Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
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	)	ET Docket No. 14-165
	)	
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 Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268

NOTICE OF PROPOSED RULEMAKING

Adopted: September 30, 2014 **Released: September 30, 2014**

Comment Date: (45 days after the date of publication in the Federal Register)
Reply Date: (65 days after the date of publication in the Federal Register)

By the Commission: Chairman Wheeler and Commissioners Clyburn, Rosenworcel, and O'Reilly issuing separate statements; Commissioner Pai approving in part, concurring in part and issuing a statement.

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I. INTRODUCTION

1. Recent actions by the Commission to repurpose broadcast television band spectrum for new wireless services as set forth in the *Incentive Auction R&O* will significantly alter the regulatory landscape for unlicensed white space devices and wireless microphones operate in the bands currently allocated for television broadcast.[1] Today, unlicensed white space devices and wireless microphones rely heavily on access to unused channels in the television bands to provide important services. Unlicensed white space devices are used typically to provide broadband data and other services for businesses and consumers, particularly in un-served and under-served areas. Wireless microphones enable broadcasters and other video programming networks to serve consumers, including covering breaking news and live sports events, and are used in theaters and music venues, film studios, conventions, corporate events, houses of worship, and internet webcasts. Following the incentive auction, with the repacking of the television band and the repurposing of current television spectrum for wireless services, there will be fewer frequencies in the UHF band available for use by unlicensed white space devices and wireless microphones.

2. In the *Incentive Auction R&O*, the Commission made several decisions to balance the spectrum needs of all incumbent uses of the TV bands. Unlicensed white space devices and wireless microphones will continue to operate on vacant channels in the TV bands, albeit there may be fewer in number in certain geographic areas. They also will be permitted to operate on segments of the 600 MHz spectrum that will be recovered and repurposed for new wireless services. The Commission also decided that it would initiate a proceeding to develop rules for unlicensed operation of white space devices and wireless microphones in the reconstituted TV bands and the repurposed 600 MHz Band after the incentive auction. We initiate this proceeding to fulfill that commitment and, in the process, we endeavor to improve the regulations to accommodate future use and encourage innovation.[2] In exploring the issues in

[1] *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions,* GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567 (2014) (*Incentive Auction R&O*). We use the term "wireless microphones" to include wireless microphones and similar devices such as cue and control communications, synchronization of TV camera signals, and in-ear monitors. Operation of these devices is authorized on a licensed basis in the television bands as "low power auxiliary stations" under the Commission's Part 74 rules, s*ee* 47 C.F.R. § 74.801, and we propose in this Notice to permit such devices to operate on an unlicensed basis under Part 15.

[2] In addition to initiating this proceeding, we also are initiating a separate proceeding to address the long-term needs of wireless microphone users, thus fulfilling the Commission's commitment in the *Incentive Auction R&O* to address those issues, 29 FCC Rcd at 6704-6705, para. 316. While this Notice focuses mostly on unlicensed operations in the TV bands and the 600 MHz Band– both white space devices and unlicensed wireless microphones – the wireless microphone proceeding broadly addresses a wide array of issues. *See generally* Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket Nos. 14-166 and 12-268, *Notice of Proposed Rulemaking*, FCC 14-145 (Wireless Microphones NPRM). That proceeding addresses issues for licensed wireless microphone operations in the TV bands, as well as opportunities for licensed and unlicensed wireless microphone use in several other frequency bands. *Id.* We cross-reference this wireless microphone proceeding on certain issues as appropriate.

this Notice, we also will consider how best to ensure that our actions will advance the Commission's overall spectrum management goals, which include promoting the best and most efficient, use of our spectrum resources.

3. This Notice of Proposed Rulemaking (Notice) proposes and seeks comments on rules for unlicensed operations in the frequency bands that are now and will continue to be allocated and assigned to broadcast television services (TV bands), including fixed and personal/portable white space devices and unlicensed wireless microphones. Our experience with the development and deployment of white space devices in the TV bands leads us to consider changes to our Part 15 rules that will allow for more robust service and efficient spectral use without increasing the risk of harmful interference to authorized users. We also propose to codify in Part 15 rules for the operation of unlicensed wireless microphones in the TV bands.

4. This Notice also addresses issues that arise from the *Incentive Auction R&O* to repurpose a portion of the broadcast spectrum for new wireless services. The 600 MHz Band Plan adopted in the *Incentive Auction R&O* provides new opportunities for unlicensed white space devices, unlicensed wireless microphones and wireless microphones licensed under Part 74. The Notice proposes and seeks comment on rules to permit those operations while also protecting authorized licensed services from harmful interference.

II. BACKGROUND

5. The Commission's Part 15 rules allow unlicensed devices to operate in the TV bands at locations where frequencies are not in use by licensed services.[3] These devices, which are commonly referred to as TV white space (TVWS) devices, may be either fixed or personal/portable. The TV bands currently consist of six-megahertz channels designated 2 to 51 in four bands of frequencies in the VHF and UHF regions of the radio spectrum (54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-698 MHz).[4] TVWS devices are not permitted to operate on channel 37 (608-614 MHz), which is allocated for the Radio Astronomy Service (RAS) and Land Mobile Service (the latter being limited to Wireless Medical Telemetry Service (WMTS),[5] or on any other channel within 2.4 kilometers of protected radio observatories.[6] To prevent harmful interference to broadcast television stations and other authorized users of these bands, TVWS devices obtain a list of available TV channels that may be used at their location from databases administered by private entities selected by the Commission.[7]

6. The TV bands are used also by wireless microphones. Certain entities may be issued licenses under Subpart H of Part 74 of the rules to operate low power auxiliary stations in the TV bands.[8] Devices authorized as low power auxiliary stations are intended to transmit over distances of approximately 100 meters for uses such as wireless microphones, cue and control communications, and synchronization of TV camera signals.[9] Because the operators of Part 74 wireless microphones are

[3] *See* 47 C.F.R. Part 15 subpart H.

[4] *See* 47 C.F.R. § 73.603(a).

[5] *See* 47 C.F.R. § 2.106.

[6] *See* 47 C.F.R. § 15.712(h).

[7] *See* 47 C.F.R. §§ 15.703(c), 15.703(i) and 15.703(n).

[8] *See* 47 C.F.R. Part 74 subpart H. These entities fall within the following categories: (1) licensees of AM, FM, TV, or International broadcast stations or low power TV stations; (2) broadcast network entities; (3) certain cable television system operators; (4) motion picture and television program producers as defined in the rules; (5) certain entities with specified interests in Broadband Radio Service (BRS) and Educational Broadcast Service (EBS) licenses; (6) large venue owners or operators; and (7) professional sound companies. *See* 47 C.F.R. § 74.832(a)(1)-(8).

[9] *See* 47 C.F.R. § 74.801. We refer to these types of devices collectively as wireless microphones. Wireless microphones may operate with a maximum bandwidth of 200 kilohertz and a maximum power of 50 milliwatts in

(continued….)

licensed, they may register the times and locations of their operation in the TV bands databases to obtain interference protection from TVWS devices. The Commission also allows the operation of wireless microphones in the VHF and UHF TV bands on an unlicensed basis under a waiver of the Part 15 rules granted in the 2010 *TV Bands Wireless Microphones R&O and Further NPRM,*[10] subject to proposed Part 15 technical requirements in the *Further NPRM*.[11] Operators of unlicensed wireless microphones are generally not permitted to register in the TV bands database, but parties operating large numbers of wireless microphones on an unlicensed basis at venues of events and productions/shows may register in the TV bands database if they meet certain criteria specified in the rules and obtain Commission approval to do so.[12]

7. In the *Incentive Auction R&O*, the Commission adopted rules to repurpose broadcast television spectrum in the UHF bands for licensed wireless services. Under these rules, full power and Class A broadcast licensees may participate in a reverse auction that will allow them to voluntarily relinquish some or all of their spectrum usage rights in exchange for financial compensation. A broadcast licensee that participates in the auction will have the option to turn in its license, move to a channel in the VHF band, or cease using its channel and share a channel with another licensee. The Commission will reorganize or repack the remaining full power and Class A television stations to clear the UHF band from channel 51 down.[13] During the post-auction transition process, lower power television (LPTV) and translator stations displaced by repacking also will be seeking and relocate to new channels in the remaining TV bands. The Commission also decided not to relocate incumbent RAS and WMTS operations from channel 37. When the transition is completed, the TV bands will occupy a shorter frequency range than they do today and fewer channels may be available for TVWS and wireless microphone uses at any given location.

8. The Commission adopted a band plan for the repurposed 600 MHz spectrum ("600 MHz Band Plan") in the *Incentive Auction R&O* that provides for a guard band between television spectrum and 600 MHz downlink services, a guard band between 600 MHz uplink and downlink services (a duplex gap), and guard bands between 600 MHz downlink services and channel 37.[14] Under the 600 MHz Band Plan, the size and location of the guard bands depends on the amount of spectrum that is recovered through the auction. The guard band between wireless downlink services and TV spectrum could be

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the VHF TV band and 250 milliwatts in the UHF TV band. *See* 47 C.F.R. §§ 74.861(e)(1) and (e)(5). Wireless microphones are secondary to the broadcast television service and must comply with minimum separation distances from co-channel TV stations. *See* 47 C.F.R. § 74.802(b). The Commission decreased the minimum separation distance requirements in the *Incentive Auction R&O*. *See Incentive Auction R&O,* 29 FCC Rcd at 6698-6699, para. 305-306.

[10] *See* 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, *Report and Order and Further Notice of Proposed Rulemaking*, 25 FCC Rcd 643, 682-87, para. 81-90 (2010) ("*TV Bands Wireless Microphones R&O and Further NPRM*").

[11] *Id* at 733-734, Appendix E (2010). These technical requirements limit wireless microphones to 50 milliwatts in the VHF and UHF TV bands, but are otherwise similar to the technical requirements for Part 74 wireless microphones, including a bandwidth limit of 200 kHz and minimum separation distances from co-channel television stations.

[12] *See* 47 C.F.R. § 15.713(h)(9). Parties wishing to register unlicensed wireless microphones on channels where white space devices can operate must first make use of all channels where white space devices cannot operate, and must use at least 6-8 microphones per channel.

[13] *See Incentive Auction R&O,* 29 FCC Rcd at 6617-6621, para. 109-118.

[14] *See Incentive Auction R&O,* 29 FCC Rcd at 7017-7025, Appendix C, para. 115-141.

seven, nine or 11 megahertz.[15] The duplex gap will be 11 megahertz wide under all spectrum recovery scenarios, but its frequency location will depend on the amount of spectrum recovered. There will be no guard bands adjacent to channel 37 if less than 84 megahertz of spectrum is recovered, a single three megahertz guard band above channel 37 if 84 megahertz of spectrum is recovered, and a three megahertz guard band on each side of channel 37 if more than 84 megahertz of spectrum is recovered.

9. In the *Incentive Auction R&O*, the Commission decided to permit unlicensed devices, including unlicensed wireless microphones, to operate in the guard bands and duplex gap. The Commission also decided to permit unlicensed devices to operate on channel 37 and in spectrum reallocated and reassigned to new wireless services except in those areas where new Part 27 600 MHz Band wireless licensees commence operations.[16] However, the Commission found that the record in the Incentive Auction proceeding was inadequate to adopt rules for these types of unlicensed operations. It stated that it planned to develop technical rules in a separate proceeding. In addition, the Commission planned to consider changes to the rules for TVWS devices, including decreasing the interval at which devices to recheck the database to verify channel availability and developing protection criteria for licensed wireless services that may operate on the same channel as TVWS devices in certain markets.

III. DISCUSSION

10. In the *Incentive Auction R&O*, the Commission decided that unlicensed operations could operate on vacant channels in the frequency bands that are now and will continue to be allocated and assigned to broadcast television services (the "TV bands"); in the 600 MHz Band Plan spectrum that, following the Incentive Auction, will be designated as guard bands (including a duplex gap); in the portion of that spectrum allocated and assigned to new Part 27 licensees where wireless licensees have not commenced operations; and in Channel 37. In this Notice, we first propose and seek comment on rules for fixed and personal/portable white space devices in these bands.[17]

11. The Notice addresses separately proposed rules for unlicensed microphone operations under Part 15 of our rules in the TV bands and in the 600 MHz Band Plan spectrum, and licensed microphone operations under Part 74 of our rules in the 600 MHz Band Plan spectrum. In the *Incentive Auction R&O,* the Commission decided that, at the end of the post-auction transition period, unlicensed microphones could operate in the guard bands, including a portion of the duplex gap, and that licensed microphones could operate in a different portion of the duplex gap.[18] During the post-auction transition period, microphones will be permitted to operate in the spectrum that will be assigned to new Part 27 licensees provided they do not cause harmful interference to those licensees as they commence operations, and microphones must cease any operations in that spectrum no later than the end of the transition period.[19]

12. The Notice addresses changes to the white space databases and changes for certifying, manufacturing and marketing white space devices and wireless microphones in the frequency bands at issue in this proceeding. We have gained considerable experience with the white space databases' ability to manage wireless microphone channel reservations in the TV bands, and we propose changes to improve this function. We also propose rules to expand the location and frequency information in these

[15] If exactly 84 megahertz of spectrum is recovered, channel 37 and its associated three megahertz guard band between wireless downlink spectrum and channel 37 also serves as the guard band between wireless downlink and television spectrum.

[16] In this Notice, we will refer to Part 27 600 MHz Band licensees or services at times as: Part 27 licensees or services; 600 MHz Band licensees or services; or merely wireless licensees or services.

[17] *See Incentive Auction R&O*, 29 FCC Rcd at 6576-6577, para. 22.

[18] *See Incentive Auction R&O*, 29 FCC Rcd at 6845, para. 683-684.

[19] *See Incentive Auction R&O,* 29 FCC Rcd at 6846, para. 687.

databases so that they can be used to identify available frequencies for white space devices, including unlicensed wireless microphones, in the repurposed 600 MHz band, guard bands, and Channel 37.

13. Parties that wish to submit comments in this proceeding should be as specific as possible regarding the proposals set out in this Notice, including detailed technical analysis to support their positions as appropriate, rather than rely on comments filed earlier on related issues that the Commission considered and addressed in the *Incentive Auction R&O*.

A. Fixed and Personal/Portable White Space Devices

14. Today, the Commission's Part 15, Subpart H rules allow unlicensed fixed and personal/portable devices to operate in the TV bands at locations where frequencies are not in use by licensed services. These devices are commonly referred to as TV white space (TVWS) devices because the rules were designed specifically for unlicensed operations in the TV bands. Our goal is to unify our rules in Part 15, Subpart H for unlicensed fixed and personal/portable operations in the TV bands, the 600 MHz Band Plan spectrum, and Channel 37; consequently, we will refer to unlicensed fixed and personal portable operations across these bands collectively as "white space" devices since they will operate on frequencies not used by authorized users. The Part 15 rules currently use the term "television band device" or "TVBD", and we propose to change this term to "white space device" throughout Subpart H.[20]

15. White space devices can be used to provide a variety of wireless services, including broadband data. The fixed devices that are being deployed today are typically used to provide backhaul services for Internet connectivity offered by wireless internet service providers (WISPS), schools and libraries.[21] The propagation range at UHF provides a relatively low-cost, high data throughput service that is well suited to many un-served or under-served areas of the country. Fixed devices could also be used as access points in conjunction with personal/portable devices to serve local areas, and personal/portable devices could be used separately for short-range device-to-device connectivity.[22]

16. We first address fixed and personal/portable white space device operation in the TV bands. Since the rules for these types of devices were finalized in 2008, we have gained considerable experience with the development and deployment of these unlicensed devices. Manufacturers and users also have suggested ways rules could be modified to allow for more robust service and efficient spectral use without increasing the risk of harmful interference to authorized users. Accordingly, we propose modifications to our rules in Part 15, Subpart H for fixed and personal portable devices in the bands that are now and will continue to be allocated and assigned for broadcast use after the auction.

17. We also propose rules for fixed and personal/portable white space devices' operation in the portions of the 600 MHz Band that will be assigned for wireless uplink and downlink services and the guard bands including the duplex gap. These white space devices would operate under rules that are generally similar to those in the TV bands. However, we are proposing a number of specific differences in the technical requirements to prevent harmful interference to 600 MHz Band services, the WMTS and the RAS both during and after the post-auction transition period.

18. During the post-auction transition, full power and Class A television stations will transition to new channels in the reconstituted TV bands over a 39 month period after the issuance of the

[20] *See* 47 C.F.R. § 15.703(m).

[21] Some deployments use white space technology for transmission to remote areas where the signals are converted to WiFi signals for direct access by users. For example, AIR.U is a consortium of higher education associations, public interest groups and high-tech companies to deploy white space networks in combination with WiFi access to upgrade broadband available to underserved campuses and their surrounding communities. *See* www.airu.net. The Gigabit Libraries Network, a consortium dedicated to expanding Internet access to library users, uses a similar approach in six pilot projects in the U.S. and three countries in Europe and Asia. *See* www.giglibraries.net.

[22] Neul, Ltd. has developed an air interface standard for white space devices that is specifically designed to support machine-to-machine applications. *See* www.neul.com.

Channel Reassignment PN.[23] Consequently, new 600 MHz Band services will be introduced in the 600 MHz Band gradually over a period of time across the country. The proposed rules for the transition and post-transition periods are specific by type of device, and the application of these rules will depend on the co- and adjacent-channel deployments of authorized operations at any given time in a given area. In other words, an unlicensed device may have to modify its operations to protect both broadcasting and new 600 MHz Band services, depending on its location and the status of the post-auction transition.

19. For the duplex gap, we propose rules for dividing the 11 megahertz band between unlicensed operations, including both white space devices and wireless microphones, and licensed wireless microphones. Finally, we propose rules for the operation of unlicensed devices on Channel 37, as well as the guard bands above and below Channel 37.

1. TV bands

20. The current rules permit fixed and personal/portable device to operate in the TV bands.[24] Fixed devices must incorporate a geo-location capability and a means to access a database that provides a list of available TV channels that may be used at their location.[25] Such devices must contact a database to obtain a channel list before operating and re-check the database at least once daily.[26] Fixed devices are permitted to operate with up to one watt transmitter power output and may use an antenna that provides up to 6 dBi of gain to produce a maximum power of 4 watts EIRP.[27] They may not operate on channels adjacent to those occupied by TV stations. Portable devices can operate in either "Mode I" or "Mode II".[28] A Mode II device must incorporate similar geo-location and database access capabilities to fixed devices.[29] A Mode I device is not required to incorporate geo-location or database access capabilities but instead obtains a list of available channels on which it can operate from either a fixed or Mode II device that has database access.[30] Personal/portable devices are permitted to operate with up to 100 milliwatts EIRP except when operating on channels adjacent to a TV service, in which case they may operate with up to 40 milliwatts EIRP.[31] All white space devices are required to incorporate transmit power control to limit their operating power to the minimum necessary for successful communication.[32] The databases used by TV bands devices are established and administered by third parties.[33]

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[23] *See Incentive Auction R&O*, 29 FCC Rcd at 6846, para. 687.

[24] *See* 47 C.F.R. §§ 15.703(c) and 15.703(i).

[25] As an alternative, fixed devices may have their geographic coordinates determined and programmed by a professional installer. *See* 47 C.F.R. § 15.711(b)(1).

[26] *See* 47 C.F.R. § 15.711(b)(3)(i).

[27] *See* 47 C.F.R. § 15.709(a).

[28] *See* 47 C.F.R. §§ 15.703(e) and 15.703(f).

[29] *See* 47 C.F.R. §§ 15.711(b)(2) and 15.711(b)(3)(ii). Unlike fixed devices, there is no option for a Mode II personal/portable device to be professionally installed as an alternative to incorporation of a geo-location capability. Additionally, a personal/portable device must re-check its location at least once every 60 seconds except when in a sleep mode.

[30] *See* 47 C.F.R. §§ 15.703(e) and 15.711(b)(3)(iv).

[31] *See* 47 C.F.R. § 15.709(a)(2).

[32] *See* 47 C.F.R. § 15.709(a)(4).

[33] *See* 47 C.F.R. § 15.715. The Office of Engineering and Technology designated ten entities to administer white spaces databases by two separate Orders. The ten designated database administrators are: Airity, Inc. (formerly WSdb LLC); Comsearch; Frequency Finder, Inc.; Google, Inc.; LS Telcom; Key Bridge Global LLC; NeuStar, Inc.; Spectrum Bridge, Inc.; iconectiv; and Microsoft Corporation. *See Order* in ET Docket Nos. 02-380 and 04-186, 26 FCC Rcd 554 (2011) (designating the first nine of these listed parties as database administrators) and *Order* in ET (continued….)

21. In this section, we discuss several issues regarding white space operations in the bands that are now and will continue to be allocated and assigned to TV broadcast operations post-incentive auction. First, we discuss the permissible frequencies of operation and propose to modify the permissible channels that could be used for fixed and personal/portable devices. We also propose changing some of the technical rules applicable to fixed and personal/portable devices. Now that we have some experience with white space devices in the TV bands, we are proposing changes that will enhance the ability of these devices to provide broadband services to a wide variety of consumers and to make more efficient use of spectrum, without increasing the risk of harmful interference to authorized services.

a. Permissible frequencies of operation

22. White space devices are currently permitted to operate on unused TV channels within the range of 2-51, excluding channels 3, 4 and 37.[34] Fixed devices may operate on any available channel within that range, while personal/portable devices may operate only on channels 21-51, excluding channel 37.[35] The Commission prohibited all white space device operations on channel 37 to protect the RAS and WMTS.[36] It established the prohibition on the use of channels 3 and 4 to prevent direct pickup interference to TV interface devices with signal outputs on channels 3 or 4, such as VCRs, DVRs, and cable and satellite converter boxes.[37] In adopting this restriction, the Commission also expressed concerns that TV receivers to which TV interface devices are connected could receive direct pickup interference on channels 3 and 4.[38] The Commission established the prohibition on personal/portable devices operation on channels 14-20 to protect the Private Land Mobile Radio Service and Commercial Mobile Radio Service ("PLMRS/CMRS") that operate on those channels in certain cities.[39]

23. The Commission decided in the *Incentive Auction R&O* that white space devices may continue to operate under the Part 15 rules—the current rules and any changes to those rules that we may adopt in this proceeding—in the spectrum that remains allocated and assigned for TV broadcast services following the incentive auction.[40] The Commission also decided to modify its rules regarding white space device and wireless microphone access to unused TV channels, which we discuss below.

