⁵² Shure at 18-21.

⁵³ *Low Power Auxiliary Stations in the 698-806 MHz Band*, Report and Order and Further Notice of Proposed Rulemaking, 25 FCC Rcd 643 at ¶¶ 71-89 (2010).

⁵⁴ Sennheiser in WT Docket No. 08-166 *et al.* at 9-12. See also Society of Broadcast Engineers at 14-15; Boeing at 5-6.

3. *The Commission should reduce required co-channel separation between TV stations and wireless microphones.*

On this point, at least, all parties seem to agree: the current separation rule, adopted to protect analog TV reception, is greater than is needed to protect digital viewers. Experience in the field suggests that some wireless microphone users have operated at less than the required separation without incident. No one opposes adjusting the rule.

Specifying any single distance, however, would needlessly lock out wireless microphones where they could operate safely, or else risk interference to over-the-air TV viewers. Sennheiser suggests instead that wireless microphones be allowed to operate at locations where a co-channel TV signal is below some specified threshold, perhaps -80 dBm over 200 kHz. 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. This approach will be faster and easier for microphone users than either database registration or full-scale frequency coordination, and will make better use of limited spectrum than would a simple distance rule.

4. *The Commission should not require wireless microphones to vacate newly auctioned spectrum prematurely.*

CTIA asks the Commission to require that wireless microphones cease to operate in repurposed spectrum as of the auction date.⁵⁵ Yet wireless service providers often require a year to build out, or more— much more, in some areas. The auction date might be a reasonable cut-off for importing or marketing wireless microphones that operate on the newly reallocated frequencies. But there is no good reason to displace users until wireless providers are ready to offer service in the area.

⁵⁵ CTIA – The Wireless Association at 5-6.

Wireless microphone users recently had to discard their 700 MHz equipment as part of the digital TV transition. Many absorbed the capital costs of replacing devices still capable of years of service. Some, perhaps most, replaced that equipment with 600 MHz gear, having no hint that these frequencies too might be in jeopardy. If the Commission must next declare the relatively new 600 MHz microphones to be unlawful, it should at least postpone doing so action until the frequencies are actually needed for other uses.

5. *Wireless microphones cannot successfully operate as TVBDs.*

Some commenters continue to propose that wireless microphones be made subject to the rules for TVBDs. If the idea were feasible, the wireless microphone industry would embrace it as a promising solution to spectrum problems. The fact, however, is that wireless microphones and TVBDs use very different technologies to serve very different purposes. In particular, TVBDs lack the near-zero latency, near-zero dropout rate, and absolute reliability that wireless microphones require. Regulating the two identically would make no sense.

CONCLUSION

Wireless microphones have proven their public interest many times over: their importance to the U.S. economy and to entertainment, worship, and public debate. Their spectrum efficiency is competitive with other technologies, and continues to improve as technology advances. As the Commission balances the interests of contenders for the shrinking

number of vacant TV channels, it should ensure that wireless microphones have adequate spectrum for operation, free of interference from unproven and less efficient technologies.

Respectfully submitted,

A handwritten signature in black ink that reads "Mitchell Lazarus". The signature is written in a cursive style with a prominent initial "M".

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APPENDIX A: NEW YORK CITY CHANNEL COUNTS

Public Interest Spectrum Coalition (PISC) says:

In fact, although the TV Bands Database shows only a single vacant TV channel available in Manhattan for unlicensed white space use, wireless microphone operators enjoy a vast array of choices – including, in practice, 22 television channels, enough to potentially operate more than 300 microphones in a single venue.^a

From this statement, PISC goes on to argue there is no need for wireless microphones to occupy TVBD spectrum, or even the two channels reserved for their use, except as a last resort for special events.^b

We explain here why PISC’s statements about channel space are wrong.

1. PISC bases its finding in part on “searching Shure’s microphone channel search database at the Rockefeller Center in Manhattan (zip code 10112).”^c The Shure database does not include low-power TV stations. Therefore the PISC estimate of 22 available channels is inflated, and its chart of available channels (on page 36) is incorrect. An expert for NBC, located at Rockefeller Center (ground zero for PISC’s search), reports that taking the next step with the Shure system, with its on-site Spectrum Search procedure, indicates no free channels whatsoever. Sennheiser thinks this reading is also wrong—that some spectrum is usable—but the NBC finding nonetheless casts serious doubt on PISC’s work.
2. Rockefeller Center is in the shadow of the Empire State building, which hosts a number of antennas for low power TV stations. These stations are listed in the FCC database, as well as Sennheiser’s frequency finder, which is driven by the FCC database: <http://en-us.sennheiser.com/service-support/frequency-finder>
3. PISC relies on the Shure ULXD system to assume 17 wireless microphones in a 6 MHz channel, and then multiplies by its (inflated) estimate of 22 channels available to reach a total of 374 usable mics. The ULXD 17 mics/channel configuration assumes clean spectrum with an extremely low RF noise floor. It is doubtful that these conditions exist anywhere in Manhattan.
4. Shure’s ideal 17 mic/channel configuration also relies on the transmitters operating at low power (20 mW max) and at short range (100 m line of sight; much less with obstacles). These limitations rule out many applications.

^a Public Interest Spectrum Coalition at 36.

^b *Id.*

^c *Id.*

5. PISC’s simple calculation of mics/channel times available channels is misleading in practice if adjacent channels are used, especially if in-ear monitor (IEM) systems are involved. (IEM frequencies must be well separated from the corresponding mic frequencies.) All of the studios at Rockefeller Center use IEM systems.
6. PISC is correct in noting that building walls provide some shielding for indoor operations.^d But at PISC’s example of Rockefeller Center, some broadcasts use outdoor locations. NBC’s Today show, for example, often broadcasts from the Rockefeller plaza / skating rink. Madison Square Garden plans to do the same outside its new FUSE studio.
7. PISC asserts that TV production facilities at Rockefeller Center reserved certain channels licensed to nearby TV stations, including channels 29 (14 miles separation), 51 (13 miles), 30 (11 miles), 44 (0 miles), and 31 (0 miles).^e NBC filed for these channels when the TVBD database first became available, as part of a test. These channels are not presently protected at Rockefeller Center. NBC’s current registration lists lists only channels 22 and 42 (already reserved for mics) and 47 and 49. The facts do not support PISC’s claims for large numbers of available TV channels.
8. PISC refers to the “far smaller number of microphone operations licensed under Part 74,” relative to unlicensed mics.^f This is misleading. One Part 74 license often covers hundreds of devices in use.
9. PISC lists list channel 5 as a TVBD channel available to wireless microphones.^g Due to constraints on the longer antennas needed at lower frequencies, mics in practical applications can use only channels 7 and above.
10. PISC’s chart lists channel 61, which is no longer part of the TV band.^h

^d *Id.* at 34.

^e *Id.* at 36.

^f *Id.* at 33 (citation footnote omitted).

^g *Id.* at 34.

^h *Id.* at 36.

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