24. *Channels for white space device and microphone use.* Under the current rules, white space devices may not operate on the first two vacant TV channels above and below channel 37 to ensure that there is spectrum available for wireless microphones.[41] In the *Incentive Auction R&O,* the Commission decided that it would no longer continue to designate up to two unused television channels in any area exclusively for wireless microphone operations.[42] The Commission stated that in this

(Continued from previous page)
Docket Nos. 02-380 and 04-186, 26 FCC Rcd 10599 (2011) (designating Microsoft Corporation at the tenth database administrator).

[34] *See* 47 C.F.R. § 15.701.

[35] *See* 47 C.F.R. § 15.703(i).

[36] *See First Report and Order and Further Notice of Proposed Rulemaking* in ET Docket Nos. 02-380 and 04-186, 21 FCC Rcd 12266, 12275 (2006) at para. 21.

[37] *See Second Report and Order and Memorandum Opinion and Order* ("*White Spaces Second R&O*") in ET Docket Nos. 02-380 and 04-186, 23 FCC Rcd 16807, 16860 (2008), para. 149-150.

[38] *Id.*

[39] *See Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 04-186, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, *First Report and Order and Further Notice of Proposed Rulemaking*, 21 FCC Rcd 12266, 12275, para. 21 (2006).

[40] *See Incentive Auction R&O,* 29 FCC Rcd at 6842-6843, para. 677.

[41] *See* 47 C.F.R. § 15.707(a).

[42] *See Incentive Auction R&O,* 29 FCC Rcd at 6845, para. 684.

proceeding we are initiating today, it would seek comment on ways it could update the rules for white spaces databases to provide for more immediate reservation of unused and available channels in the television bands to help ensure that licensed wireless microphone operators can obtain access to available television channels without receiving harmful interference from white space devices. It decided that it would continue to prohibit white space devices from operating on the first two vacant TV channels above and below channel 37 until such time as revised Commission rules are in effect to provide for more immediate interference protection. After that time, any available channels could be used by either wireless microphones or white space devices.

25. We propose to eliminate the prohibition on white space device operation on the first two vacant TV channels above and below channel 37 and make them available for use by white space devices when the rules we propose in this Notice become effective. Specifically, we propose to increase the frequency at which white space devices must re-check the database, and limit the time required for a wireless microphone registration made in one white spaces database to appear in all other white spaces databases.[43] The effect of these two proposals will ensure that a white space device ceases operation on a channel used by a wireless microphone within 30 minutes after a new microphone registration is entered into the database. Under current rules, wireless microphone registrations typically have to be entered into the database at least one day in advance to ensure that a white space device does not access the same channel. We seek comment on these proposals.

26. In the *Incentive Auction R&O,* the Commission also stated that it expects there will be at least one channel not assigned to a television station in all areas of the United States at the end of the repacking process, and that it intends, after notice and an opportunity for public input, to designate one such channel in each area for shared use by white space devices and wireless microphones.[44] It also indicated that for engineering reasons, there may be a few areas with no spectrum available in the television bands for unlicensed devices and wireless microphones to share.[45] We plan to address the issue of a preserved white space channel in a separate proceeding. We are not proposing in this Notice to make any changes to the white space rules with respect to a future preserved channel. Such a channel would simply appear in the white spaces database as vacant and would therefore be available for white space devices under the existing rules as well as any new or modified rules we adopt in this proceeding.

27. *Operation of fixed devices on channels 3 and 4*. The current prohibition on fixed white space device operation on channels 3 and 4 may no longer be warranted.[46] As discussed above, the Commission established this prohibition to protect TV interface devices and TV receivers from direct pickup interference on channels 3 and 4.[47] The Commission did not have detailed data on the susceptibility of TV interface devices and TV receivers to direct pickup interference on channels 3 and 4, but decided to take a cautious approach due to the expected large number of TV interface devices with outputs on those channels.[48] The number of these devices has declined significantly since 2008. The transition from analog to digital TV in 2009 spurred many consumers to replace their old analog TV receivers with digital receivers that have multiple inputs that allow the connection of external devices without requiring the use of a channel 3 or 4 input signal, including HDMI, component video and composite video inputs.[49] Further, the price of new TV receivers has dropped significantly since that

[43] *See infra* para. 190.

[44] *See Incentive Auction R&O,* 29 FCC Rcd at 6682-6683, para. 264.

[45] *Id.* at footnote 803.

[46] *See* 47 C.F.R. §§ 15.701, 15.703(m) and 15.707(b).

[47] *See supra* para.22.

[48] *See TV White Spaces Second R&O,* 23 FCC Rcd at 16860, para.150.

[49] HDMI (High Definition Multimedia Interface) is a digital interface that carries video and audio signals. Component video is an analog interface that uses three cables to carry a video signal. Composite video uses a single (continued….)

time, resulting in many more consumers replacing their old analog TV receivers. TV receivers also have been required to come equipped with digital TV tuners for a number of years, thus eliminating the need to use an external converter box to receive over-the-air signals. While we recognize that some consumers continue to use older analog TV sets with a converter box or other TV interface devices with a channel 3 or 4 output, we believe that number is significantly less than in 2008, and will continue to drop over time as older TV sets are replaced.

28. We therefore propose to eliminate the prohibition on the use of channels 3 and 4 by fixed white space devices. This proposed action would provide an additional 12 MHz of contiguous spectrum for use by white space devices in areas where those channels are not used for authorized services. Limiting the use of these channels to fixed white space devices will reduce the likelihood of direct pickup interference to TV interface devices and TV receivers that continue use these frequencies, since a fixed white space device is less likely to be used in close proximity to a TV receiver than a portable device. We seek comment on this proposal. Specifically, we seek comment on the extent to which consumers still use TV interface devices that operate on channels 3 and 4, *e.g.,* the estimated number and types of devices. We also seek comment on the susceptibility of TV interface devices and receivers to direct pickup interference on channels 3 and 4, particularly the signal levels at which such interference would occur as compared to the expected signal level from a nearby white space device. In addition, we seek comment on the extent to which white space device manufacturers would use TV channels 3 and 4 if they were available for fixed devices.[50]

29. *Operation of personal/portable devices on channels 14-20 and below channel 14*. Operation of personal/portable white space devices is currently prohibited below TV channel 21.[51] The Commission initially established a prohibition on personal/portable device operation on channels 14-20 in the *White Spaces First Report and Order* to prevent possible interference to public safety and other operations in the PLMRS/CMRS that use channels in that range in certain cities and in other areas under waivers.[52] The Commission expressed concern that detecting PLMRS/CMRS operations through spectrum sensing could be difficult because these services typically transmit intermittently rather than continuously. It therefore decided to prohibit the use of personal/portable devices on channels 14-20 nationwide since the devices could be easily transported anywhere. The Commission did not adopt final technical rules for white space devices in that *Order* and did not decide which other channels personal/portable devices could use. In the *White Spaces Second Report and Order,* the Commission affirmed its decision to prohibit the operation of personal/portable white space devices on channels 14-20 due to concerns about interference to public safety and other important communications in the PLMRS/CMRS.[53]

30. The repurposing of spectrum for Part 27 services will reduce the number of channels available for white space use, and relaxing the restrictions on the channels available for personal/portable

(Continued from previous page)
cable to carry an analog video signal. Component and composite video cables are used in conjunction with cables that carry an analog audio signal.

[50] We also seek comment on whether we should allow personal/portable devices to operate on channels below 14. *See infra* para. 32.

[51] *See* 47 C.F.R. § 15.707(b). Only fixed devices that communicate with another fixed device may operate on channels below 21.

[52] *See Unlicensed Operation in the TV Broadcast Bands,* ET Docket No. 04-186*, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, First Report and Order and Further Notice of Proposed Rulemaking, 21 FCC Rcd 12266, 12275, para.21 (2006).

[53] *See Unlicensed Operation in the TV Broadcast Bands,* ET Docket No. 04-186*, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket No. 02-380, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807, 16860, para.152 (2008).

devices could offset that reduction. We believe that it is appropriate to revisit the Commission's previous decisions to prohibit personal/portable device operation on channels 14-20 and below channel 14. Since the time the Commission made these decisions, it has designated multiple TV bands database administrators and has had extensive experience working with their databases. Based on that experience, we have a high degree of confidence that the databases can reliably protect PLMRS/CMRS operations. The locations where the PLMRS/CMRS is used, both in eleven cities and in other areas where it is authorized under waiver, are already in the TV bands database since that information is used to protect those operations from fixed white space operations.[54] Personal/portable devices rely on database access to determine their list of available channels rather than spectrum sensing as envisioned in the *White Spaces First Report and Order*, so they can protect the PLMRS/CMRS in the same manner as fixed devices.

31. Accordingly, we propose to remove the prohibition on personal/portable device operation on channels 14-20. This proposed action would make 42 megahertz of spectrum potentially available in locations where the spectrum is not used for the PLMRS/CMRS or other authorized services. In particular, we seek comment on the risk of interference to public safety and other PLRMS/CMRS based on the Commission's current technical rules for personal portable devices, *e.g.,* power limits and database access. We also seek comment on any changes to the rules that would be required to minimize the risk of harmful interference if we were to allow operations on channels 14-20.

32. In addition, we seek comment on whether we should permit personal/portable devices to operate below channel 14. Allowing operation of personal/portable devices on channels 7-13 would make another 42 megahertz of spectrum potentially available for personal/portable devices. On which channels should we permit operation? Would manufacturers be interested in developing personal/portable devices that operate below channel 14 given the longer radio wavelengths at these lower frequencies?

b. Technical rule changes

(i) Fixed device operation on adjacent channels

33. Fixed white space devices, which can operate with a maximum power of four watts EIRP, are not permitted to operate on channels that are adjacent to occupied TV channels. They must always operate outside the defined service contours of adjacent channel TV stations by a minimum distance specified in the rules.[55] These separation distances vary from 0.7 to 2.4 kilometers, depending upon the height above average terrain (HAAT) of the fixed device antenna.[56] Personal/portable devices, which can operate with a maximum power of 100 milliwatts EIRP, are generally required to operate outside the defined service contour of adjacent channel TV stations as well. However, personal/portable devices are permitted to operate within the service contour of adjacent channel TV stations if they reduce their power to 40 milliwatts EIRP. There is currently no corresponding provision in the rules that permits fixed devices to operate within the service contour of adjacent channel stations at reduced power. The requirement for fixed white space devices to avoid adjacent channel operation means that they may operate only at locations where there are three contiguous vacant TV channels, regardless of how low they reduce their operating power.

[54] Section 90.303(b) of the rules lists thirteen urban areas where the PLMRS/CMRS may operate on certain channels in the range of 14-20: 1) Boston, MA; 2) Chicago, IL; 3) Cleveland, OH; 4) Dallas/Ft. Worth, TX; 5) Detroit, MI; 6) Houston, TX; 7) Los Angeles, CA; 8) Miami, FL; 9) New York, NY/Northeast NJ; 10) Philadelphia, PA; 11) Pittsburgh, PA; 12) San Francisco/Oakland CA; and 13) Washington DC/MD/VA. PLMRS/CMRS operation under these provisions is currently not permitted in Cleveland, OH and Detroit, MI. *See* 47 C.F.R. § 90.303(b), footnotes 2 and 3.

[55] *See* 47 C.F.R. § 15.712(a)(2).

[56] *Id.*

34. After the incentive auction and TV spectrum repacking, there will be fewer vacant TV channels available for white space devices. Therefore, we expect that there will be fewer locations where three contiguous vacant channels exist, particularly in urban areas, thus limiting the locations where fixed devices may be used. We propose two changes to the current rules to provide fixed devices access to more vacant TV channels.

35. First, we propose to allow fixed devices to operate adjacent to occupied TV channels (*i.e.,* within their service contour), provided the operating power is reduced to 40 milliwatts EIRP. This is the same maximum power level that we permit for personal/portable devices that operate adjacent to occupied TV channels. This change would allow fixed devices to operate in locations where the spectrum is highly congested and available channels are not contiguous. We also propose to modify the table of separation distances in Section 15.712(a)(2) to include co-channel separation distances for 40 milliwatt fixed devices. The current table of separation distances between fixed white space devices and co-channel television service contours was developed assuming a four watt EIRP device, so the separation distances are greater than necessary to protect TV service from a 40 milliwatt white space device. The methodology we will use for determining these distances and the proposed distances are discussed below.[57]

36. We seek comment on these proposals. In particular, we seek comment on the appropriateness of making the rules for fixed and personal/portable white space devices consistent with respect to operation within an adjacent TV station's contour. We also seek comment on the usefulness of a 40 milliwatt power level for fixed devices and whether we could allow higher power levels without causing interference to adjacent TV stations. Parties that recommend higher power levels should submit technical justification (*e.g.,* analysis or test data) to support their recommendations.

37. Second, we propose to allow fixed devices to operate with a maximum power of four watts EIRP at locations where there are two contiguous vacant channels rather than three. When the Commission adopted the current requirement for three contiguous vacant channels, it stated that it would remain open to modifying this requirement if parties develop options that would permit operations on first adjacent channels that would not increase the potential for interference to television service and submit those for our consideration.[58] We revisit this issue here because such operation will increase spectrum efficiency and we believe, based on several studies, that operating in this manner will not increase the potential of interference to television reception.[59] We invite parties to submit information on such studies in response to this Notice. We further propose that such operation would have to be within a six megahertz band centered on the boundary between the two vacant television channels, effectively reducing the frequency separation from six megahertz to three megahertz on each side of the white space channel. We also propose that the device would have to comply with all fixed white space requirements with respect to the six megahertz band in which it operates (*e.g.,* maximum conducted power, power spectral density and out-of-band emissions.) These changes would allow fixed devices to operate at the

[57] *See infra* para. 64-67.

[58] *See White Spaces Second R&O*, 23 FCC Rcd at 16876, para. 170.

[59] Several studies have tested the use of white space devices operating adjacent to television channels and report no instances of interference to broadcast reception. *See,* "Studies on the Use of Television White Spaces in South Africa: Recommendations and Learnings from the Cape Town Television White Spaces Trial", Section 8.6.2.2, (Channels Available for Use). This section states that, "[t]he Cape Town Trial operated in channels adjacent to channels used by TV broadcasters, and in some cases, between two channels used by TV transmitters (adjacent on either side to the TVWS channel). No interference was detected. The Trial Partners believe that this evidence demonstrates that the FCC approach is very conservative and does not maximize spectrum utilization." The study is available at: http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-trial. *See also*, "White space radio technology empowers young entrepreneurs in Ghana" which states that, "[t]he network has been tested on channels adjacent to active television channels, over a 10 km link, with no interference observed." (http://www.djunglewifi.com/white-space-radio-technology-empowers-young-entrepreneurs-in-ghana/).

maximum power currently permitted under the rules in locations where they cannot operate under the current rules.

38. We seek comment on these proposals, particularly whether such operation would adequately protect television stations operating on adjacent channels. Commenters should indicate if they believe any rule changes are necessary to ensure protection of adjacent channel TV stations. For example, should we require slightly greater adjacent channel separation distances for fixed devices that operate with two vacant channels instead of three? If so, what are the appropriate distances?

(ii) Operation at lower power levels

39. As proposed above, there would be three power levels at which white space devices could operate: 40 milliwatts, 100 milliwatts and 4000 milliwatts EIRP. We note however, that the current table of separation distances in Section 15.712(a)(2) was based on an EIRP of 4000 milliwatts which results in greater distance than necessary to protect TV reception from devices operating at 40 milliwatts or 100 milliwatts. By allowing shorter separation distances for devices operating at less than 4000 milliwatts EIRP, we can expand the locations at which they can operate.

40. In addition, we can provide even more flexibility for white space device users by defining intermediate power levels and corresponding separation distances. This will allow white space devices operating at less than the maximum permissible power to meet separation distances commensurate with their actual power and still protect over-the-air TV reception and other authorized services from harmful interference. As a result, white space devices, which must include transmit power control, would be able to operate in more locations with limited spectrum availability than available today. In crafting our proposal, we observe that the power increase from 40 milliwatts to 100 millwatts is 4 dB, and that the difference in power from 100 milliwatts to 4000 milliwatts is 16 dB. We therefore propose a series of tables providing co- and adjacent channel separation distances from the TV contour based on intermediate power levels in uniform 4 dB steps for fixed devices.[60] Specifically, we propose to define separation distances for fixed devices at EIRP levels of 40 milliwatts, 100 milliwatts, 250 milliwatts, 625 milliwatts and 1600 milliwatts (*i.e.,*16 dBm, 20 dBm, 24 dBm, 28 dBm and 32 dBm, respectively) in addition to the current separation distances at 4000 milliwatts (36 dBm). The proposed separation distances and methodology for determining them are discussed below.[61] We also propose that a device be required to indicate to the white space database the power at which it will operate when it requests a list of available channels. We further propose that when a device operates between two defined power levels, it must comply with the separation distances for the higher power level.

41. The current maximum fixed device power level of 4000 milliwatts EIRP is based on a maximum conducted power of one watt (1000 milliwatts) into an antenna with a gain of 6 dBi (a factor of four). If the antenna gain exceeds 6 dBi, the maximum conducted power must be reduced by the amount in dB that the gain exceeds 6 dBi.[62] We propose similar requirements for fixed devices that operate at power levels less than 4000 milliwatts EIRP. Specifically, we propose to define a maximum conducted power limit for each EIRP level, which would be 6 dB lower than the EIRP.[63] In addition, because the power spectral density (PSD) limit for fixed devices is based on the maximum conducted power limit, we propose to define a PSD limit for each of the proposed conducted power levels. We further propose to calculate the PSD limit using the same methodology described in the *White Spaces Third MO&O*. That is, we will assume that the power of a device will be confined to a 5.5 megahertz band to allow a 250

[60] These additional separation distances at lower power levels could also be applied to the use of the fixed white space device directional antennas in protecting TV reception. *See infra* para. 73.

[61] *See infra* para. 64-67.

[62] *See* 47 C.F.R. § 15.709(a)(1).

[63] The EIRP is the conducted power level (in dBm) plus the antenna gain (a maximum of 6 dBi for fixed white space devices). Working backwards from a specified EIRP level, the conducted power is equal to the EIRP minus 6 dB.

kilohertz roll-off at the upper and lower edges of a channel to meet the adjacent channel emission limits.[64] Consistent with the current rules, we also propose to require that the maximum conducted power and PSD limits for each EIRP level be reduced by the amount in dB that the maximum antenna gain exceeds 6 dBi.[65] In addition, we propose that if a fixed device operates between these defined EIRP levels, the conducted power and PSD limits must be interpolated between the defined values shown.

42. Based on the foregoing discussion, the following table shows our proposed EIRP, conducted power and PSD limits.[66]

EIRP limit (6 MHz)	Conducted power limit (6 MHz)	PSD limit (100 kHz)
16 dBm (40 mW)	10 dBm (10 mW)	-7.4 dBm
20 dBm (100 mW)	14 dBm (25 mW)	-3.4 dBm
24 dBm (250 mW)	18 dBm (63 mW)	0.6 dBm
28 dBm (625 mW)	22 dBm (158 mW)	4.6 dBm
32 dBm (1600 mW)	26 dBm (400 mW)	8.6 dBm
36 dBm (4000 mW)	30 dBm (1000 mW)	12.6 dBm

43. We seek comment on these proposals. In particular, we seek comment on the usefulness of operation at the power levels proposed and whether there is a need to specify protection distances at additional power levels. We also seek comment on how the information on the power level and available channels should be communicated between the device and the database. For example, a fixed device could simply supply its geographic coordinates to the database, and the database could return a list of channels that indicates the maximum power at which the device could operate on each channel. Alternatively, the device could supply its locations and maximum power level and the database could return a list of available channels corresponding to operation at that location/power level combination. Are there other combinations of parameters for information exchange that would better suit such operation? What are the benefits and drawbacks of each alternative with respect to database operation and design and to equipment design? We also seek comment on the proposed PSD limits. Do these limits provide sufficient flexibility for device design and operation? Or would different limits be more appropriate? Commenters who advocate alternative limits and methodology should provide detailed technical analysis and justification to support their position.

(iii) White space devices in rural areas

44. We seek comment on a number of possible changes that could give more flexibility to operators of white space devices that would allow them to increase coverage and provide improved service in rural areas. For purposes of these proposals only, we use the term "rural" to refer to areas where there are numerous unused TV channels, which may be areas of low population density or areas that are merely under-served by broadcast services. In these cases, the potential for harmful interference from a white space device to a broadcasting station is significantly reduced. Specifically, we seek

[64] *See White Spaces Third MO&O,* 27 FCC Rcd at 3704, para. 32.

[65] *See* 47 C.F.R. §§ 15.709(a)(1) and 15.709(a)(5)(i).

[66] The EIRP (effective or equivalent isotropically radiated power), is a characterization of the power radiated from an antenna. All else being equal, an increase in the EIRP will increase the signal propagation distance. The conducted power is the power from the transmitter into the antenna input. For a given antenna, the EIRP will increase or decrease by the same amount as the power conducted into the antenna. The power spectral density (PSD) is a characterization of how the energy from a transmitter is spread across the operating channel. The white space PSD limits were designed to ensure that the energy from a transmitter is spread uniformly across most of a channel, while allowing for roll-off near the channel edges to comply with the adjacent channel emission limits. *See White Spaces Third MO&O*, 27 FCC Rcd at 3703-3704, para. 30.

comment on whether to increase the limit on antenna height above ground for fixed devices in rural areas. We also seek comment on whether to allow higher power by fixed and personal/portable white space devices operating in rural areas. Finally, we seek comment on an appropriate definition of rural area for purposes of these proposals.

45. *Definition of rural area.* The Part 15 rules do not define what constitutes a rural area. We propose to identify rural areas for white space devices as those where at least half of the TV channels are unused for broadcast services and available for white space use. At higher power, would fixed devices need to be located at a greater distance from a broadcast station contour, or would the fixed devices need to avoid operating on first, second or third adjacent channels? How might these factors affect the number and location of unused channels in identifying a rural area? We seek comment on the appropriateness of such a criterion or whether a different definition would better meet the needs of service providers.[67] Because white space devices rely on a database to determine their list of available channels, the database would need to determine whether a fixed white space device is located in a rural area to allow such operation. Although we believe that the white space databases already have the information needed to identify a rural area under the proposed criterion (*i.e.*, the identification of vacant TV channels at a given white space device location), we seek comment on what changes might be needed to implement this proposal, including the cost and programming complexity of such changes.

46. *Fixed device antenna height above ground.* The range at which a white space device could cause interference to authorized services increases as the antenna height increases. To limit this interference potential, the Commission established maximum height limits of 30 meters above ground level (AGL) and 250 meters HAAT for fixed white space device antennas.[68] The Commission also established minimum required separation distances between white space devices and authorized services such as broadcast television that were determined based on the antenna height above ground and average terrain. The Commission adopted the 30-meter height above ground limit as a balance between increasing the white space device transmission range and the need to minimize the impact on licensed services.[69] A higher antenna height above ground can improve signal propagation in suburban and urban areas by raising the antenna above obstacles such as trees and buildings. However, this increased signal propagation can also have a negative impact on spectrum sharing in congested areas where there are few available channels. The Commission stated that it could revisit the antenna height above ground limit in the future if experience with TV bands devices indicates they could operate at higher antenna heights without causing harmful interference.[70]

47. A higher antenna height above ground could be beneficial in rural areas since an antenna could be mounted on a tower or other structure at a sufficient height to clear intervening obstacles such as trees and hills that would attenuate the transmitted signal. Increasing the antenna height could increase

[67] The Commission has previously used a criterion of a county with a population density of 100 or fewer persons per square mile based on the most recently available population statistics from the Bureau of the Census. *See*, *e.g.*, 47 C.F.R. § 27.50 (allowing a 3 dB increase in power levels for fixed and base stations located in rural areas). We do not believe that this type of criterion would necessarily identify areas where numerous unused TV channels are located, thus reducing the potential for interference from white space devices. If we were to use population density, white space databases would need to include this type of information and correlate it to a white space device's location in order to identify vacant TV channels at the device's location.

[68] *See* 47 C.F.R. § 15.709(b)(2). The antenna height above ground is the distance from the antenna center of radiation to the ground directly below the antenna. To calculate the antenna height above average terrain (HAAT), the average elevation of the surrounding terrain above mean sea level must be determined along at least 8 evenly spaced radials at distances from 3 to 16 km from the transmitter site. The HAAT is the difference between the antenna height above mean sea level (the antenna height above ground plus the site elevation) and the average elevation of the surrounding terrain.

[69] *See White Spaces Third MO&O,* 27 FCC Rcd at 3697, para. 14.

[70] *See White Spaces Second MO&O,* 25 FCC Rcd at 18689, para. 65.

the maximum distance at which a signal can be received. There will generally be a significant number of available white space channels in rural areas, so there will not be the same concerns in those locations as in more congested areas about multiple users competing for spectrum. Since there are fewer authorized users of the spectrum in rural areas, there is a lower likelihood that an increased antenna height above ground will cause harmful interference. Accordingly, we seek comment on whether we should allow fixed white space device antennas at a height above ground of more than 30 meters in rural areas. If so, what is the maximum height that we should allow? What interference or spectrum sharing concerns would be raised by a higher antenna height above ground? Would we need to increase the minimum required separation distances to co-channel and adjacent channel television stations since the current distances assume a maximum antenna height above ground of 30 meters?[71] If so, what are the appropriate separation distances? Similarly, should we also consider increasing the HAAT limit for rural areas or keep that limit at 250 meters, but only allow a higher antenna height above ground level? What are the implications on interference distance from a higher HAAT limit along with a higher AGL limit?

48. *Power limit for fixed devices.* In adopting the four watt EIRP limit for fixed white space devices, the Commission recognized that there would be advantages to allowing operation of white space devices at higher power levels, such as reduced infrastructure costs and increased service range.[72] However, the Commission decided not to allow the operation of fixed white space devices at power levels above four watts EIRP due to concerns about the increased risk of interference in congested areas that could make sharing spectrum between white space device users difficult.[73] The Commission also stated that because it did not have experience with unlicensed wireless broadband operations in the TV bands, it would take a cautious approach in setting power limits to minimize the risk of harmful interference to authorized users of the TV bands.[74] The Commission indicated that it would explore in a future proceeding whether higher powered unlicensed operation might be accommodated in the TV white spaces in rural areas.[75]

49. We seek comment on whether we should allow fixed white space devices in rural areas to operate with up to ten watts EIRP, which could improve broadband service coverage in these areas. We expect that equipment manufacturers can achieve this higher EIRP level by using higher gain antennas (10 dBi rather than 6 dBi), with no increase in the one watt conducted power level currently permitted. We believe that requiring a higher gain antenna to achieve the higher EIRP as opposed to a higher transmitter power is appropriate for several reasons. First, it will result in more efficient spectrum use because the power from a higher gain antenna will be concentrated in a narrower beamwidth, thus reducing the likelihood of interference to authorized services and to other white space device users. Also, we believe that use of fixed devices at these higher power levels would be limited to point-to-point type operations as it is unlikely that lower power personal/portable devices would be able to communicate over the increased distances.

50. We seek comment on the appropriateness of a ten watt power level and the degree to which it could help rural broadband operators improve or expand their service offerings to additional areas. What is the trade-off in terms of cost and system complexity of using a single high power fixed station as opposed to several lower power stations? We also seek comment on whether we should allow higher transmitter output power (*i.e.*, greater than one watt) as an alternative to, or in addition to, higher gain antennas. In addition, if we were to adopt rules for higher power, should we provide for intermediate

[71] The TM 91-1 model used to determine the minimum required separation distances at lower antenna heights and shorter distances considers the transmit antenna height above ground. *See infra* para. 64.

[72] *See White Spaces Second Report and Order,* 23 FCC Rcd at 16847, para. 106.

[73] *Id.*

[74] *Id.*

[75] *Id.*

levels between 4 and 10 watts EIRP? If so, what are the appropriate levels? We further seek comment on the impact of these proposed changes on authorized services in the TV bands. We recognize that allowing a higher power level for white space devices will require greater separation distances from co-channel and adjacent channel TV stations. Would the methodology described below for determining such separation distances be appropriate for higher power white space devices in rural areas?[76] Would we need to increase the minimum separation distance from protected services such as licensed wireless microphones, registered receive sites, and the PLMRS in addition to full power and Class A television stations?

51. *Power limit for personal/portable devices.* The Commission established a lower power limit for personal/portable devices (100 milliwatts EIRP) than for fixed devices (4 watts EIRP).[77] The Commission adopted this lower limit because it found that personal/portable devices generally pose a greater risk of harmful interference to authorized operations than fixed devices because portable devices will change locations, making identification of both unused TV frequencies and the devices themselves, if harmful interference occurs, more complex and difficult.[78] It further stated that the significant distances at which harmful interference could occur from a personal/portable device operating at greater than 100 milliwatts would make it very difficult to identify a device that is the source of harmful interference.[79]

52. Higher power limits for personal/portable devices in rural areas could benefit the public by enabling applications that are limited or precluded by the current rules, such as mobile communications and vehicle tracking. We recognize the Commission's previous concerns with higher power limits for personal/portable devices. However, we believe that personal/portable devices may be able to operate at higher power levels in certain limited situations without a high risk of harmful interference to authorized services. Specifically, they may be able to operate at higher power in rural areas where there are a large number of TV channels available for white space use. In that situation, the risk of harmful interference to services operating in the TV bands is lower. Further, the rules contain detailed requirements for Mode II personal/portable devices that are designed to prevent harmful interference to authorized services. Specifically, they must: 1) be capable of determining their position to within 50 meters; 2) re-check their position every 60 seconds; 3) access a database to determine the list of available channels at their location; and 4) re-check the database whenever they move at least 100 meters from their last location.

53. We seek comment on whether we should permit personal/portable devices to operate at higher power in rural areas. If so, what should be the maximum power at which they can operate?[80] Should we limit higher power personal/portable devices to certain types of applications? If so, what applications? If we were to allow personal/portable devices to operate at higher power, would we need to adopt any additional requirements to prevent harmful interference to authorized services? If so, what requirements? For example, should personal/portable devices be required to comply with larger separation distances from authorized services than fixed devices operating at comparable power levels?

(iv) Channel bonding and out-of-band emission limits

54. White space devices must comply with a three part out-of-band emission limit. First, they must comply with a power limit (conducted for fixed devices and EIRP for portable devices) in the

[76] *See infra* para. 64-67.

[77] *See* 47 C.F.R. § 15.709(a).

[78] *See White Spaces Second MO&O,* 25 FCC Rcd at 18694, para. 78.

[79] *Id.*

[80] Personal/portable white space devices with a source-based time-average output power greater than 20 milliwatts are subject to routine evaluation for compliance with RF safety requirements. *See* 47 C.F.R. § 15.709(d).

television channels immediately adjacent to the channel in which the device operates.[81] Second, they must comply with the Section 15.209 radiated emission limits at frequencies beyond the television channels immediately adjacent to the channel in which the white space device is operating.[82] Third, they must comply with stringent out-of-band emission limits on channels 36 through 38.[83]

55. We note that the current out-of-band emission rules were written with the assumption that a white space device would transmit on a single six megahertz TV channel and meet the appropriate out-of-band emission limits at all frequencies outside of this single channel. However, a white space device could be designed to use two or more channels simultaneously to increase its transmission bandwidth and maximum data rate. A device could use multiple non-contiguous channels, *i.e.* channel aggregation, or could use multiple contiguous channels, *i.e.* channel bonding. There is no prohibition in the rules on the use of multiple channels by a white space device. In fact, the rules already implicitly allow the use of multiple channels by a single device since they specify the maximum power limits per six megahertz of bandwidth, indicating that a device may use multiple six megahertz channels.[84] However, because the rules do not consider cases where a white space device transmits on multiple channels simultaneously, we believe that the current out-of-band emission rules in Section 15.709(c) could be modified so that users could better make use of the efficiencies associated with channel aggregation and channel bonding. Channel aggregation and channel bonding will allow the development of devices that transmit at higher data rates, thus making higher speed equipment available to consumers.[85]

56. We, therefore, propose several rule changes with respect to channel bonding. We propose to modify Section 15.709(c)(1) to specify that the adjacent channel emissions limits do not apply within an adjacent channel that is being used by the same white space device, since in such cases there would be no TV station or other authorized service to protect on the adjacent channel; that is, to operate on two adjacent channels, a device would need to receive a message from a white space database that both channels are available at its location. Instead, we propose to apply these limits within the six megahertz bands immediately above and below the edges of the band of contiguous channels used by the white space device. We also propose to require that a device must meet the Section 15.209 limits at frequencies more than six megahertz above and below the edges of the highest and lowest channels used in the device, except as discussed below. We further propose to apply these requirements to fixed devices that operate centered on the boundary of two channels as proposed above, since that is a form of channel bonding. We seek comment on these proposals.[86] In particular, we seek comment on whether the white space databases will need to make any adjustments to accommodate channel bonding as proposed. Would programming changes be necessary or should the logic to bond channels reside solely within a

[81] *See* 47 C.F.R. § 15.709(c)(1).

[82] *See* 47 C.F.R. § 15.709(c)(3).

[83] *See* 47 C.F.R. § 15.709(c)(4). *See infra*. para. 128 for proposals regarding emission requirements for channels 36 through 38.

[84] *See* 47 C.F.R. §§ 15.709(a)(1) and (2).

[85] In February 2014, IEEE published IEEE 802.11af 2013, a global standard for wireless local area networks using white space channels. The standard supports bonding and aggregation of up to four channels to provide higher data rates. *See* www.standards.ieee.org.

[86] As examples of our proposals, if a fixed white space device were to operate on channels 22 and 23 simultaneously, it would have to comply with the adjacent channel emission limits on channels 21 and 24, and the Section 15.209 limits below channel 21 and above channel 24. If a fixed device were to operate on the boundary between channels 22 and 23, it would have to comply with the adjacent channel emission limits from the middle of channel 21 to the middle of channel 22 (six megahertz), and from the middle of channel 23 to the middle of channel 24 (six megahertz). It would also have to comply with the Section 15.209 limits below the middle of channel 23 and above the middle of channel 24.

device based on the list of available channels obtained from the white space database. How easily can existing devices accommodate these changes or would new devices need to be designed?

57. With respect to channel aggregation, we propose to modify Section 15.709(c)(2) to indicate that when a white space device transmits on multiple non-contiguous channels simultaneously, it must comply with the adjacent channel emission limits in the six megahertz bands above and below each of the single channels or channel groups used by the white space device. In such cases, the white space device would have to comply with the Section 15.209 limits at frequencies outside of the channels used by the device and the six megahertz bands adjacent to the channels used by the device. We seek comment on this proposal.

58. *Adjacent channel emission levels.* In addition to our proposals to modify the adjacent channel emission rules to allow for channel bonding and aggregation, we are proposing to add emission limits for fixed devices operating at the proposed new power levels that are less than four watts EIRP. We are further proposing to correct the method of specifying the emission limits for fixed devices using a high gain (greater than 6 dBi) antenna.

59. In the *White Spaces Third MO&O,* the Commission decided to set the adjacent channel emission limit, measured in a 100 kHz bandwidth, as 72.8 dB below the maximum permitted power measured in a 6 MHz bandwidth.[87] This results in an adjacent channel conducted emission limit of -42.8 dBm for the maximum permissible one watt (30 dBm) conducted power for fixed devices. Because we are now proposing to define additional conducted power levels for fixed devices that are less than 30 dBm, we are proposing adjacent channel emission limits corresponding to these lower power levels. These proposed limits, shown in the table below, are calculated using the methodology in the *White Spaces Third MO&O.* We propose that a device that operates between two defined power levels must comply with the limit for the higher power level.

Conducted power limit (6 MHz)	**Adjacent channel emission limit (100 kHz)**
10 dBm (10 mW)	-62.8 dBm
14 dBm (25 mW)	-58.8 dBm
18 dBm (63 mW)	-54.8 dBm
22 dBm (158 mW)	-50.8 dBm
26 dBm (400 mW)	-46.8 dBm
30 dBm (1000 mW)	-42.8 dBm

60. We seek comment on the appropriateness of these limits. We recognize that we could simply adopt the -42.8 dBm level for all power levels, but by providing flexibility based on power, our rules will provide for lower power white space devices to operate closer to the TV contours than higher power devices.

61. Similarly, the rules in Section 15.709(c)(1)(i) do not compensate for fixed devices with antenna gains greater than 6 dBi where the device must operate by reducing its maximum conducted power by the amount in dB that the antenna gain exceeds 6 dBi.[88] In such situations, the adjacent channel emission limits also need to be reduced because they are calculated relative to the maximum conducted power (*i.e.,* 72.8 dB lower). We therefore propose to modify Section 15.709(c)(1)(i) to require that the adjacent channel emission limits for fixed devices be reduced in the same manner as the in-band power, *i.e.,* by the amount in dB that the antenna gain exceeds 6 dBi. This approach is consistent with the

[87] *See White Spaces Third MO&O,* 27 FCC Rcd at 3703, para. 29.

[88] *See* 47 C.F.R. § 15.709(a)(1).

methodology used to determine compliance with the power spectral density limit for fixed devices.[89] We seek comment on this proposal.

62. In light of the proposals above, we seek comment on whether we should relax the current adjacent channel emission limits. Are these limits difficult to meet and does the necessary filtering increase the cost of equipment?[90] Commenters advocating for less stringent adjacent channel emission limits are requested to provide proposals detailing different levels along with analysis showing the effect of TV reception, the potential interference to other authorized services in the band and any effect such changes would have on the required separation distance between white space devices and adjacent channel TV stations. For example, to compensate for less stringent out-of-band requirements we could increase the adjacent channel separation distances to TV station contours. What are the benefits of adopting such rules? And what would be the effect on the white space databases? Would devices need to transmit information regarding their out-of-band emission levels to the database to be used when calculating the list of available channels? Or could information regarding the capabilities of various devices reside in the database? How would such a scheme work? Another option would be to provide a range of adjacent channel emission limits with corresponding separation distances. We seek comment on this option and what benefits such flexibility would add. Or would the added complexity introduced to both devices and the database negate any potential benefits? Finally, we seek comment on the effect that less stringent adjacent channel emission limits would have on services and uses where there are no adjacent channel separation requirements, such as on wireless microphones or on TV stations adjacent to 40 milliwatt white space devices.

(v) Calculating the separation distances from a TV station contour

63. The rules require that white space devices protect defined service contours of analog and digital full service and low power television stations.[91] These contours are calculated using the methodology in Section 73.684 of the rules and the F(50,50) and F(50,90) curves contained in Section 73.699.[92] Under the current rules, fixed white space devices must operate outside the contours of co-channel and adjacent channel TV stations at the distances specified in the table in Section 15.712(a)(2). This table provides co-channel and adjacent channel separation distances for nine ranges of fixed device HAAT, up to a maximum of 250 meters.[93] Personal/portable devices that operate with an EIRP greater than 40 milliwatts, up to the maximum of 100 milliwatts, must comply with the co-channel and adjacent channel separation distances at the lowest HAAT in the table (*i.e.*, less than 3 meters).[94] Personal/portable devices operating at 40 milliwatts or less only need to comply with the co-channel separation distance at the lowest HAAT listed in the table.[95]

[89] *See* 47 C.F.R. § 15.709(a)(5)(i).

[90] These concerns had been raised in the earlier TVWS proceedings. *See White Spaces Third MO&O*, 27 FCC Rcd at 3701-3702, para. 23.

[91] *See* 47 C.F.R. § 15.712(a)(1).

[92] *Id.* The F(50,50) and F(50,90) curves are statistical models that the Commission uses to determine the distance from a transmit antenna to a specific field strength contour when the radiated transmit power and the antenna height above average terrain are known. They represent the statistical percentage of locations and times at which a signal will be at or above a specific level. For example, a signal level determined from the F(50,50) curves will be exceeded at 50% of locations 50% of the time.

[93] Fixed devices may not operate at locations where their HAAT would exceed 250 meters.

[94] *Id.*

[95] *Id.*

64. The Commission described the methodology it used to determine the table of separation distances in the *White Spaces Third MO&O*.[96] Specifically, the Commission calculated the distances assuming a fixed white space device with an EIRP of four watts.[97] It used a D/U signal ratio of 23 dB to protect co-channel TV reception, and -33 dB to protect adjacent channel TV reception.[98] The Commission assumed that a TV receive antenna within a TV station's protected service contour would have a front to back ratio of 14 dB as specified in the DTV planning factors of OET Bulletin 69.[99] Using these factors, it calculated the minimum required separation distances that a white space device must operate outside a TV stations' protected contour using the F(50,10) and F(50,50) curves over the range of antenna heights and distances at which these curves are defined.[100] For HAAT values below 30 meters and for contour distances of less than 1.5 kilometers where the F(50,50) and F(50,10) curves are not defined, the Commission used the TM 91-1 propagation model to calculate the required separation distances.[101]

65. We are proposing to amend the table of separation distances in Section 15.712(a)(2) to reflect the proposals above that would allow fixed device operation at a range of power levels below four watts EIRP. Requiring shorter separation distances for fixed white space devices with power levels below four watts will permit them to operate in more locations than the current rules allow, *i.e.*, closer to a television station service contour, since the current separation distances were based on the assumption that a fixed device always operates at the maximum power level. In addition, since the separation distances for personal/portable devices were also based on an EIRP of four watts, they are greater than necessary since personal/portable devices may operate with a maximum EIRP of 100 milliwatts, or 40 milliwatts if they are on a channel adjacent to an occupied channel. Because we are calculating separation distances for fixed devices at 40 milliwatts and 100 milliwatts EIRP, we propose to apply those separation distances, based on the lowest antenna HAAT, to personal/portable devices. This proposal will increase the number of locations where personal/portable devices may operate.

66. We note that the table of separation distances will increase in size due to the inclusion of additional power levels and therefore propose to split the table into two: one for co-channel and the other for adjacent channel separation distances. We also propose to add an entry to show which separation distances apply to personal/portable devices. The proposed co-channel separation distance table is as follows: [102]

[96] *See White Spaces Third MO&O*, 27 FCC Rcd at 3698-3700, para. 16-18.

[97] *See White Spaces Third MO&O*, 27 FCC Rcd at 3700, para. 18.

[98] *See White Spaces Third MO&O*, 27 FCC Rcd at 3699, para. 17.

[99] *Id.* The DTV planning factors are listed in *OET Bulletin No. 69, Longley-Rice Methodology for Evaluating TV Coverage and Interference*, February 6, 2004 at 10.

[100] *See White Spaces Third MO&O*, 27 FCC Rcd at 3698-3699, para. 16 and 47 C.F.R. § 73.699, Figures 9, 9a, 10, 10a, l0b and 10c. Interfering signal contours are generally calculated using the F(50,10) curves. However, the F(50,10) curves are undefined at distances less than 15 kilometers, so the F(50,50) curves are used to compute interfering contours at distances from 1.5 to 15 kilometers. The F(50,50) curves are undefined at distances less than 1.5 kilometers, so TM-91-1 is used for these distances.

[101] *See White Spaces Third MO&O*, 27 FCC Rcd at 3698, para. 16 and *Propagation in Suburban Areas at Distances Less than Ten Miles*, FCC/OET TM-91-1, January 25, 1991, http://transition.fcc.gov/oet/info/documents/technical/tm91-1.pdf.

[102] *See supra* footnote 100.

Antenna height above average terrain of unlicensed device	Required separation distances in kilometers from co-channel digital or analog TV (full service or low power) protected contour					
	16 dBm (40 mW)	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Personal/portable	1.3	1.7	N/A	N/A	N/A	N/A
Less than 3 meters	1.3	1.7	2.1	2.7	3.3	4.0
3-Less than 10 meters	2.4	3.1	3.8	4.8	6.1	7.3
10-Less than 30 meters	4.2	5.1	6.0	7.1	8.9	11.1
30-Less than 50 meters	5.4	6.5	7.7	9.2	11.5	14.3
50-Less than 75 meters	6.6	7.9	9.4	11.1	13.9	18.0
75-Less than 100 meters	7.7	9.2	10.9	12.8	17.2	21.1
100-Less than 150 meters	9.4	11.1	13.2	16.5	21.4	25.3
150-Less than 200 meters	10.9	12.7	15.8	19.5	24.7	28.5
200-250 meters	12.1	14.3	18.2	22.0	27.3	31.2

67. The proposed adjacent channel separation distance table is as follows. There is no entry for 40 milliwatt (16 dBm) devices because fixed and personal/portable devices operating at this power level would not have to meet adjacent channel separation distance requirements. This proposed table would correct an error in the current rules for the separation distances at the four watt power level.[103] We determined that the current separation distances were inadvertently calculated without considering the 14 dB receive antenna front-to-back ratio that the Commission previously stated it would use in determining these distances. Therefore, they are larger than they would be if the receive antenna directivity were taken into account. All of the distances in the following table were calculated using the 14 dB receive antenna front-to-back ratio.[104]

Antenna height above average terrain of unlicensed device	Required separation distances in kilometers from adjacent channel digital or analog TV (full service or low power) protected contour				
	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Personal/portable	0.1	N/A	N/A	N/A	N/A
Less than 3 meters	0.1	0.1	0.1	0.1	0.2
3-Less than 10 meters	0.1	0.2	0.2	0.2	0.3
10-Less than 30 meters	0.2	0.3	0.3	0.4	0.5
30-Less than 50 meters	0.3	0.3	0.4	0.5	0.7
50-Less than 75 meters	0.3	0.4	0.5	0.7	0.8
75-Less than 100 meters	0.4	0.5	0.6	0.8	1.0
100-Less than 150 meters	0.5	0.6	0.8	0.9	1.2
150-Less than 200 meters	0.5	0.7	0.9	1.1	1.4
200-250 meters	0.6	0.8	1.0	1.2	1.5

[103] *See* 47 C.F.R. § 15.712(a)(2).

[104] Calculations for this table are based on TM-91-1.

68. We seek comment on this proposal. In particular, we seek comment on whether these separation distances will provide adequate protection to co-channel and adjacent channel TV stations at the power levels and antenna HAATs listed. Parties that suggest changes to these distances should provide a technical analysis explaining their rationale. We also seek comment on the validity of the calculated prediction distances at low power levels (*e.g.,* 40 milliwatts) and high HAAT. Is a 40 milliwatt white space device capable of causing interference to co-channel television stations at the calculated distances (over 12 kilometers at the maximum HAAT)? Do we need to consider the HAAT of low power white space devices?

69. In addition, we note that some parties have informally advised the Commission that they believe the Commission's current table of separation distances is overly conservative in some cases, and therefore limits the amount of white space spectrum available for unlicensed devices. We therefore seek comment on whether we should make additional rule changes with respect to the following issues.

70. *Alternative propagation models for calculating interference.* As discussed above, the Commission requires the use of the propagation curves in the rules for calculating the protected service contours of TV stations.[105] Digital TV service contours are calculated using the F(50,90) curves, and analog TV service contours are calculated using the F(50,50) curves. Additionally, the table of separation distances between TV station service contours and white space devices was calculated using the F(50,10) and F(50,50) curves over the range where they are defined. Some parties have suggested that the Commission use other propagation models such as the Longley-Rice methodology or the Hata models to determine where white space devices could operate without causing interference to TV reception.[106]

71. In seeking comment on alternative propagation models, we note that we are not proposing any changes to the method of calculating the protected service contours of TV stations using the F(50,90) and F(50,50) propagation curves. This is the method specified in the Part 73 rules for calculating TV service contours, and we believe it is appropriate to require unlicensed white space devices to follow the same method for determining protected TV contours. In addition, we do not believe the use of the Longley-Rice methodology would be appropriate for determining whether a white space device would cause interference to TV reception as it is computationally intensive and would significantly slow the determination of available TV channels by the white spaces databases.

72. With regard to the calculation of distances in the separation table, the Commission used a combination of its own propagation curves and the TM 91-1 to calculate separation the distances. We recognize that this may not be the only appropriate methodology for calculating separation distances. We therefore seek comment on whether the Commission should consider using other propagation models that could give a more accurate indication as to whether interference is likely occur to TV reception. For example, are the Hata models appropriate for making these calculations? Are there other models that could be used? Could the separation distances calculated using other models provide a high degree of confidence that interference to TV would not occur? How would the separation distances obtained with an alternative model differ from those calculated with the methodology previously used by the Commission? Would the differences in these distances increase the amount of available white space, and if so, by how much?

73. *Directional antenna use by white space devices.* As discussed above, the Commission considered the directivity of TV receive antennas in developing the table of separation distances for white space devices and assumed a 14 dB front-to-back ratio. Because a TV receive antenna located just inside the protected contour of a TV station would be pointed toward the TV station, it would therefore be pointed away from a white space device located just outside the contour. However, the Commission did

[105] *See supra* para. 64.

[106] The Hata models are widely used to predict the behavior of cellular transmissions in urban, suburban and open areas. They are valid over the frequency range of 150 to 1500 MHz. OET Bulletin 69 provides guidance on the implementation and use of the Longley-Rice methodology.

not consider the directivity of a white space transmit antenna in developing the table of separation distances and assumed an omnidirectional transmit antenna with a transmit power of four watts EIRP. The Commission stated that it was desirable to minimize the complexity for compliance while providing assurance that TV stations would be adequately protected.[107] Likewise, when the Commission modified the table of protection distances in the *White Spaces Third MO&O* to allow white space device operation at higher antenna HAAT, it did not consider the directivity of the white space device transmit antenna.[108]

74. The directional pattern of a fixed white space device transmit antenna could affect the identification of available channels. In the case where the transmit antenna points away from a TV station that the white space device must protect, the effect would be that the white space device has a lower EIRP in the direction of the TV station. Under such situations it may be possible to reduce the required separation distance between the white space device and the protected contour of the co-channel and adjacent channel TV stations. This change could increase the number of locations where a fixed device could operate. However, there are a number of factors that have to be considered to ensure that white space devices provide adequate protection to TV stations. For example, antenna pattern information for fixed white space devices, including the orientation of the antenna as installed in the field would be needed. This information would then have to be stored in some format in the white spaces databases. We would also have to develop appropriate protection criteria for a fixed white space device that uses a directional antenna. For example, we may need to specify the minimum arc size over which the power must be reduced in the direction of a protected TV station, since reduced power over a very narrow arc may not provide adequate protection.

75. Accordingly, we seek comment on whether we should modify the rules to consider the directional antenna pattern for fixed space devices. If so, how can we assure the accuracy of antenna pattern information? Should we require the database to store detailed information, such as the antenna gain at one degree intervals, or could we define several simpler generic patterns that approximate commonly used antennas? Should the database be responsible for storing various antenna patterns or should they be transmitted to the databases by the device at power up the first time it requests a channel list? How would we specify the appropriate protection criteria for white space devices using directional antennas? For example, could the protection distances proposed above for multiple power levels be used in conjunction with directional antenna information to protect TV reception? What other criteria would we need to specify?

(vi) Location accuracy

76. A fixed or Mode II personal/portable device must be able to determine its position and provide that information to the white spaces database, which then determines whether the device meets the minimum required separation distances from protected services. The rules currently require that a fixed or Mode II personal/portable device incorporate a geo-location capability that can determine its geographic coordinates to within ±50 meters.[109] GPS is capable of determining coordinates to this level of accuracy, but there may be circumstances where it is not possible to receive a GPS signal, such as indoors or at outdoor locations where there are obstacles such as buildings and trees. We seek comment on whether there are other location methods besides GPS that can determine a white space device's location to within ±50 meters. If so, what are these methods? We also seek comment on whether devices need to determine their position with this level of accuracy to protect authorized services.

[107] *See White Spaces Second Report and Order,* 23 FCC Rcd at 16870, para. 181.

[108] *See White Spaces Third MO&O*, 27 FCC Rcd at 3700, para. 18. The Commission used an EIRP of four watts and assumed an omnidirectional antenna in calculating the separation distances.

[109] Fixed devices may also have their geographic coordinates determined and programmed by a professional installer. *See* 47 C.F.R. § 15.711(b)(1).

77. In addition, we seek comment on whether we should allow white space devices to use geo-location methods that are less accurate than the current rules require, provided they provide the same level of protection to authorized services. If so, what level of accuracy should be required? How could we assure that devices with a lower level of geo-location accuracy do not cause interference to authorized services? Could we require white space devices to operate at greater distances from authorized services to offset the increased uncertainty in a device's location?[110] If so, should we require all white space devices to meet increased separation distances, or only those with less accurate geo-location capabilities? If we allow only some devices to use a less accurate geo-location method, how could the white space databases take into account a device's geo-location accuracy in determining the list of available channels? The accuracy of some geo-location technologies, such as GPS, is well established, but this may not be the case for geo-location technologies, some of which may be proprietary, that manufacturers wish to use for white space devices. How should the location accuracy of a device be tested? Should manufacturers be required to certify the accuracy of the location technology incorporated into a device as part of the equipment certification process? Are there any other approaches that would allow white space devices to incorporate less accurate geo-location capabilities while still protecting authorized services?

2. 600 MHz guard bands

78. The 600 MHz Band includes a guard band between the wireless downlink services band and the TV band that will vary in size and frequency depending on the amount of spectrum recovered in the auction. There are three possibilities for the size of this guard band: 11 megahertz, nine megahertz and seven megahertz. However, if exactly 84 megahertz of spectrum is recovered in the auction, channel 37 plus the three megahertz guard band that protects the WMTS and RAS on channel 37 will serve as the guard band between the wireless downlink services band and TV band. Therefore, there would not be a separate guard band between the TV band and the wireless downlink services band that could be made available for unlicensed use as there would be under all other spectrum recovery scenarios.

79. The Spectrum Act states that the Commission may permit unlicensed use of the guard bands,[111] and stipulates that (a) unlicensed use shall rely on a database or subsequent methodology as determined by the Commission, and (b) the Commission may not permit any use of a guard band that the Commission determines would cause harmful interference to licensed services.[112] The term "guard band" includes the duplex gap, and thus the Spectrum Act's requirements discussed here apply equally to the duplex gap.[113] Fixed and personal/portable white space devices clearly satisfy the Act's stipulation that "unlicensed use rely on a database" since our rules already require that these devices access a database to identify vacant TV channels in their area that meet the interference avoidance requirements of our rules, and they may only operate on the vacant channels that the database identifies.[114] We are proposing in this Notice to expand the information in the white space databases to include 600 MHz Band services that will be entitled to interference protection. The Commission's Part 15 rules already require that unlicensed devices not cause harmful interference to and must accept interference from authorized users.[115] In this Notice, we propose technical and operational rules for white space devices in these bands that will satisfy the requirements of both the Spectrum Act and our rules.

[110] As an example, if we decreased the allowable location accuracy from ±50 meters to ±250 meters, we would have to increase the minimum required separation distances from authorized services by 200 meters (0.2 kilometers).

[111] Spectrum Act § 6407 (c).

[112] Spectrum Act § 6407(d), (e).

[113] *See Incentive Auction R&O,* 29 FCC Rcd at 6613-6614, para. 97 & n. 322.

[114] *See* 47 C.F.R. § 15.711.

[115] *See* 47 C.F.R. § 15.5(b).

80. We propose to allow fixed and personal/portable devices to operate in the guard bands and duplex gap. The current white space rules provide for two types of personal/portable devices. Mode II devices, like fixed devices, incorporate geo-location and database access capabilities which facilitate their ability to meet the required separation distances at their operating location, while Mode I devices do not.[116] Instead, Mode I devices must obtain a list of available operating channels from a fixed or Mode II personal/portable white space device that is within their transmission range and may only operate so long as they can receive a controlling signal from the fixed or Mode II device.[117] Because Mode I devices are limited to a maximum EIRP of 100 milliwatts, or 40 milliwatts EIRP if they are adjacent to an occupied TV channel, they must operate relatively close to the device that provides the list of available channels.[118] Thus, the actual location of a Mode I device is different from the device providing it a list of available channels. We seek comment from parties contemplating use of Mode I devices on the types of functions and applications they envision for these devices, and the typical and maximum operating range envisioned for these devices. We also seek comment on any studies that address the interference potential of Mode I devices. We further seek comment on whether we should we limit operation in these bands to fixed and Mode II devices only to ensure protection to authorized services in these bands. Alternatively, should we also allow Mode I devices to operate in these bands, but increase the separation distances to offset the uncertainty in the devices' locations? In addition, we seek comment on whether any limitations on the types of devices in the duplex gap would be necessary after the 39 month transition period when all television stations are moved from the spectrum that is designated as the duplex gap.[119] We ask commenters to address the effect that any limitations on the permissible types of devices in these bands may have on the development of white space services and applications.

81. A white space device operating in a guard band would have to protect two different authorized services on frequencies immediately adjacent to the guard band. Broadcast television will operate in the lower adjacent spectrum, and licensed wireless downlink services will operate in the upper adjacent spectrum. The current rules permit operation of personal/portable white space devices on a channel that is immediately adjacent to an occupied TV channel, provided the device power is reduced to 40 milliwatts. In this Notice, we are proposing to also allow fixed devices to operate on a channel immediately adjacent to an occupied TV channel at the same 40 milliwatt power level, and we are proposing to allow fixed devices to operate at 4 watts EIRP three megahertz away from an occupied TV channel.[120] However, we do not currently have rules for white space devices that address operation on a channel immediately adjacent to wireless downlink services. Therefore, we must develop rules to protect wireless downlink services adjacent to the guard bands, that is, protecting the ability of handsets to receive signals from a base station. The analysis we discuss below applies equally to the duplex gap because white space devices operating in the duplex gap must also protect wireless downlink services in adjacent frequency bands. We propose to protect wireless handsets by limiting the power of white space devices in the guard bands and duplex gap, and by requiring a buffer between the edge of the channel used by the white space device and wireless downlink services. The proposed approach ensures against harmful interference to licensed services and promotes the public interest and benefits inherent in maximizing spectrum use.

82. We consider separately the guard band sizes under each of the spectrum recovery scenarios. In each case, we assume that the white space devices could be either fixed or

[116] *See* 47 C.F.R. § 15.703(e)-(f).

[117] *See* 47 C.F.R. § 15.711(b)(iv)(D).

[118] *See* 47 C.F.R. § 15.709(a)(2).

[119] The duplex gap will be the same nationwide regardless of any market variation in the final band plan. However, the size and frequency range of the guard band between wireless downlink spectrum and television spectrum will not be uniform nationwide if there is market variation in the final band plan.

[120] *See supra* para. 35 and 37.

personal/portable, that they will transmit over a six megahertz wide bandwidth, that they could be operating at 40 milliwatts immediately adjacent to an occupied TV channel, and that their operation will be controlled through use of a database. The power limits and frequency separation needed to protect Part 27 wireless services will alter the assumptions for white space devices' power limits and bandwidth in each case and, ultimately, how white space devices could use the guard bands. Based on our preliminary analysis, discussed below, we also assume a three megahertz frequency separation between the white space devices and the handset receive band to offset a worst case interference distance of less than seven meters. Our preliminary analysis is based on conservative assumptions, and intended as a starting point for purposes of developing a record on these issues. There are numerous ways to conduct interference analyses and each depends on a number of assumptions, such as filter characteristics, the propagation model and miscellaneous losses (*e.g.*, body loss, polarization mismatch, etc.).[121] In addition, we note that there is a lack of real world testing between white space transmitters and LTE receivers, and we invite manufacturers and other interested parties to submit data and test results to the record in this proceeding. Nevertheless, we believe that under reasonable conditions white space devices can operate in the duplex gap and guard bands without causing harmful interference to LTE receivers.

83. In the Incentive Auction proceeding, Qualcomm has submitted analyses purportedly showing that unlicensed use in the guard bands and duplex gap is not feasible without extremely large frequency separations from licensed services[122] and Broadcom has submitted analyses to the contrary.[123] Both parties' analyses rely on the 3GPP industry standards which define the onset of blocking interference at more than a five percent degradation in throughput.[124] While we do not go into the merits of these analyses here, our preliminary analysis also relies on the 3GPP standard for frequencies closest to the 600 MHz band as a starting point. However, we note that these standards contain minimum specifications and equipment used by wireless carriers may significantly exceed these minimums.[125]

84. This standard sets a floor of -97 dBm for LTE receiver sensitivity and an adjacent channel selectivity of 33 dB.[126] We believe it is reasonable to assume at least 25 dB of additional loss over any path loss to include an additional 10 dB for adjacent channel selectivity[127] plus an additional 15 dB of loss due to a combination of obstructions, body loss and antenna polarization mismatch, etc.[128] We further assume a minimum of three megahertz frequency separation between white space devices and LTE receivers, resulting in a seven dB pass band filter attenuation. We calculate the required separation distances using the TM 91-1 model. In doing so, we assume a white space device with a maximum EIRP of 40 milliwatts and an antenna height of three meters, which is the lowest antenna height the Part 15 rules specify for white space devices. We also assume a 1.5 meter LTE handset height, which we believe is representative of typical wireless handset use. Based on these assumptions, our calculations show a worst case interference distance of less than seven meters.

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[121] *See Incentive Auction R&O,* 29 FCC Rcd at 6685-6686, para. 272.

[122] *Id.*

[123] *Id.*

[124] *See* 3GPP TS 36.10 at Section 7.6.1.1.

[125] *See e.g., 3GPP TS 36.10, 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception.* ("3GPP TS 36.10").

[126] *Id.*

[127] While this is 10 dB greater than the 3GPP standard, information in the record of the Incentive Auction proceeding indicates that this is a reasonable assumption. *See* Broadcom March 4, 2014 *ex parte* filing in GN Docket No. 12-268, attachment at 2.

[128] *See Advanced Wireless Service Interference Tests Results and Analysis*, Federal Communications Commission Office of Engineering and Technology, October 10, 2008.

85. While we recognize there may be concerns about the potential for interference to wireless handsets at seven meters, we emphasize that our preliminary analysis is a static, worst case analysis that does not consider many other factors that would tend to reduce this distance. For example, it does not take into account the behavior of deployed networks which manage operating channels and handset power in noisy conditions to ensure the best possible connection, nor does it take into account the probabilistic nature of the conditions that lead to an interference situation. For example, if an LTE handset is operating at the edge of coverage on a frequency at the edge of the band closest to the guard band in very close proximity to a white space device, the white space device, which must incorporate transmit power control, will limit its operating power to the minimum necessary for successful communication, so its power will often be less than the maximum on which we based our preliminary analysis.[129] Additionally analyses that are based on the onset of blocking may not rise to the threshold of harmful interference if one considers transmission protocols and modulation schemes which are designed to facilitate operations when conditions are less than ideal by incorporating coding, bit interleaving, and retransmission events when necessary. Finally, we note that based on device and spectrum usage evolution, manufacturers have incorporated a range of unlicensed and licensed bands into devices and we expect that this will be the case with white space devices too. Given that there is some time prior to networks being deployed, we expect manufacturers to improve filter technology and designs to ensure a minimum potential for harmful interference.

86. In the guard band scenarios discussed below, we are proposing to allow white space devices to generally operate in the guard bands and the duplex gap at a maximum power level of 40 milliwatts and a three megahertz frequency separation from the handset receive band. We seek comment on this proposal. We invite comment on the assumptions we make for wireless broadband service to the public by both licensed services and unlicensed devices. Parties that disagree are requested to provide their own assumptions, including what frequency separations are needed to protect wireless services from harmful interference, along with justification and analysis. We also ask those parties who advocate against use of the guard bands for unlicensed use to provide details on what services they believe could operate there and under what operating conditions, so that valuable spectrum does not lay fallow. Parties should address how white space use in each scenario below would satisfy the Spectrum Act's requirement that no harmful interference is caused to licensed services.

87. *Eleven megahertz guard band.* Fixed and personal/portable white space devices could operate in the lower six megahertz portion of the guard band, adjacent to broadcast TV spectrum, leaving a five megahertz separation to wireless downlink services at the upper portion of the band. In this case, under the existing white space rules, the white space devices could operate at 40 milliwatts adjacent to an operating TV station and 100 milliwatts if the adjacent station is vacant. We propose that white space devices be permitted to operate at 40 milliwatts so long as it maintains a three megahertz separation distance from the lower edge of the band where handsets will receive. Is the 40 milliwatt power level useful for unlicensed devices? Should we permit operation up to 100 milliwatts if the white space device can maintain 4 or 5 megahertz separation from the handset receive band and satisfy the conditions for protecting TV reception as well as the necessary distance separation from adjacent base stations? Would a different power level be used?

88. *Nine megahertz guard band.* We propose that fixed and personal/portable white space devices could operate at 40 milliwatts in the lower six megahertz portion of the guard band adjacent to broadcast TV spectrum, leaving three megahertz separation to wireless services. As we describe above, we believe this would adequately protect handsets from harmful interference while providing an opportunity for unlicensed devices to operate. We seek comment on this proposal and ask if there are other operating scenarios for the nine megahertz guard band that could be adopted to provide for unlicensed device use while protecting wireless handsets.

[129] *See* 47 C.F.R. § 15.709(a)(3).

89. *Seven megahertz guard band.* In this case, if fixed and personal/portable white space devices operated adjacent to the broadcast TV band at the lower end of the guard band, there would be only one megahertz separation to wireless downlink services at the upper end of the band. Under this situation, could we provide for 40 milliwatt white space device operation? Alternatively, could white space devices operate at reduced power with only one megahertz of separation from broadband downlinks and still protect those operations? What power level and separation distance would provide for such operation? Another option is to restrict white space devices to a four megahertz bandwidth to maintain three megahertz separation from broadband downlinks. Is the current white space equipment capable of such operation? Is there a market for operating in this manner as it would necessitate slower data rates? What parameters in terms of power and separation distance would be required to ensure operation of all services? We seek comment the appropriate power limits and frequency separations for white space devices to protect both TV and wireless services in this case.

90. *Three megahertz plus channel 37.* In the case where 84 megahertz of spectrum is recovered in the auction, the guard band between wireless downlink services and TV spectrum will consist of channel 37 plus a three megahertz guard band. The purpose of the three megahertz guard band is primarily to protect the WMTS and RAS on channel 37 from interference from wireless downlink services, but it also would protect wireless downlink services from harmful interference from white space devices operating on channel 37. If we determine that less than three megahertz separation is needed to protect Part 27 services, could fixed or personal/portable devices make use of any portion of this three megahertz band? We seek comment on whether any types of low power, narrowband devices could use this guard band without causing harmful interference to licensed services in the adjacent bands. Is so, what types of devices and at what power levels and bandwidths?

3. 600 MHz duplex gap

a. Types of permitted operations

91. The 600 MHz Band includes a duplex gap of 11 megahertz between the wireless uplink and downlink services bands to prevent harmful interference between them.[130] The frequency range of this duplex gap will depend on the outcome of the incentive auction, but the size of the band will be the same nationwide, regardless of whether there is any market variation in the amount of spectrum recovered in certain areas. Wireless downlink services will operate in the lower adjacent spectrum to the duplex gap, and wireless uplink services will operate in the upper adjacent spectrum to the duplex gap. In the *Incentive Auction R&O,* the Commission concluded that the public interest would be served by allowing broadcasters and cable programming networks to use wireless microphones on a licensed basis in a portion of the duplex gap and to obtain interference protection from unlicensed devices at specified times and locations, on an as-needed basis.[131] The Commission decided that it would in a future proceeding examine how best to provide access to a portion of the duplex gap by licensed wireless microphone users, while also ensuring that unlicensed users of the duplex gap can make use of this spectrum to provide broadband services.[132] It anticipated that the duplex gap could be partitioned such that six megahertz would be available for unlicensed broadband devices to operate under the existing white space rules for 40 milliwatt personal/portable devices, and four megahertz adjacent to the wireless downlink services band would be available for licensed wireless microphone operations.[133] This approach would leave one megahertz available for use as a buffer to protect licensed wireless services.

92. There are several different ways to divide the duplex gap to accommodate wireless microphones and white space devices, although there are trade-offs with each one. As an initial proposal,

[130] The duplex gap is a guard band between 600 MHz uplink and downlink services.

[131] *See Incentive Auction R&O,* 29 FCC Rcd at 6703-6704, para. 314.

[132] *Id.*

[133] *Id.*

we propose to allow unlicensed operations, including both fixed and personal/portable white space devices and unlicensed microphones, to operate in the six megahertz band segment at the upper end of the duplex gap. We also propose to allow licensed wireless microphones to operate in the four megahertz band segment immediately below this six megahertz segment. We further propose to use the remaining portion of the duplex gap spectrum to provide a one megahertz frequency separation between licensed wireless microphones and wireless downlinks in the spectrum below the duplex gap, thereby providing an additional margin of interference protection to mobile handsets. Thus, licensed wireless microphones would be able to operate in the band between one and five megahertz above the lower end of the duplex gap, and unlicensed devices, including wireless microphones, would be able to operate in the band from five to eleven megahertz above the lower end of the duplex gap.

93. We believe that providing a six megahertz band for unlicensed devices is appropriate since that is the minimum size that many parties indicated is useful for unlicensed uses, and it is consistent with the current fixed and personal/portable white space rules.[134] Additionally, we believe that a four megahertz segment of the duplex gap will be useful for licensed wireless microphones that are used on short notice since it will be available nationwide. Manufacturers have indicated that as many as 16 wireless microphones can operate in a six megahertz channel, and while we are proposing a smaller channel size here, manufacturers should still be able to get a substantial number of microphones to operate in it.[135]

94. We are not proposing to provide a guard band between licensed wireless microphones and unlicensed white space devices, since white space devices must comply with low emission limits outside their channel of operation. Also, wireless microphones that operate in this spectrum use narrow (no greater than 200 kilohertz) bandwidths and many can operate close together within a six megahertz channel, so we expect their receivers to have good selectivity. Thus, we believe that there is a low risk of unlicensed white space devices causing interference to licensed wireless microphones in the adjacent band.

Wireless downlink spectrum (handsets)	Buffer (1 MHz)	Licensed wireless microphones (4 MHz)	White space devices and unlicensed wireless microphones (6 MHz)	Wireless uplink spectrum (base stations)

Duplex gap with 1-4-6 megahertz split

95. We seek comment on this proposal for partitioning of the duplex gap between licensed wireless microphones and unlicensed white space devices and unlicensed wireless microphones. Our proposed split maximizes the frequency separation between a six megahertz segment of the duplex gap for unlicensed use and wireless downlink spectrum, thereby reducing the risk of interference to those adjacent band services as required by the Spectrum Act, but it does not provide any frequency separation between the six megahertz unlicensed segment and wireless uplink spectrum used for base stations. The one megahertz separation at the lower end of the duplex gap provides an additional margin of interference protection to wireless handsets from licensed wireless microphones. We also seek comment on other possible partitioning scenarios and whether other approaches would provide interference protection to adjacent wireless uplink and downlink services while maximizing use of the spectrum. For example, should the one megahertz buffer be located at the upper end of the duplex gap? Is it needed to provide increased interference protection to wireless uplink spectrum from unlicensed operations operating in a six megahertz bandwidth? If so, how would this scenario affect the operation of licensed microphones in the lower duplex gap? Could licensed wireless microphones operate in the lower four megahertz portion of the duplex gap without a one megahertz buffer to separate them from wireless downlink spectrum? Would that approach increase the interference risk to either licensed wireless microphones or wireless downlink spectrum? Do we need a buffer at both ends of the duplex gap to protect both wireless uplink and downlink services? If so, what size buffers are appropriate and how would increasing the number or

[134] *See Incentive Auction R&O,* 29 FCC Rcd at 6613-6614, para. 97.

[135] *See Incentive Auction R&O,* 29 FCC Rcd at 6699, para. 306.

size of those buffers affect the available spectrum for unlicensed white space and wireless microphone users? For example, if we were to require a one megahertz buffer at each end of the duplex gap, should we allow only three megahertz of spectrum for licensed wireless microphones at the lower end of the duplex gap and six megahertz for white space devices and unlicensed wireless microphones at the upper end? Parties should address how white space use in each scenario above would satisfy the Spectrum Act's requirement that no harmful interference is caused to licensed services.

b. Technical rules for fixed and personal/portable operations

96. We propose to allow fixed and personal/portable white space devices to operate in the six megahertz segment of the duplex gap described above with a power level of 40 milliwatts. This is consistent with our proposal to allow 40 milliwatt white space device operation in the guard bands. We do not believe that a buffer is necessary to protect wireless uplink services above the duplex gap since the receivers of interest are those in base stations, and we expect there to be a greater separation distance from base station receivers than from mobile receivers, thus reducing the likelihood of harmful interference. We seek comment on this proposal. Is the 40 milliwatt power level useful for unlicensed devices? Would the proposed power level and frequency separation adequately protect wireless uplink services in the upper adjacent band? Do we need to limit the HAAT of fixed devices to minimize the possibility of interference to licensed services outside the duplex gap and licensed wireless microphones within the duplex gap?

4. Channel 37

97. The WMTS is used for remote monitoring of patients' vital signs and other important health parameters (*e.g.,* pulse and respiration rates) inside medical facilities. WMTS includes devices that transport the data via a radio link to a remote location, such as a nurses' station, which is equipped with a specialized radio receiver. WMTS operates licensed stations on three bands, including 608-614 MHz (channel 37) in the UHF band. Health care institutions are required to register their locations and coordinate the use of all three bands through the American Society for Health Care Engineering (ASHE) of the American Hospital Association – the designated frequency coordinator– prior to commencing operation.[136] This process minimizes the potential of WMTS users from causing harmful interference to, and receiving harmful interference from, other WMTS devices.

98. RAS is a receive-only service that uses highly sensitive receivers to examine and study radio waves of cosmic origin. There are twelve RAS telescopes that have been using channel 37 or plan to use channel 37 in the near future.[137] Of them, ten comprise the National Radio Astronomy Observatory's (NRAO's) Very Long Baseline Array (VLBA), which are distributed in several locations in the United States and its territories, and collect simultaneous observations that are combined to emulate a single telescope 5000 miles in diameter.[138] The remaining two telescopes are single dish instruments.[139] The Commission protects RAS from in-band harmful interference by imposing field strength limits on WMTS and requiring coordination of WMTS use within certain distances of RAS observatories.[140]

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[136] *See Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Medical Telemetry Service*, ET Docket 99-255, Order, 16 FCC Rcd 4543 (2001).

[137] *See Incentive Auction R&O,* 29 FCC Rcd at 6688-6689, para. 280.

[138] These stations operate together as a large interferometer. Detailed information on the VLBA is available at: http://www.vlba.nrao.edu/astro/obstatus/current/node5.html. The VLBA telescopes are located in Mauna Kea, Hawaii, Owens Valley, California, Brewster, Washington, Kitt Peak, Arizona, Pie Town, New Mexico, Fort Davis, Texas, Los Alamos, New Mexico, North Liberty, Iowa, Hancock, New Hampshire, St. Croix, Virgin Islands.

[139] Two large radio telescopes operate at Green Bank West Virginia and Arecibo, Puerto Rico.

[140] *See* 47 C.F.R. §§ 95.1115(a)(1) and 95.1119.

99. In the *Incentive Auction R&O,* the Commission decided to permit unlicensed operations on channel 37, subject to the development of the appropriate technical parameters for such operations to protect the WMTS and RAS from harmful interference.[141] It stated that authorizing the use of channel 37 for unlicensed operations would make additional spectrum available for unlicensed devices in areas of the country that are not in close proximity to hospitals or other medical facilities that use WMTS equipment, or to RAS sites.[142] The Commission believed it appropriate to revisit its previous decision to prohibit unlicensed operation on channel 37 since the repurposing of spectrum for wireless services will reduce the number of channels available for white space use, and channel 37 could provide additional spectrum for such use in those areas where it is not used for the WMTS and RAS.[143] It noted that channel 37 spectrum could be combined with guard bands on one or both sides of channel 37, if the amount of recovered spectrum requires the use of such guard bands, to provide a larger band for unlicensed use.[144]

100. We recognize the importance of WMTS to patient care, and will remain mindful of this critical function when developing these technical parameters. In this Notice, we propose technical parameters below to protect the WMTS and RAS from harmful interference and will develop a full record on the issues raised in this proceeding before adopting final rules. In the Incentive Auction proceeding, WMTS equipment manufacturers and users expressed concerns about the potential for unlicensed operations on channel 37 to cause harmful interference to the WMTS.[145] Parties disagreed on the appropriate interference analysis methodology (*e.g.*, I/N ratio and signal attenuation factors) as well as the ability of the TV bands databases to provide adequate protection to the WMTS.[146] We first consider herein the protection criteria in case of unlicensed devices operating on channel 37 (*i.e.,* co-channel with the WMTS and RAS), then consider protection criteria in the case of unlicensed devices operating in the spectrum immediately adjacent to channel 37 (either used for television or as guard bands, depending on the results of the incentive auction).

a. Power limits and separation distances

101. *General technical requirements.* There are several different approaches that we could take regarding the types of white space devices that we would permit to operate on channel 37. The most cautious approach would be to limit operations on channel 37 to fixed devices only and to require registration of the locations where the devices are used in the white spaces database. Fixed devices are required to register their location and operator information in the white spaces database because the rules permit them to operate at higher power than personal/portable devices.[147] The registration requirement makes fixed devices easer to locate in the event harmful interference occurs.[148] Another approach would be to allow both fixed and Mode II personal/portable devices to operate on channel 37. Like fixed devices, Mode II devices must incorporate geo-location and database access capabilities. Unlike fixed devices, they are not required to register with the database since their maximum permitted power is lower than that allowed for fixed devices, and their operating location changes frequently.[149] A third approach would be to allow fixed and both Mode I and Mode II personal/portable devices to operate on channel 37.

[141] *See Incentive Auction R&O,* 29 FCC Rcd at 6686, para. 274.

[142] *See Incentive Auction R&O,* 29 FCC Rcd at 6687, para. 276.

[143] *Id.*

[144] Depending on the amount of spectrum recovered, a single three megahertz guard band may be required above channel 37, or three megahertz guard bands may be required both above and below channel 37.

[145] *See Incentive Auction R&O,* 29 FCC Rcd at 6686-6687, para. 275.

[146] *Id.*

[147] *See White Spaces Second R&O*, 23 FCC Rcd at 16826, para. 47.

[148] *Id.*

[149] *Id.*

As discussed above, Mode I devices are not required to incorporate a geo-location capability and obtain their list of available channels from a fixed or Mode II device that is within their transmission range. Thus, the separation distances we calculate below to protect the WMTS and RAS may need to be increased if Mode I devices are permitted to operate on or adjacent to channel 37.[150]

102. We seek comment on the types of white space devices that should be permitted to operate on channel 37. If we allow personal/portable devices to operate on channel 37, should we require them to register with the white spaces database, and if so, what registration information should be required? What interference concerns are raised by allowing personal/portable devices on channel 37, and how could these be addressed, particularly those involving Mode I devices? Are there technology solutions or other means to mitigate the risk? Would we need to specify greater separation distances for personal/portable devices than for fixed devices of comparable power levels? If we initially allow only fixed devices on channel 37, should we then allow personal/portable devices at a later date once we have confidence that they will not cause harmful interference to the WMTS and RAS? We seek comment on any studies that address the interference potential of personal/portable devices to the WMTS and RAS.

103. We propose to allow the same maximum four watt EIRP for channel 37 fixed white space devices that is allowed for fixed devices in the TV bands. If we allow personal/portable devices on channel 37, we propose that the maximum EIRP would be 100 milliwatts, consistent with the current rules for operation in the TV bands. However, as discussed in more detail below, these power levels may need to be reduced depending on what devices operate in the adjacent bands. We also propose to require white space devices on channel 37 to meet the other technical requirements for white space devices, including the conducted power, antenna gain and PSD limits as appropriate. We further propose that these devices must access a database over the internet to determine if channel 37 is available at their location, meaning that the location is sufficiently far removed from all WMTS and RAS sites to avoid causing harmful interference.[151] The required separation distances are discussed below.

104. *Power limits.* The maximum power at which an unlicensed device can operate may be limited based upon the need to protect authorized services in adjacent bands, in addition to services in the same band. For example, neither the current rules nor our proposals discussed above permit fixed devices to operate at four watts in bands immediately adjacent to occupied TV channels. Currently, the adjacent spectrum bands to channel 37 (channels 36 and 38) are allocated for TV broadcasting. After the incentive auction, this situation may or may not change depending upon the amount of spectrum recovered in the auction. There are three possible scenarios. First, if less than 84 megahertz of spectrum is recovered, channels 36 and 38 will continue to be available for TV broadcasting, so there will be essentially no change from the current situation. Second, if exactly 84 megahertz of spectrum is recovered, channel 36 will continue to be available for TV broadcasting, while channel 38 will not. Instead, there will be a three megahertz guard band directly above channel 37 which will separate channel 37 from licensed wireless downlink spectrum. Third, if more than 84 megahertz of spectrum is recovered, there will be three megahertz guard bands above and below channel 37 to separate channel 37 from licensed wireless downlink spectrum.

105. Under the first scenario, channel 37 in a particular location could be treated similarly to any other television channel, provided it is sufficiently far removed from the WMTS and RAS to avoid harmful interference. We therefore propose to permit fixed white space devices to operate with an EIRP of up to four watts on channel 37, provided channels 36 and 38 are also vacant. If we allow personal/portable device operation, we propose that the maximum EIRP would be limited to 100 milliwatts in this scenario. In locations where channel 37 is available, but both channels 36 and 38 are

[150] Adjacent channel separation distances are required to protect the WMTS from white space devices operating on channels 36 and 38. *See infra* para 112.

[151] Mode I devices, if permitted on channel 37, would obtain their list of available channels from a fixed or Mode II device as the rules currently require.

occupied, we propose to allow a maximum allowable power of 40 milliwatts to protect television services on the adjacent channels. In locations where channel 37 is available, but only one of the adjacent channels is occupied, we propose to allow fixed unlicensed device operation with a maximum power of 4 watts EIRP, where the device operates in the six megahertz band centered on the boundaries of channel 37 and the unoccupied channel.

106. Under the second scenario (84 megahertz recovered), we propose to allow a maximum white space device power of 40 milliwatts EIRP on channel 37 to protect wireless downlink services that will be three megahertz above channel 37 and to protect television on channel 36 if that channel is occupied. If channel 36 is vacant, a white space device could also operate at 40 milliwatts, and possibly higher, in a six megahertz band centered on the boundary of channels 36 and 37, leaving a three megahertz separation from channel 35 and a six megahertz separation from wireless downlink spectrum.

107. Under the third scenario (more than 84 megahertz recovered), we propose to allow a maximum white space device power of 40 milliwatts on channel 37 where there will be a three megahertz guard band on each side of channel 37 to protect licensed wireless downlink services in the adjacent bands.

108. We seek comment on these proposals. In particular, we seek comment on the appropriateness of the proposed power limits for white space devices in each of these scenarios. Should these limits be lower to reduce the likelihood of harmful interference to the WMTS, RAS and wireless downlink services? Conversely, could the proposed limits be higher without a risk of harmful interference? For example, could a white space device operate at power levels higher than 40 milliwatts under the second scenario with a three megahertz separation to TV and a six megahertz separation to wireless downlink services? If so, what is the maximum power that could be used? Should we allow a fixed device power limit on channel 37 that is higher than four watts in rural areas under those scenarios where we propose a four watt limit?

109. *Determination of WMTS separation distances.* WMTS systems typically consist of small patient-worn transmitters and receive antennas located within a healthcare facility. According to GE, WMTS transmitters are frequency-division multiplexed with typical occupied bandwidth of 10 kHz and a relatively low transmit power of less than 0 dBm (1 milliwatt) to extend battery life.[152] GE argues that, to prevent interference to the WMTS, the signal level at the perimeter of a registered WMTS facility should not exceed 10 microvolts per meter within a 100 kilohertz bandwidth on channel 37, or 20 millivolts per meter within a one megahertz bandwidth on channels 36 and 38.[153]

110. We calculated the minimum co-channel separation distances that would be required for white space devices to meet GE's recommended field strength limit for channel 37. We used the TM 91-1 propagation model and white space device power levels that range from 40 milliwatts to 4,000 milliwatts in four dB steps. We assumed that the WMTS transmitter would be at 10 meter height above ground, which is the highest height specified in the ASHE/AHA database, and used the same range of HAAT currently specified in the rules for fixed white space devices.

111. We calculated the minimum required adjacent channel separation distances in two different ways using the same basic methodology that we used to determine the co-channel separation distances (TM 91-1 model, WMTS height of 10 meters, same range of white space device power and HAAT). First, we calculated the distances considering receiver "blocking" using the field strength limits on channels 36 and 38 that GE recommended to avoid interference.[154] We then considered the out-of-

[152] *See* GE Healthcare comments in GEN Docket No. 12-268 ("GE comments") at 39.

[153] *See* GE comments at 24.

[154] WMTS receivers use a filter that has a flat response across channel 37 and high rejection of channels 35 and below and 39 and above, but limited rejection of signals in channels 36 and 38. Thus, strong signals on channels 36 and 38 can block reception of signals on channel 37. *See* GE comments at 39-40.

band emission power that would fall into channel 37 from white space devices operating on channels 36 and 38 and calculated the minimum required separation distances based on GE's recommended field strength limit on channel 37. Based on our analysis, the effect of receiver blocking is greater than the effect of out-of-band emissions, so we considered receiver blocking in determining the minimum required separation distances.

112. The calculated co-channel and adjacent channel separation distances based on our methodology are shown in the following two tables. These are the distances that would be required between a white space device and an individual WMTS receiver, and not the total distance that would be required to protect WMTS use that relies on large distributed antenna systems throughout buildings and that may be spread out across a large facility but represented by only single point in the database. The separation distances are rounded to the nearest tenth of a kilometer. In cases where the calculated adjacent channel separation distance is less than one tenth of a kilometer, we listed a separation of one tenth of a kilometer to avoid specifying extremely small distances. If we allow personal/portable devices on channel 37, the separation distances would be those at an HAAT of less than three meters at a power level of either 40 milliwatts or 100 milliwatts, depending on which authorized services are in the adjacent frequency bands. We seek comment on the appropriateness of these separation distances for protecting the WMTS as well as our methodology used to calculate them.

Antenna height above average terrain of unlicensed device	**Required co-channel separation distances in kilometers from WMTS sites**					
	16 dBm (40 mW)	**20 dBm (100 mW)**	**24 dBm (250 mW)**	**28 dBm (625 mW)**	**32 dBm (1600 mW)**	**36 dBm (4 watts)**
Less than 3 meters	0.3	0.4	0.5	0.6	0.8	1.0
3-Less than 10 meters	0.6	0.7	0.9	1.1	1.4	1.7
10-Less than 30 meters	1.0	1.2	1.5	1.9	2.7	2.9
30-Less than 50 meters	1.2	1.6	2.1	2.4	3.0	3.8
50-Less than 75 meters	1.5	1.9	2.4	2.9	3.6	4.5
75-Less than 100 meters	1.7	2.2	2.7	3.3	4.2	5.3
100-Less than 150 meters	2.1	2.7	3.1	3.8	5.0	6.5
150-Less than 200 meters	2.5	3.1	3.4	4.3	5.8	7.4
200-250 meters	2.8	3.5	3.7	4.7	6.3	8.0

Antenna height above average terrain of unlicensed device	**Required adjacent channel separation distances in kilometers from WMTS sites**					
	16 dBm (40 mW)	**20 dBm (100 mW)**	**24 dBm (250 mW)**	**28 dBm (625 mW)**	**32 dBm (1600 mW)**	**36 dBm (4 watts)**
Personal/portable	0.1	0.1	N/A	N/A	N/A	N/A
Less than 3 meters	0.1	0.1	0.1	0.1	0.1	0.1
3-Less than 10 meters	0.1	0.1	0.1	0.1	0.1	0.1
10-Less than 30 meters	0.1	0.1	0.1	0.1	0.2	0.2
30-Less than 50 meters	0.1	0.1	0.1	0.2	0.2	0.3
50-Less than 75 meters	0.1	0.1	0.2	0.2	0.3	0.3
75-Less than 100 meters	0.1	0.2	0.2	0.2	0.3	0.4
100-Less than 150 meters	0.2	0.2	0.2	0.3	0.4	0.5

150-Less than 200 meters	0.2	0.2	0.3	0.3	0.4	0.6
200-250 meters	0.2	0.2	0.3	0.4	0.5	0.6

113. The current ASHE/AHA database allows the registration of only a single geographic point, whereas a hospital or health care facility is often a large building or group of building on a campus.[155] We also note that GE stated that its recommended protection criteria for the WMTS should apply at the perimeter of a facility. For these reasons, we expect that we will need to increase the calculated distances listed above to compensate for the fact that a single point may not accurately represent WMTS usage that could be spread out over a large facility. If so, what is the appropriate adjustment and why? For example, should we simply add an additional distance to our calculated distances? Alternatively, as discussed below in the database section, should we allow a facility to specify multiple points that define a bounded area around a large facility that uses the WMTS as opposed to specifying a single point?[156]

114. We also seek comment on any ways we can simplify the process of protecting the WMTS. For example, there are thousands of registered WMTS sites, many of which are clustered close together in urban areas. Could we define exclusion zones in urban areas where operation is prohibited on channel 37 rather than requiring the databases to consider each individual WMTS location? If so, how should we define the exclusion zones and enter this information into the white spaces databases?

115. We further seek comment on whether there are any other requirements necessary to protect the WMTS. For example, would a limit on the HAAT of fixed devices on channel 37 reduce the potential for interference to the WMTS? Should we prohibit the operation of Mode I personal/portable devices on channels 36 and 38 since they rely on another device's geo-location capability and could possibly operate slightly closer to adjacent channel WMTS locations than the device that obtained the list of available channels?[157] Alternatively, should we limit operation on channel 36 and 38 to fixed devices only?

116. *Determination of RAS separation distances.* We propose different protection criteria for the ten VLBA stations than for the two single dish radio astronomy observatories because of their differing potential to receive interference. VLBA observations are less susceptible to interference than single dish observations because interfering signals do not correlate across the multiple receivers that comprise the array.[158] We propose to require that white space devices operating on channel 37 comply with separation requirements based on their operating power to protect the ten VLBA observatories, and that they may not operate within defined exclusion zones around the two single dish observatories that receive on channel 37.

117. We propose requirements for white space devices to protect the VLBA based on the existing requirements that protect those stations from WMTS stations operating on channel 37. Section 95.1115(a) of the rules allows a maximum WMTS field strength on channel 37 of 200 millivolts per meter measured at a distance of three meters (this equates to an EIRP of approximately 12 mW).[159] Further, Section 95.1119(b) specifies that WMTS operations within 32 kilometers of the ten VLBA sites must coordinate with those sites.[160] Using these two requirements as a basis, we can determine the

[155] *See infra* para.174.

[156] *Id*.

[157] *See supra* para. 80 (describing Mode I operation).

[158] *See Incentive Auction R&O,* 29 FCC Rcd at 6694, para. 293, footnote 885.

[159] *See* 47 C.F.R. § 95.1115(a).

[160] *See* 47 C.F.R. § 95.1119(b).

minimum distance that a white space device must be from a VLBA site to provide the same level of protection as a WMTS transmitter located just outside the 32 kilometer coordination zone. Using the WMTS criterion, we calculate the appropriate path loss exponent to be 2.53.[161] Therefore, we propose to calculate the separation distances between fixed white space devices and VLBA sites using a propagation model with a path loss exponent of 2.53. This model considers only the power of the white space device and not its antenna height above ground or average terrain.

118. Based on the foregoing, our calculated minimum co-channel separation distances between white space devices operating on channel 37 and VLBA sites are as follows:

Calculated co-channel separation distances in kilometers from VLBA sites					
16 dBm (40 mW)	**20 dBm (100 mW)**	**24 dBm (250 mW)**	**28 dBm (625 mW)**	**32 dBm (1600 mW)**	**36 dBm (4 watts)**
51	73	105	151	219	314

119. We note that in developing this table, factors which would act to shorten the protection distance such as buildings, mountains, trees or other ground clutter were not considered. In addition, because VLBA stations require very low noise environments, most have been constructed in remote areas that have substantial natural shielding due to the fore mentioned obstructions. Also, we note that most of these distances would be beyond the radio horizon for most, if not all, paths between white space devices and VLBA sites.[162]

120. We seek comment on these separation distances and the methodology and assumptions used to calculate them. In particular, we seek comment on whether these separation distances are appropriate for protecting the VLBA. Do they provide adequate protection to the VLBA? Are they greater than necessary to protect the VLBA? Should we place a cap on the maximum separation distances, such as 100 kilometers, to account for the fact our analysis did not account for any factors as mentioned above that would act to shorten the required separation distances and that radio astronomy sites will be beyond the radio horizon in most instances? Are the assumptions made in our analysis reasonable? For example, would a different propagation model or different protection criteria for the VLBA be more appropriate? Is so, what model or criteria should we use to determine the minimum separation distances? Commenters on this issue should provide detailed technical criteria and analysis to justify their position.

121. We also seek comment on whether we should establish adjacent channel separation distances between white space devices operating on channels 36 and 38 and the ten VLBA observatories. Under the current rules, white space devices cannot operate on these channels because they are reserved for wireless microphones if they are not being used by television stations.[163] However, as discussed above, we will allow white space devices to operate on these channels if they are still available for television broadcasting after the incentive auction and are not being used by a television station at a white

[161] We assume a propagation model in which the signal drop-off as a function of distance is proportional to $1/d^n$, where d is the distance and n is the exponent. In the simplest case where there are no obstructions between the transmitter and receiver, n is equal to two. In that case, the signal drop-off is proportional to the square of the distance, so a doubling of distance results in a signal one-fourth as strong. Higher exponents correspond to a more rapid signal drop-off with distance.

[162] For example, assuming no obstructions, the radio horizon between a station with an effective antenna height of 250 m and a station with effective antenna height of 100 m is approximately 106 km where effective antenna height is defined as the average height above the surrounding terrain.

[163] *See* 47 C.F.R. § 15.707(a).

space device's location.[164] Under the current rules, white space devices must operate at least 2.4 kilometers away from VLBA sites, so this requirement would apply to white space devices operating on channels 36 and 38.[165] Is this adjacent channel separation distance adequate to protect the VLBA observatories? If not, what is the appropriate separation distance and why?

122. With respect to the two single dish RAS observatories that receive on channel 37 (Green Bank Telescope and Arecibo Observatory), Section 1.924 of the rules defines coordination requirements to protect them.[166] Specifically, Section 1.924(a) requires parties planning to construct and operate a new or modified station at a permanent fixed location within a specified quiet zone around the National Radio Astronomy Observatory at Green Bank West Virginia to notify the observatory in writing of the technical details of the proposed operation.[167] Similarly, Section 1.924(d) requires parties planning to construct and operate a new station at a permanent fixed location on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra to notify the Interference Office of the Arecibo Observatory in writing or electronically of the technical parameters of the planned operation.[168]

123. Because we do not believe it reasonable for operators of white space devices to coordinate with the Green Bank and Arecibo Observatories, and because separation distances to protect these observatories would be extremely large, we are proposing that white space devices not operate on channel 37 within the National Radio Quiet Zone around Green Bank or on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra. Much of the quiet zones are in less populated areas, and we expect that in these areas there will be many other channels available for white space operation in addition to spectrum in the guard bands and duplex gap. However, we seek comment on whether there are ways to allow operation of white space devices on channel 37 within these areas. For example, are there coordination procedures that white space device operators and/or white space database administrators could follow to enable operation in these areas?

124. We also seek comment on whether we could establish minimum separation distances that white space devices must meet to protect the Green Bank Telescope and the Arecibo Observatory that would affect a smaller area than the existing quiet zones. If so, what are the appropriate interference assumptions, propagation model and separation distances? Because we are proposing protection criteria for white space devices over a range of power levels and HAAT, could we establish smaller exclusion zones for white space devices that operate at lower power levels or lower HAAT? If so, how should we determine these zones or separation distances?

b. Guard bands adjacent to channel 37

125. Under certain spectrum recovery scenarios, there will be a three megahertz guard band on one or both sides of channel 37, resulting in a contiguous block of nine or 12 megahertz of spectrum. We seek comment on whether these guard bands could be combined with the six megahertz of channel 37 spectrum in areas where it is not being used for the RAS and WMTS to create a wider band for white space device use. If so, what power level, frequency separation and other technical requirements would be necessary to protect wireless downlink services adjacent to these guard bands?

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[164] *See supra* para. 24.

[165] *See* 47 C.F.R. § 15.712(h)(3).

[166] *See* 47 C.F.R. § 1.924.

[167] *See* 47 C.F.R. § 1.924(a). The area within which notifications must be provided is bounded by N 39°15′0.4″ on the north, W 78°29′59.0″ on the east, N 37°30′0.4″ on the south, and W 80°29′59.2″ on the west. The notification must include the geographic coordinates of the antenna location, the antenna height, antenna directivity (if any), the channel, the emission type and power.

[168] *See* 47 C.F.R. § 1.924(d). The notification must include the geographic coordinates of the antenna location, the antenna height, antenna directivity (if any), proposed channel and FCC rule part, type of emission, and EIRP

c. Out-of-band emission limits on channels 36-38

126. The Commission requires white space devices to comply with out-of-band emission limits on channels 36 through 38 in addition to the adjacent channel and Section 15.209 limits that white space devices must meet on other channels.[169] The white space device out-of-band emission limit on channel 37 is significantly more stringent (approximately 25 dB lower) than the Section 15.209 limit on this channel.[170] Manufacturers must incorporate an additional band-reject filter into white space devices to comply with the limit on channel 37. The high level of attenuation needed to meet the limit requires a sharp roll-off across channels 36 and 38, which may extend as far as channels 35 and 37, potentially precluding the use of all four of those channels by white space devices. The emission limits on channels 36 through 38 were originally recommended by GE Healthcare to protect the WMTS from interference by personal/portable white space devices that could be used in close proximity to WMTS receive antennas.[171] The Commission adopted these recommended limits and applied them to fixed devices as well as personal/portable devices.[172]

127. The inability of white space devices to use channels 36 and 38 was not previously a concern since the rules did not permit their use by white space devices.[173] However, in the *Incentive Auction R&O,* the Commission decided to stop reserving two vacant channels exclusively for wireless microphones and to make them available for both white space devices and wireless microphones, provided those channels are not repurposed for licensed wireless broadband use.[174] At the same time, we can also take steps to ensure that channels 35 and 39 can be used by white space devices, provided those channels are available after the incentive auction. Additionally, because we are allowing unlicensed devices to operate on channel 37, we need to remove the stringent emission limit that applies on that channel.

128. We are proposing to remove the out-of-band emission limits that apply on channels 36 through 38 and instead require white space devices to meet either the current adjacent channel or the Section 15.209 emission limits as appropriate. Our proposal to allow white space device operation on channel 37 requires that the devices access a database to ensure that they will operate sufficiently far from both WMTS and RAS sites to avoid causing interference to these services. The database will enforce both co-channel and adjacent channel separation distances from the WMTS, which will ensure that emissions that fall within channel 37 do not cause harmful interference to the WMTS. Thus, there will no longer be a need for the more stringent out-of-band emission limits on channels 36 through 38. This proposed change will eliminate the need for white space devices to incorporate additional filtering that blocks channel 37 and impacts the first and second adjacent channels, thus making channels 35, 36, 37, 38 and 39 useable by white space devices. We seek comment on this proposal.

5. Repurposed 600 MHz Band

129. We are proposing technical criteria for protecting licensed wireless services that will operate in the 600 MHz Band from interference from white space device operations. These criteria will be applicable in two situations. First, the Commission decided to permit the continued operation of white

[169] *See* 47 C.F.R. § 15.711(c)(4).

[170] The white space device out-of-band emission limit on channel 37 is 30 dB above a microvolt per meter measured at a one meter distance. The Section 15.209 limit on channel 37 is 200 microvolts per meter measured at a three meter distance, which is equivalent to 55.6 dB above a microvolt per meter measured at a one meter distance.

[171] *See* GE Healthcare *ex parte* letter in ET Docket No. 04-186 dated May 6, 2008 at 2.

[172] *See White Spaces Second R&O* 23 FCC Rcd at 16889, para. 236.

[173] If these channels are vacant, they are reserved for wireless microphones and therefore cannot be used by white space devices. *See* 47 C.F.R. § 15.707(a).

[174] *See Incentive Auction R&O,* 29 FCC Rcd at 6845, para. 684.

space devices in repurposed spectrum except in those areas in which a 600 MHz Band licensee commences operations.[175] It took this action because it expects that 600 MHz Band licensees will be commencing operations at different places at different times, depending on their business plans and other factors, both during and after the post-auction transition period. Some of the repurposed television spectrum may not be used for licensed wireless services in some areas for a considerable amount of time.

130. Second, the Commission decided to allow market variation in developing the 600 MHz Band Plan.[176] Therefore, some spectrum may be assigned for broadcasting in some areas and licensed wireless services in others. The Commission decided in the *Incentive Auction R&O* to allow the continued use of white space devices on all spectrum that remains allocated for TV broadcasting, which would include that spectrum with uses that vary by market.[177] Since both white space devices and licensed wireless services can potentially operate on the same frequencies due to market variation, we need technical requirements to prevent harmful interference between the services.

131. The current white space device rules contain protection requirements for a variety of services that operate in the TV bands, but they do not contain protection requirements for licensed wireless broadband services as such wireless services did not operate in the TV bands at the time the Commission adopted those rules. Therefore, we propose to develop appropriate protection criteria, specifically, minimum distance separations, to protect these wireless services. These criteria will be used by the white space databases to ensure that unlicensed operations no longer occur on a channel in an area in which a licensee has commenced operations. When a 600 MHz Band licensee plans to commence operations on frequencies that includes spectrum available for unlicensed operations under the rules for white space devices, that licensee can notify any of the white spaces database administrators when and where it plans to commence operations. The white spaces databases would then preclude unlicensed operations in those areas on the channels in use for wireless systems. We discuss the proposed methodology that will be used to place 600 MHz Band licensee information in the databases below.[178]

132. Consistent with our discussion above with respect to the guard bands and duplex gap, we seek comment on whether we should allow both Mode I and Mode II personal/portable devices, in addition to fixed devices, to operate in the repurposed 600 MHz band. We ask commenters to address the effect that any limitation on the permissible types of devices in this band may have on the development of white space services and applications. For commenters that believe Mode I personal/portable white space devices should be permitted in these bands, we seek comment on the typical operating range of such a device, as that range will need to be incorporated into many of the protection distances proposed in the sections that follow. With respect to Mode II personal/portable devices, the current white space rules assume protection distances for these devices based on them not operating above three meters HAAT.[179] Thus, for all protection criteria that follows below, we propose that protection from Mode II personal/portable devices be based on operating at that low HAAT. We seek comment on this proposal.

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[175] *See Incentive Auction R&O,* 29 FCC Rcd at 6843-6844, para. 680. "Commence operations" has not yet been defined for the purpose of establishing when white space devices are to cease operations in a particular area. This issue will be decided during the pre-auction process. *See Incentive Auction R&O*, 29 FCC Rcd at 6840, para. 668 n.1861.

[176] *See Incentive Auction R&O,* 29 FCC Rcd at 6604-6605, para. 81-82. Less spectrum may be recovered for wireless services in some markets than others due to broadcaster participation and other factors. The Commission allowed for market variations to prevent these constrained markets from being a limiting factor in the amount of spectrum recovered.

[177] *See Incentive Auction R&O,* 29 FCC Rcd at 6683-6684, para. 269.

[178] *See infra* para.178-179.

[179] Fixed devices are required to report their antenna height above ground level to the white spaces databases, but there is no comparable requirement for personal/portable devices. *See* 47 C.F.R. § 15.711(b)(3)(i)-(ii).

133. Depending on the channel used by a white space device, it could be in the same band as either wireless uplinks or downlinks.[180] Therefore, we propose co- and adjacent channel protection criteria for both wireless uplinks and downlinks.

134. *Wireless uplinks.* Wireless uplinks are the transmissions from mobile devices to fixed base stations. The receivers of concern in developing protection criteria are therefore those in fixed base stations. As detailed below, we propose that 600 MHz licensees provide information to the white space databases which defines a polygon representing the outer edge of their base station deployment.[181] Using that information, we propose to protect fixed stations by determining the minimum separation distance needed between a white space device and that polygon to prevent harmful interference. Because the amount of spectrum available for white space devices in this band will shrink over time as 600 MHz Band licensees build-out their systems, there is little benefit in developing complex criteria to manage white space device use in this band. Thus, we are taking a simple approach in developing protection criteria based on the worst case of a white space device emission fully overlapping the receive band of a base station.[182] However, we propose that the co-channel protection requirements apply for any amount of frequency overlap between a channel used by a white space device and a five megahertz spectrum block used by a Part 27 licensee.[183]

135. To determine the necessary separation distance to protect 600 MHz Band base stations, we must make certain assumptions regarding their usage. As already stated, we are assuming the worst case for this preliminary analysis and basing the protection distance on 5/6 of the total energy of the white space device being present in the base station receiver pass band. In addition, we assume, consistent with other analysis throughout the incentive auction proceeding as well as in this instant proceeding, that a typical base station operates at 30 meters or less above ground level and that a white space device can operate at various heights up to 250 meters above average terrain. Further, we base our analysis on the base station receiver sensitivity level of the 3GPP standard of -101.5 dBm for wide area base stations. We believe this is the correct criteria for this analysis rather than assuming actual operation at 10 dB or more above this level as in other analyses in this proceeding. In those analyses, adjacent channel operations were being protected mostly in areas of high wireless signal levels. However, here, we are specifically protecting base stations at the outer edge of a 600 MHz Band licensees coverage area that are providing service to the most distant subscribers. Using the TM 91-1 propagation model, we believe the following separation distances (rounded to the nearest kilometer) from the polygon representing the edge of base station deployment will protect base station operations from harmful interference from co-channel white space devices. [184]

Antenna height above average terrain of unlicensed device	**Required co-channel separation distances in kilometers between white space devices and 600 MHz Band Base stations**					
	16 dBm (40mW)	**20 dBm (100 mW)**	**24 dBm (250mW)**	**28 dBm (625 mW)**	**32 dBm (1600 mW)**	**36 dBm (4W)**

[180] A white space device could also operate on frequencies that are designated as part of a guard band or the duplex gap.

[181] *See infra.* para. 178.

[182] White space devices are designed to operate on six megahertz channels, whereas the 600 MHz Band Plan is based on five megahertz channels. Depending on which TV channel is being used by a white space device, its emissions could overlap the wireless channel by as little as one megahertz or fully overlap all five megahertz.

[183] The amount of frequency overlap will range from one to five megahertz depending on the channel being used by the white space device.

[184] TM-91-1 is consistent with Egli terrain model, which has range applicability up to 40 miles, as such TM-91-1 is used to calculate separation distances between white space devices and 600 MHz band base stations.

Less than 3 meters	5	6	7	9	12	15
3-Less than 10 meters	9	11	14	17	22	27
10-Less than 30 meters	15	19	24	30	38	47
30-Less than 50 meters	20	24	31	38	49	60
50-Less than 75 meters	24	30	37	47	60	60
75-Less than 100 meters	27	34	43	54	60	60
100-Less than 150 meters	33	42	53	60	60	60
150-Less than 200 meters	39	49	60	60	60	60
200-250 meters	43	54	60	60	60	60

136. We therefore propose that white space devices adhere to these separation distances from the edge of the polygon defining the location of base stations as provided by the 600 MHz Band licensees, and that these criteria will be enforced by the white space databases to protect co-channel 600 MHz base stations in the repurposed TV spectrum. In making this proposal, which provides for a maximum separation distance of 60 kilometers, we recognize that based strictly on calculations, the distances could be much greater. However, the line-of-sight radio horizon for a 30 meter high base station antenna and a 250 meter high white space device antenna is 87 kilometers.[185] Thus, there is no reason for distances to be greater than that. Further, that line-of-sight radio horizon assumes perfect atmospheric conditions, and the absence of any obstructions such as buildings, mountains, trees or other ground clutter which further acts to reduce actual operating range. In addition, although we developed these distances based on full overlap of the white space device's emissions with the base station receiver, there may be many cases where the overlap is less and thus, these proposed distances will provide additional protection. We therefore, believe that the 60 kilometer maximum separation distance is reasonable and seek comment on this proposal. We ask that commenters address our assumptions and conclusions and provide technical information and analysis if they believe we should use different criteria or whether we should take a different approach to protecting these stations.

137. In the repurposed 600 MHz Band, white space devices may also be operating on an adjacent channel to wireless licensees. In these situations, the white space device must comply with certain separation distances to provide the required protection to avoid causing harmful interference. In this instance, we are defining adjacent channel operations as any overlap of a white space device's six megahertz operating channel with any portion of a five megahertz block directly adjacent to a five megahertz block that is being used by a 600 MHz base station. As with our proposal for co-channel separation, we recognize that in many cases, white space devices will operate with a greater frequency separation from 600 MHz base stations than we use in our analysis, but for the same reasons stated in the proposal to protect co-channel operations, we base our proposed separation distances on the worst case situation where a white space device operates immediately adjacent to a five megahertz block used by a 600 MHz base station (*i.e.,* with a zero megahertz frequency offset).

138. In conducting our analysis to determine the necessary protection distances, we assume, similar to our analysis for handset protection, that the base station is operating 10 dB above its sensitivity level of -101.5 dBm. We also assume an adjacent channel selectivity of 43.5 dB. In addition, we assume a wireless base station filter roll-off of 5.7 dB/MHz.[186] Based on these assumptions, we calculate the following separation distance values for white space devices to protect 600 MHz wireless base stations.

[185] The radio horizon is an approximation of the maximum propagation distance for radio signals.

[186] *See* Incentive Auction R&O at Appendix C – Technical Appendix.

Antenna height above average terrain of unlicensed device	Required separation distances in meters between white space devices and adjacent channel 600 MHz Band base stations					
	16 dBm (40mW)	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4W)
Less than 3 meters	112	141	177	223	282	354
3-Less than 10 meters	204	257	323	407	514	646
10-Less than 30 meters	354	445	560	704	890	1120
30-Less than 50 meters	457	575	723	909	1150	1446
50-Less than 75 meters	560	704	885	1113	1408	1770
75-Less than 100 meters	646	813	1022	1285	1626	2044
100-Less than 150 meters	792	996	1252	1574	1991	2504
150-Less than 200 meters	914	1150	1446	1818	2299	2891
200-250 meters	1022	1285	1616	2033	2571	3232

139. We therefore propose that white space devices operating in the repurposed 600 MHz Band maintain these adjacent channel separation distances from the edges of the boundary defined by the 600 MHz Band licensees defining the area in which their base stations are located. This requirement will be enforced through the white space databases. We seek comment on this proposal and our assumptions. Commenters who believe that different separation criteria are needed should provide detailed comments and analysis containing all assumptions and analysis.

140. *Wireless downlinks*. Wireless downlinks are the transmissions from fixed base stations to mobile devices. The receivers of concern in developing protection criteria in the wireless downlink spectrum are therefore the mobile device's receivers. A database cannot track the constantly changing locations of mobile devices, so the protection criteria must be based on base station location. We propose to calculate the required separation distances as follows. First, we propose to define the minimum separation distance necessary to protect a mobile device from interference from a white space device. We then propose to define a maximum distance from base stations at which mobile devices would typically operate. The minimum required separation distance from the boundary of the area in which base stations operate would be the sum of these two distances.

141. As with our approach for base stations, our goal is to provide a simple mechanism for protecting 600 MHz Band handsets from co-channel interference from white space devices. For our preliminary analysis, we use the same assumptions as for the analysis for base stations above except that we use the handset sensitivity of -97 dBm and assume that handsets operate 1.5 meters above the ground. Based on those assumptions, we calculate the following separation distances to protect 600 MHz Band handsets from white space devices.

Antenna height above average terrain of unlicensed device	Calculated co-channel separation distances in kilometers between white space devices and wireless handsets					
	16 dBm (40mW)	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4W)
Less than 3 meters	0.15	0.18	0.23	0.29	0.37	0.46
3-Less than 10 meters	0.27	0.33	0.42	0.53	0.67	0.84
10-Less than 30 meters	0.46	0.58	0.73	0.91	1.16	1.45
30-Less than 50 meters	0.59	0.75	0.94	1.18	1.49	1.88

50-Less than 75 meters	0.73	0.91	1.15	1.44	1.83	2.30
75-Less than 100 meters	0.84	1.06	1.33	1.67	2.11	2.65
100-Less than 150 meters	1.03	1.29	1.62	2.04	2.58	3.25
150-Less than 200 meters	1.19	1.49	1.88	2.36	2.98	3.75
200-250 meters	1.33	1.67	2.10	2.64	3.34	4.20

142. Inspecting this table reveals that the protection distance for white space devices operating at maximum height are not that much greater than for those operating near ground level. Therefore, for simplicity, we will base our proposal only on the single separation distance corresponding to the largest calculated – 4.2 km. To calculate the total separation distance from a base station to protect handsets, we must also provide a maximum distance from a 600 MHz band base station at which mobile devices would typically operate. We believe that assuming a maximum of 30 km for this distance is reasonable.[187] We therefore propose that personal/portable white space devices maintain a minimum distance of 35 kilometers from the edge of the carrier's defined base station deployment. This distance will be enforced through the white space databases. We seek comment on this proposal and our assumptions and ask that commenters who disagree provide detailed technical analysis supporting their conclusions.

143. As with protection of adjacent channel 600 MHz base stations, we also need criteria to protect adjacent channel handsets. Using the same assumptions for handsets as used above for interference analysis between wireless handsets in the duplex gap and white space devices and assuming the worst case of no frequency separation between the edge of the handset receive band and the white space transmit band, we calculate the following separation distances to protect handsets from interference.

Antenna height above average terrain of unlicensed device	**Calculated adjacent channel separation distances in meters between white space devices and wireless handsets**					
	16 dBm (40mW)	**20 dBm (100 mW)**	**24 dBm (250mW)**	**28 dBm (625 mW)**	**32 dBm (1600 mW)**	**36 dBm (4W)**
Less than 3 meters	12	15	19	24	31	39
3-Less than 10 meters	22	28	35	44	56	71
10-Less than 30 meters	39	49	61	77	97	122
30-Less than 50 meters	50	63	79	99	126	158
50-Less than 75 meters	61	77	97	122	154	193
75-Less than 100 meters	71	89	112	140	178	223
100-Less than 150 meters	86	109	137	172	217	273
150-Less than 200 meters	100	126	158	199	251	316
200-250 meters	112	140	177	222	281	353

144. Under the same reasoning as used above; that is assuming a maximum 30 kilometer service areas for wireless handsets around a base station, and using the largest protection distance

[187] The Commerce Spectrum Management Advisory Committee Final Report - Working Group 1 – 1695-1710 MHz Meteorological-Satellite, Rev. 1, Appendix 3 – Baseline LTE Uplink Characteristics , defines an inter site distance for rural deployments of 7 km for eNodeB stations (http://www.ntia.doc.gov/files/ntia/publications/wg1_report_07232013.pdf). By adjusting for the difference in frequency, while also accounting for obstructions such as buildings, mountains, trees or other ground clutter, we believe an increase of a little more than 6 dB to 30 km is reasonable.

calculated, we propose that white space devices operating adjacent channel to 600 MHz systems maintain a 31 kilometer distance from the edge of the area defined by the wireless licensees that contains their base stations. We seek comment on this proposal and our assumptions and ask that commenters who disagree provide detailed technical analysis supporting their conclusions.

B. Wireless microphones

145. In the 2010 *TV Bands Wireless Microphones R&O and Further NPRM*, the Commission issued a waiver to permit unlicensed wireless microphones in the television bands (Channels 2-51, except channel 37) under Part 15 pursuant to certain technical rules.[188] The Commission stated that this waiver would remain in place until such time as final rules for their operations were established.[189] The Commission also sought comment on proposed Part 15 rules for unlicensed wireless microphone operations in the TV bands. In particular, the Commission proposed to define these devices as intentional radiators used to transmit voice, music, or other audio material over short distances. It also proposed to permit these devices to operate with a power level to the antenna of up to 50 milliwatts in both the VHF and UHF TV bands, and proposed technical rules that were in many respects similar to the technical rules applicable to devices licensed under Part 74 as low power auxiliary stations.[190]

146. We continue to believe that we should codify Part 15 rules for the operation of unlicensed wireless microphones in the TV bands, but we believe that the Commission's 2010 proposals should be modified for a number of reasons. Subsequent to these proposals, the Commission adopted rules for the incentive auction, which will reduce the number of TV channels where wireless microphones can operate. The *Incentive Auction R&O*, also changed the method for determining the minimum separation between licensed Part 74 wireless microphones and co-channel TV stations, and we believe we should consider the same approach for unlicensed wireless microphones. In addition, because there will be less TV spectrum available for wireless microphones after the incentive auction, we believe we should consider modifying the out-of-band emission limits for wireless microphones to enable more efficient spectrum use. Finally, upon further consideration, we believe that the Commission's previous proposed definition for unlicensed wireless microphones is overly broad and should be modified. Thus, the proposals in this Notice supersede those in the 2010 *TV Bands Wireless Microphones R&O and Further NPRM*. We will therefore not carry over the record from the previous proceeding concerning the proposals to codify Part 15 rules for unlicensed wireless microphones. Parties that wish to comment on this issue must file comments in this proceeding.

147. In this section we also address the operation of unlicensed wireless microphones in the 600 MHz Band Plan guard bands and duplex gap, as well as the operation of wireless microphones licensed under Part 74 in a portion of the duplex gap. Finally, we address the operation of unlicensed wireless microphones in the repurposed 600 MHz Band during the post-auction transition period.

1. Unlicensed wireless microphones in the TV bands.

148. *Definition of unlicensed wireless microphones in Part 15.* We propose to define a wireless microphone as a device that converts sound into electrical audio signals that are transmitted using radio signals to a receiver which converts the radio signals back into audio signals that are sent through a sound recording or amplifying system. We also propose that wireless microphones may be used for cue and control communications and synchronization of TV camera signals as defined in section 74.801 of this part. We further propose that this definition would not include auditory assistance devices as defined in section 15.3(a) of this part. We believe that this definition would encompass the types of wireless microphones that currently operate within the TV bands, but is not so broad as to encompass

[188] *See supra* para. 6.

[189] *See TV Bands Wireless Microphones R&O and FNPRM*, 25 FCC Rcd at 669, para. 52.

[190] *See generally id.*

other types of unlicensed devices that already have provisions in Part 15 for operation outside the TV bands. We seek comment on this definition.

149. *Permissible frequencies of operation.* We propose to allow unlicensed wireless microphones to operate in the TV spectrum on channels 2-51, excluding channel 37 in all locations and channel 17 in Hawaii, which is allocated for non-broadcast purposes. Since the number of TV channels that will be available for unlicensed wireless microphones will be reduced after the incentive auction, we also propose to add an advisory in the rules indicating that the highest channel available for wireless microphones will be determined by the outcome of the incentive auction and will be modified consistent with the auction results. We seek comment on these proposals. We also seek comment on whether we should allow unlicensed wireless microphone operation on channels 14-20 in locations where the PLMRS/CMRS operates and whether there is a need to establish protection criteria for these services.

150. To prevent harmful interference to co-channel TV stations, we propose to require unlicensed wireless microphones to operate at least four kilometers outside the following protected service contours of co-channel TV stations, which is the same protection requirement that the Commission adopted in the *Incentive Auction R&O* for Part 74 wireless microphones.[191]

Type of station	Protected contour		
	Channel	Contour (dBu)	Propagation curve
Analog: Class A TV, LPTV, translator and booster	Low VHF (2-6)	47	F(50,50)
	High VHF (7-13)	56	F(50,50)
	UHF (14-51)	64	F(50,50)
Digital: Full service TV, Class A TV, LPTV, translator and booster	Low VHF (2-6)	28	F(50,90)
	High VHF (7-13)	36	F(50,90)
	UHF (14-51)	41	F(50,90)

151. *Technical requirements for unlicensed wireless microphones.* Consistent with the current technical rules that apply under the existing Part 15 waiver and the Commission's previous proposals, we propose to permit wireless microphones to operate with a power level to the antenna of up to 50 milliwatts in both the VHF and UHF TV bands. We expect that this proposed power level is appropriate for most users, particularly because we expect that parties using Part 15 wireless microphones will typically be entities operating in smaller venues that do not require the longer range operation that higher power allows.[192] We seek comment on the appropriateness of this power level. We also seek comment on whether the equipment certification rules should prohibit component parts such as amplifiers from being attached after market to a microphone and whether the rules should specify a maximum field strength or other emission limits (*e.g.,* EIRP) for equipment instead of a conducted power level.

152. We propose to require unlicensed wireless microphones to comply with the same channelization, frequency stability, and bandwidth requirements as Part 74 wireless microphones.[193] Specifically, we propose to require that operation be offset from the upper or lower channel edge by 25 kHz or an integral multiple thereof and that the operating frequency tolerance be 0.005 percent. We also propose to specify that one or more adjacent 25 kHz segments within a TV channel may be combined to form an operating channel with a maximum bandwidth not to exceed 200 kHz. Consistent with the measurement requirements for other Part 15 transmitters, we further propose to require that the frequency tolerance be maintained over a temperature variation of -20 degrees to +50 degrees C at normal supply

[191] *See Incentive Auction R&O,* 29 FCC Rcd at 6698-6699, para. 305.

[192] Licensed Part 74 wireless microphones may operate with a power level of up to 250 milliwatts in the UHF TV band. *See* 47 C.F.R. § 74.861(e)(1)(ii).

[193] *See* 47 C.F.R. § 74.802(c).

voltage, for a variation in the supply voltage from 85 percent to 115 percent of the rated supply voltage at a temperature of 20 degrees C, and that battery operated equipment be tested using a new battery.[194] We expect that the proposed 25 kHz offset requirement would prevent wireless microphones from operating at the edge of a TV channel where they could interfere with TV stations on adjacent channels, and the proposed frequency tolerance requirement would ensure that devices do not drift from the designated frequencies. The limit on the bandwidth that a wireless microphone may occupy will leave room for multiple microphones within a channel. We seek comment on these proposals.

153. We propose that unlicensed wireless microphones comply with the same emission mask that we are proposing for licensed Part 74 wireless microphones in the Wireless Microphones proceeding.[195] Specifically, we propose to require that emissions from analog and digital unlicensed wireless microphones comply with the emission masks in ETSI EN 300 422-1, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement.*[196] Requiring wireless microphones to meet these tighter emission requirements will protect authorized services in adjacent bands from harmful interference, and will improve spectrum sharing by wireless microphones. In light of the fact that there will be fewer vacant TV channels available for wireless microphones and more intensive use of the remaining TV spectrum after the incentive auction, we now propose tighter emission limits for wireless microphones than the Commission previously proposed in 2010.[197] Shure supports Commission adoption of these masks, stating that the reduced out-of-band emissions would facilitate tighter spacing of wireless microphones operating together within a TV channel.[198]

154. We also propose to require that unlicensed wireless microphones comply with the Section 15.209 emission limits outside the frequency range where the ETSI masks are defined (one megahertz above and below the wireless microphone carrier frequency). We further propose that emissions would not have to be attenuated below the 15.209 limits, even if the ETSI mask would require greater attenuation.

155. We seek comment on these proposals. In particular, we seek comment on the benefits of requiring unlicensed wireless microphones to comply with the ETSI limits, and whether these benefits would outweigh the costs. Are these limits necessary to protect authorized services in adjacent frequency bands? To what extent would compliance with the proposed limits improve spectrum sharing by wireless microphones? Would equipment manufacturers have difficulty in complying with these limits? Do any existing wireless microphones already comply with them? Are the Section 15.209 emission limits appropriate beyond the range where the ETSI masks are defined, or should the limit at the outer edges of the ETSI masks (-90 dBc) apply at frequencies more than one megahertz removed from the wireless microphone carrier frequency? We also seek comment on whether we should specify separate emission

[194] *See id.* §§ 15.225(e), 15.229(d) and 15.231(d).

[195] *See* Wireless Microphone NPRM at III.C.1.b.(i)(c) (Adoption of ETSI emission mask standards for analog and digital wireless microphones).

[196] This standard is available at www.etsi.org.

[197] The Commission previously proposed to require that emissions from unlicensed wireless microphones comply with the same emission mask as Part 74 licensed wireless microphones. *See TV Bands Wireless Microphones R&O and Further NPRM,* 25 FCC Rcd at 694-695, para. 118. Using this mask, the out-of-band emissions from an unlicensed wireless microphone could be considerably higher than the Section 15.209 limits that apply to most other unlicensed devices. The previously proposed attenuation of $43+10 \log_{10}P$ on any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth corresponds to an attenuation of 30 dB when the conducted power is 50 milliwatts (17 dBm). Assuming the wireless microphone has an antenna gain of 0 dBi, the out-of-band radiated power (-13 dBm) would exceed the Section 15.209 limit of 200 microvolts/meter at 3 meters (-49 dBm EIRP) by 36 dB.

[198] *See* Shure comments in ET Docket No. 10-24 at 29.

masks for analog and digital microphones, or whether a single mask is sufficient. For example, ETSI EN 300 422-1 suggests that its mask for digital microphones could also be used for analog microphones. Should the Commission incorporate the ETSI standard by reference into the rules, or should it simply specify the emission mask(s) in the Part 15 rules?

156. Reducing the required separation distance between wireless microphones and co-channel television stations could increase the number of locations where wireless microphones could operate. We seek comment on whether we could reduce the proposed four kilometer separation distance, which was calculated using a power level of 4,000 milliwatts.[199] Is this a realistic assumption for the combined power level of multiple wireless microphones operating within a television channel? Should we assume a lower power level? If so, what is the appropriate power level and separation distance?[200] How much would a shorter separation distance benefit wireless microphone users?

157. Finally, we seek comment on whether any other technical requirements need to be specified for unlicensed wireless microphones. For example, the Part 74 rules for low power auxiliary stations have additional requirements for wireless microphones including a maximum frequency deviation specification when frequency modulation is used.[201] Additionally, Part 74 states that a transmitter may be either frequency synthesized or crystal controlled.[202] We seek comment on whether these or any other requirements should be incorporated into the Part 15 rules for wireless microphones.

2. 600 MHz guard bands and duplex gap

a. Unlicensed wireless microphones

158. Unlicensed wireless microphones will be permitted to operate in the 600 MHz Band Plan guard bands, including the duplex gap. We propose to require that unlicensed wireless microphones that operate in the guard bands and duplex gap meet many of the same technical requirements that we propose in this Notice for unlicensed wireless microphones that operate in the TV bands. Specifically, we propose the same definition of wireless microphone, since we believe that we should have a uniform definition for unlicensed wireless microphones regardless of the bands in which they operate.[203] We also propose to require that unlicensed wireless microphones that operate in the guard bands and duplex gap comply with the same channelization, bandwidth, frequency stability and emission mask requirements as wireless microphones that operate in the TV bands.[204] These requirements are necessary in the guard bands and duplex gap as well as the TV bands to enable more efficient use of spectrum and prevent harmful interference to authorized services outside the bands where wireless microphones operate. We seek comment on these proposals.

159. *Frequencies of operation.* We propose to allow unlicensed wireless microphones to operate in certain segments of the guard bands and duplex gap. Specifically, we propose to allow unlicensed wireless microphones to operate in the same six megahertz portion of the duplex gap as white

[199] The Commission adopted this separation distance for licensed wireless microphones since it is the separation distance required between personal/portable white space devices and the protected contours of co-channel television stations. This separation distance was calculated based on a white space device operating power level of 4,000 milliwatts, which is the same as the total power from 16 LPAS devices operating in a TV channel at 250 milliwatts each. *See Incentive Auction R&O,* 29 FCC Rcd at 6698-6699, para. 305-306.

[200] We are proposing co-channel separation distances for white space devices operating at power levels less than 4,000 milliwatts EIRP. *See supra* para. 66.

[201] *See* § 74.861(e)(3).

[202] *See* § 74.861(e)(2).

[203] *See supra* para. 148.

[204] *See supra* para. 152-153.

space devices.[205] In the guard band between television and wireless downlink spectrum, we propose that unlicensed wireless microphones may operate across the guard band with the exception of a one megahertz segment at the upper end that would act as a buffer between unlicensed wireless microphone operations and wireless downlink services. As with white space devices, the amount of spectrum available for wireless microphone operation in the guard band would depend on the size of the guard band and amount of frequency separation needed to protect wireless services from harmful interference. For example, if the guard band is 11 megahertz wide, unlicensed wireless microphones would be allowed to operate in the lower ten megahertz segment of the band; if the guard band is nine megahertz wide, unlicensed wireless microphones would be allowed to operate in the lower eight megahertz segment; and if the guard band is seven megahertz wide, unlicensed wireless microphones would be allowed to operate in the lower six megahertz segment. We seek comment on the amount of frequency separation needed between wireless microphones and wireless services in the adjacent bands in the duplex gap and guard bands.[206] In the three megahertz guard bands adjacent to channel 37, we propose to allow unlicensed wireless microphones to operate in the two megahertz segment closest to channel 37, leaving a one megahertz buffer to protect wireless downlink services adjacent to these guard bands. We seek comment on these proposals.

160. *Power limits.* We propose that unlicensed wireless microphones operating in the guard bands and duplex gap operate with a maximum conducted power output of 20 milliwatts to the antenna. This is less than the 50 milliwatt power level we proposed for unlicensed wireless microphones in the TV bands, but would still be useful by wireless microphone operators, since many wireless microphones operate at power levels between 10 and 20 milliwatts. We believe that this lower power limit for wireless microphones is necessary in the guard bands and duplex gap to protect licensed wireless services outside these frequency bands.[207] In addition, since we are proposing that white space devices can operate in the guard bands and duplex gap at power levels of 40 milliwatts, limiting the power of unlicensed wireless microphones can help enable coexistence between unlicensed wireless microphones and white space devices by making both types of devices operate at more comparable power levels. Wireless microphones operate in 200 kilohertz channels as opposed to the six megahertz (6000 kilohertz) channels used by white space devices, and as many as 16 wireless microphones potentially could operate in the same amount of spectrum as a single white space device. Thus, the aggregate wireless microphone power within a six megahertz channel can be greater than a white space device power within a six megahertz channel. We recognize that even at our proposed lower power level for unlicensed wireless microphones in the guard bands and duplex gap, there would still be a disparity between the aggregate power for wireless microphones and the power for white space devices, but the lower power level we propose for wireless microphones in these bands would reduce this disparity.

161. We seek comment on the proposed power level for unlicensed wireless microphones. Is this power level useful for unlicensed wireless microphones? Will it provide adequate protection for wireless uplink and downlink services as well as TV broadcasting services? How would the power limit for unlicensed wireless microphones impact the ability of a white space device to operate co-frequency in the duplex gap, *i.e.,* would the operation of one device preclude the operation of the other? Should the proposed power level be reduced further to allow for better coexistence between unlicensed wireless microphones and white space devices? Alternatively, could the proposed power level be increased without causing interference to authorized services or adversely affecting white space operations?

[205] *See supra* para. 92.

[206] *See supra* paras. 86, 92, and 95 (parties should address what frequency separation is needed to protect wireless services from harmful interference).

[207] The guard band is adjacent to wireless downlink services (on the upper end), and the duplex gap is between wireless downlink and wireless uplink services.

162. *Database access.* The Spectrum Act states that the Commission may permit unlicensed use of the guard bands,[208] and stipulates that (a) unlicensed use shall rely on a database or subsequent methodology as determined by the Commission, and (b) the Commission may not permit any use of a guard band that the Commission determines would cause harmful interference to licensed services.[209] The Commission's Part 15 rules already require that unlicensed devices not cause harmful interference to and must accept interference from authorized users.[210] In this Notice, we propose and seek comment on technical and operational rules for unlicensed wireless microphones in the guard bands and duplex gap that would satisfy the requirements of both the Spectrum Act and our rules that unlicensed wireless microphones not cause harmful interference to authorized services.

163. Unlike fixed and personal/portable white space devices that are required to comply with rules that clearly satisfy the Spectrum Act's stipulation that "unlicensed use shall rely on a database,"[211] wireless microphones do not operate in a similar way to "rely on a database." Nonetheless, we propose that unlicensed wireless microphones that operate in the guard bands and duplex gap must "rely on a database" prior to operation to ensure that their intended operating frequencies are available for unlicensed wireless microphones at the location where they will be used.[212] We believe this proposed requirement is necessary because during the post-auction transition period, there will be a time when TV stations continue to operate in spectrum that will eventually become the guard bands and duplex gap, so the database will indicate to users whether operation is permitted in the guard bands and duplex gap. Also, there may be market variation in the amount of spectrum recovered, so the frequency and size of the guard band between TV and wireless downlink spectrum may differ in different parts of the country. Thus, the database can indicate which spectrum is available for unlicensed wireless microphones at a particular location. We believe that this requirement is not unduly burdensome because there are several white space databases available, and unlicensed wireless microphone users will have an incentive to check a database to identify available frequencies for their use. We seek comment on this proposal.

164. We seek comment on how unlicensed wireless microphones would comply with the Spectrum Act's stipulation that the devices rely on a database or subsequent methodology. For example, could wireless microphones be designed to access directly a database through an Internet connection and download a list of available frequencies of operation in the same manner as white space devices? Would such an approach be practical, and would it add cost and complexity to wireless microphones? Would requiring users of unlicensed wireless microphones to manually check a database through another device, *e.g.*, a laptop or smart phone, to get a list of available frequencies of operation comply with the Act's stipulation "to rely on a database" and ensure that the devices operate only in permissible frequency bands? Alternatively, would manual database checking be a "subsequent methodology" which is permitted by the Spectrum Act in lieu of a database? Are there alternative methodologies that could be used in compliance with the Act? We note that after the end of the post-auction transition period, the duplex gap would be cleared of all broadcasters and would be uniform nationwide. Would designating a nationwide six megahertz block of spectrum in the duplex gap exclusively for unlicensed operation constitute a "subsequent methodology" under the Spectrum Act, and therefore eliminate the need for a database access requirement for both white space devices and wireless microphones?

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[208] Spectrum Act § 6407 (c).

[209] Spectrum Act § 6407(d), (e).

[210] *See* 47 C.F.R. § 15.5(b).

[211] *See supra* para. 79.

[212] While we are making a specific proposal here to require database access for unlicensed wireless microphones that operate in the guard bands and duplex gap, the wireless microphone NPRM explores more generally whether wireless microphone systems could potentially benefit from the ability to access to a database. See Wireless Microphone NPRM, Section III.B.2 (Other technological advancements).

b. Licensed wireless microphones in the duplex gap

165. We propose to require that licensed wireless microphones operating in the duplex gap comply with the same technical requirements described above for unlicensed wireless microphones in the guard bands and duplex gap, with the following two exceptions. First, we propose that the permissible frequencies of operation would be limited to the four megahertz segment of the duplex gap which we propose to designate for licensed wireless microphone use.[213] Second, we are not proposing to require licensed users to access a database before beginning operation because we do not believe such a requirement is necessary. At the end of the post-auction transition period, the duplex gap will be cleared of all broadcast operations, including low power TV and translator stations, and the duplex gap will be uniform nationwide. Thus, there will be no need for database access to determine whether the four megahertz segment of the duplex gap is available. During the post-auction transition period, however, a licensed wireless microphone user may need to determine whether the duplex gap is available in an area. We believe that broadcaster and cable programming network entities that will be licensed to operate in the duplex gap are sophisticated users that are capable of determining whether the duplex gap is available at their location. Thus, we do not believe it necessary to propose rules requiring licensed users of the four megahertz segment of the duplex gap to access a database to determine frequency availability. Since we are proposing to limit operation in this four megahertz segment to licensed users, there is no statutory requirement that use must rely on database access or a subsequent methodology determined by the Commission.[214] We seek comment on these proposals. We also seek comment, as discussed above regarding the splitting of the duplex gap, whether licensed wireless microphones could protect wireless services in the adjacent band from harmful interference.[215]

3. Repurposed 600 MHz Band

166. In the *Incentive Auction R&O,* the Commission decided to permit wireless microphone users to continue to operate in the 600 MHz Band during the Post-Auction Transition Period subject to certain conditions. Specifically, wireless microphone users must cease operations in the 600 MHz Band if they cause harmful interference to any 600 MHz licensee's operations, and they must accept interference received from these operations.[216] The Commission also decided that all wireless microphone operations must be transitioned out of the 600 MHz Band no later than the end of the Post-Auction Transition Period, which will be 39 months after the issuance of the *Channel Reassignment PN*.[217] The Commission did not adopt any specific criteria to prevent harmful interference from wireless microphones to 600 MHz Band licensees, such as minimum separation distances from a co-channel wireless licensee's service area.

167. We propose that both licensed and unlicensed wireless microphones operating in the repurposed 600 MHz Band during the Post-Auction Transition Period comply with minimum separation distance requirements to prevent harmful interference to 600 MHz Band licensees. We believe that protection requirements are necessary because wireless microphones could cause harmful interference to 600 MHz Band equipment (*e.g.,* handsets) while not receiving any interference since 600 MHz Band equipment transmits and receives on different frequencies. Thus, the wireless microphone operator may be unaware that it is causing harmful interference, and the party receiving the harmful interference may be unaware of its source.

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[213] *See supra* para. 92.

[214] *See* Spectrum Act § 6407(d).

[215] *See supra* para.95.

[216] *See Incentive Auction R&O*, 29 FCC Rcd at 6846, para. 687.

[217] *Id.* In Section III.C.1.b.iii of the Wireless Microphones NPRM, we seek comment on how best to facilitate a smooth transition of wireless microphones out of the 600 MHz Band.

168. We propose to protect 600 MHz Band licensees from harmful interference from wireless microphones using the same criteria we propose to protect 600 MHz Band licensees from harmful interference from white space devices. Specifically, we propose to require that wireless microphones operate at the same distance outside a 600 MHz Band licensee's service area as white space devices operating with a power of 4,000 milliwatts EIRP and an antenna height of three meters above average terrain. This is similar to the approach the Commission used in the *Incentive Auction R&O* to determine the minimum separation distance between wireless microphones and the protected contour of co-channel television stations.[218] In that case, the Commission based its determination on a power level significantly higher than a single wireless microphone since multiple wireless microphones can operate in a single six megahertz channel. It used the three meter antenna height above average terrain because that height is used in determining the separation distances for portable white space devices, and wireless microphones are also portable devices. Are the proposed protection distances appropriate, or do we need to increase or decrease them? We seek comment on this proposal.

169. We also seek comment on how best to implement the proposed separation distances. As discussed below, we are proposing that the white space databases include information on the geographic areas and frequency bands where 600 MHz Band licensees have commenced operation. This information will be used to ensure that white space devices operate sufficiently far outside a licensee's service area to prevent harmful interference, and could also be used to ensure that wireless microphones operate sufficiently far outside a licensee's service area. Is there a need to require unlicensed wireless microphone users to check a database to ensure that they are outside a wireless licensee's service area,[219] or are the general non-interference requirements described in the *Incentive Auction R&O* sufficient to protect 600 MHz Band licensees? Wireless microphone users would most likely access the databases through an Internet connection separate from the microphone since, during the post-auction transition period, users will likely continue to use microphones certified under current Part 74 rules which are not designed to access the white space databases. How often should unlicensed wireless microphone users be required to check the database to determine whether a licensee has commenced operation?[220] Should there be a time limit on how far in advance of an event a wireless microphone user can check the database? Are the timing intervals that we propose below for white space devices appropriate for wireless microphones to check for 600 MHz licensees that have commenced operation? Would the white spaces database administrators have to make any changes to their databases to allow unlicensed wireless microphone users to check whether they comply with the proposed separation distances? If so, what costs would be incurred and who would pay the costs? If any commenters believe the general non-interference requirements described in the *Incentive Auction R&O* are sufficient to protect 600 MHz Band licensees during the post-auction transition period, they should explain how interference would be resolved, by whom, and what mechanism would be used to identify interference sources.

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[218] *See Incentive Auction R&O,* 29 FCC Rcd at 6699, para. 306.

[219] Complying with separation distances to protect wireless services presents different issues than complying with separation distances to protect TV contours. Although we are proposing that unlicensed wireless microphones must meet a separation distance beyond a TV stations contour, we are not proposing that microphone users access the white space databases to determine the appropriate distance at their location (*see supra* para. 150). Unlike in the TV broadcast service, 600 MHz Band licensees rely on the deployment of multiple base stations to provide service, and expand the number and locations of base stations as they increase their service areas. This is a more dynamic set of circumstances that may be more suitable for microphone users having to access the databases to identify the appropriate separation distances to protect wireless services.

[220] For example, fixed white space devices are required to check the databases for a channel list at least once per day, and personal/portable devices are required to check each time they are activated from a power-off condition and re-check if they change location during operation by more than 100 meters from the location at which they last accessed the database. *See* 47 C.F.R. § 15.711(b)(3). We are proposing in this Notice to modify these rules for identifying channels reserved by wireless microphone users which we are proposing would be those users licensed under Part 74 only. *See infra* paras. 185-186.

C. White Spaces Databases

1. Expanding location/frequency information in database

a. WMTS

170. Authorized health care providers are authorized by rule to operate transmitters in the WMTS. Although the Commission does not issue individual licenses in this service, it does require that authorized health care providers that use WMTS devices must register the devices with a Commission-designated frequency coordinator prior to operation.[221] The registration program assists users in meeting their obligation to cooperate in selecting and using frequencies to reduce the potential for interference with each other or co-primary RAS operations.[222] ASHE/AHA, the Commission-designated WMTS frequency coordinator,[223] has contracted with Comsearch to develop and maintain the WMTS database.[224] WMTS users pay fees to ASHE/AHA and Comsearch to register their systems.

171. Some of the information already in the WMTS database, *e.g.*, the geographic coordinates of the transmitters operating on Channel 37, is the same type of information needed to protect the WMTS from interference by white space devices operating on channel 37 and in the adjacent bands, which would be either three megahertz guard bands or channels 36/38, depending on the outcome of the incentive auction.[225] Specifically, we propose to include in the white spaces databases the following information obtained from the WMTS database for each WMTS device registration on channel 37:

1) Frequency of operation (*i.e.,* channel 37),
2) Geographic coordinates of transmitters, and
3) Cross reference to the registration in the WMTS database (*e.g.,* record number).

172. We believe that the number of WMTS transmitters at a location is not needed by the white spaces database since a white space device would have to meet the same distance separation requirements whether there is a single or many WMTS transmitters at a health care facility. We propose to require that a record for a WMTS operating location in the white spaces database include a cross

[221] *See* 47 C.F.R. § 95.1111(a).

[222] *See* 47 C.F.R. § 95.1115 (d)(4).

[223] *See supra* para. 97. ASHE/AHA and the Commission, under authority delegated to the Wireless Telecommunications Bureau, *see* 47 C.F.R. § 0.331, have a Memorandum of Understanding governing ASHE/AHA's obligations as the WMTS frequency coordinator. Memorandum of Understanding between The United States Government, The Federal Communications Commission, and the American Society of Health Care Engineering of the American Hospital Association Regarding Frequency Coordination for the Wireless Medical Telemetry Service.

[224] The responsibilities of the designated frequency coordinator include: 1) reviewing and processing coordination requests, 2) maintaining a database of WMTS use, 3) notifying WMTS users of potential conflicts, and 4) coordinating WMTS operation with radio astronomy observatories and Federal Government radar systems. *See* 47 C.F.R. § 95.1113(b). The coordinator must also notify certain Part 90 and Part 27 licensees of the requirement to comply with specific field strength limits in the 1427-1432 MHz and 1392-1395 MHz bands. Comsearch also is one of the designated white spaces database administrators.

[225] A WMTS registration request must include: 1) specific frequencies or frequency range(s) used, 2) modulation scheme used, 3) effective radiated power, 4) number of transmitters in use at the health care facility and the manufacturer name(s) and model numbers, 5) name of the authorized health care provider, 6) location of transmitter (coordinates, street address, building), and 7) contact information for the authorized health care provider. *See* 47 C.F.R. § 95.1111(a). We believe that it is not necessary for the white spaces database to include information on the modulation scheme, effective radiated power or the number of WMTS transmitters used at a location. The proposed protection criteria for the WMTS are minimum co-channel and adjacent channel separation distances, and the white spaces database does not need information on modulation and power to determine if a white space device meets the minimum separation distance requirements.

reference to the corresponding information in the WMTS database, such a unique record identification number. We believe that this requirement is necessary because the WMTS does not require individual licensing, so there are no call signs that could be used to cross-reference information between databases. Since we are only proposing to require the minimum information in the white spaces database necessary to determine if a device meets the required separation criteria from WMTS operating locations, we need to be able to reference the more detailed information in the WMTS database if there are questions concerning data accuracy or if interference occurs.

173. We believe that using data from the WMTS database in the white space databases is preferable to requiring authorized health care providers to register in both databases. A duplicative registration requirement would be burdensome for WMTS users, could result in discrepancies in the data in both databases, and could delay populating the white space databases with the information necessary to protect WMTS users. We also recognize concerns raised by parties in the incentive auction proceeding that information in the WMTS database may be missing or imprecise.[226] For example, although location information in the WMTS database may be sufficient for WMTS coordination purposes, that information may need to be updated before it could be used by the white space databases to determine interference protection distances. The Wireless Telecommunications Bureau (WTB), under delegated authority to oversee the WMTS coordinator and in conjunction with OET which has delegated authority to oversee the white spaces database administrators, would work with ASHE/AHA to accomplish this task under the terms of the MOU it has executed with ASHE/AHA for this purpose. OET also would work with ASHE/AHA and Comsearch to develop procedures to transfer the necessary information to the white spaces databases in a compatible format.[227] We emphasize that under the current rules, all parties that operate WMTS equipment are already required to register with the WMTS coordinator.[228] OET plans to work with ASHE/AHA and other parties as necessary to remind hospitals and other health care providers that use WMTS equipment of their obligation to register with the designated frequency coordinator and to ensure that such registration information is accurate.

174. We seek comment on these proposals. In particular, we seek comment on the use of information from the WMTS database to protect the WMTS in the white spaces databases. Is the information we proposed for inclusion in the white spaces database adequate, or is additional information necessary? What steps would ASHE/AHA and Comsearch have to take to modify the data in the WMTS database or the database functions to transfer data to the white spaces databases on a regular basis? How long would these modifications take, what costs would be incurred, and how would those costs be recovered? Are there any steps we can take to ensure the accuracy of the WMTS information? For example, could we allow the specification of multiple points to define a bounded area around a large facility that uses the WMTS as opposed to specifying a single point? If so, how could that be accomplished? Should we require ASHE/AHA to add more detailed location information to its database that would be transferred to the white spaces databases?

b. Radio Astronomy Service (RAS)

175. The current white space rules list the locations of 14 radio astronomy sites and require that all fixed and personal/portable devices operate at least 2.4 kilometers away from them.[229] The 12 locations where the RAS receives on channel 37, specifically, the Arecibo Observatory, the Green Bank Telescope, and the ten sites that comprise the VLBA, are included in this list. Therefore, these locations are already in the white spaces database since they are protected under the current rules. However, the

[226] *See Incentive Auction R&O,* 29 FCC Rcd at 6686-6687, para. 275.

[227] We believe that OET's actions could be taken under its existing authority to oversee the white spaces database administrators. *See* 47 C.F.R. § 0.241(h).

[228] *See* 47 C.F.R. § 95.1111(a).

[229] *See* 47 C.F.R. § 15.712(h)(3).

required 2.4 kilometer separation distance from these sites was based on the assumption that white space devices do not operate on channel 37. As discussed above, we are proposing to allow white space device operation on channel 37, and proposing protection criteria for the RAS receive sites that receive channel 37 to protect them from interference.[230] The white spaces database administrators would need to make two changes to their systems as a result of the proposed rules. First, they would have to require that white space devices meet separation distances greater than 2.4 kilometers from the ten VLBA sites. Second, they would have to include information on the quiet zones at Green Bank and the islands of Puerto Rico where white space devices may not operate. We seek comment on whether any other changes to the database would be required.

176. The other two RAS sites listed in Section 15.712(h)(3) (the Allen Telescope Array and the Very Large Array) do not receive signals in the TV bands or the 600 MHz Band.[231] We are therefore proposing to delete them from the list of sites in this section.[232] We seek comment on this proposal.

c. 600 MHz Band services

177. In the *Incentive Auction R&O,* the Commission decided to permit the continued operation of white space devices on repurposed spectrum except in those areas in which a 600 MHz Band licensee commences operations.[233] Recognizing that new licensees would likely commence operations at different places within their licensed service area at different times depending on their business plans and other factors, the Commission concluded that since white space devices can operate only on channels identified in the white spaces databases, these databases can serve to ensure that unlicensed operations will no longer occur on a channel on which a licensee has commenced operations.[234] It stated that when a 600 MHz Band licensee plans to commence operations on frequencies that include channels available for unlicensed operations under the rules for white space devices, that licensee can notify any of the white spaces database administrators when and where it plans to commence operations. The Commission noted that, as an example, the white spaces databases could include the coordinates of four corners of a polygon that corresponds to the area where the 600 MHz Band licensee has commenced operations, and thus prevent operation of white space devices on the channel(s) used by the licensee within the defined area.

178. We propose to require that TV bands database administrators store information on the locations where 600 MHz Band licensees commence operations in a similar fashion to the example that the Commission discussed in the *Incentive Auction R&O.* Specifically, we propose that the database administrators allow 600 MHz band licensees to enter the coordinates of at least eight points representing the corners of a polygon of the minimum size necessary to encompass all base stations within the area where a licensee is commencing operations, as well as the frequencies that a licensee will use in the specified area.[235] The white spaces databases will use this information along with the protection criteria proposed in this Notice to ensure that white space devices operate at a sufficient distance outside the border of the defined polygon to prevent interference to wireless services. We are proposing to base the size of the polygon on the minimum size necessary to encompass base stations, since the proposed

[230] *See supra* para. 120 and 123.

[231] *See Incentive Auction R&O,* 29 FCC Rcd at 6689-6690, para. 282, footnote 850. The National Radio Astronomy Observatory (NRAO) states that the Very Large Array cannot easily observe at 500 – 1000 MHz and that the Allen Telescope Array cannot operate below 900 MHz. *See* NRAO comments in GN Docket No. 12-286 at 2.

[232] This proposal is consistent with our action in the *Incentive Auction R&O* in which we did not include these two locations on the list of sites that 600 MHz Band licensees must make reasonable efforts to protect. *See Incentive Auction R&O,* 29 FCC Rcd at 6923, Section 27.19(a).

[233] *See Incentive Auction R&O,* 29 FCC Rcd at 6843-6844, para. 680.

[234] *Id.*

[235] Because the Commission is licensing the five megahertz blocks in pairs, there will always be at least one uplink and one downlink block in a service area.

protection criteria for both wireless uplinks and downlinks are based on a minimum distance from base stations.

179. We propose that wireless licensees specify a polygon with a minimum of eight sides rather than four as the Commission previously suggested, and that a TV bands database be capable of accepting up to 120 points to delineate the wireless carrier's area of operation. This is the maximum number of points that a licensee may enter when partitioning a license area.[236] This approach would provide wireless carriers with sufficient flexibility to describe different areas of operation. They could enter the coordinates of multiple polygons in cases where it plans to commence service in multiple non-contiguous areas. They also could specify shapes more complex than an eight-sided polygon to designate an area that includes irregular boundaries, such as PEA boundaries so that the protected area in the database stops at the edge of a carrier's licensed area.

180. We seek comment on these proposals. In particular, we seek comment on whether a polygon with a minimum of eight sides is the appropriate method for defining the area where a licensee has commenced service. We also seek comment on whether it is necessary to allow for polygons with up to 120 sides. Would such a requirement be difficult for the database administrators to implement? We further seek comment on how the database should handle situations where a licensee is providing service up to the boundary of its licensed PEA. Should the database contain information on PEA boundaries so a licensee does not need to enter them? How difficult would it be for the database administrators to add that capability?

181. We propose that a 600 MHz Band licensee enter the date it plans to commence operations when it registers a polygonal area and operating frequencies with the TV bands database. We also propose that the white space database administrators provide to the other database administrators on a daily basis the data registered by 600 MHz licensees, as they do for other services.[237] Requiring the database to include the date for commencing operations will allow a licensee to define its operations area well in advance without limiting the ability of white space devices to operate until the actual date when the 600MHz wireless licensee commences operation. The database will disregard the registration information prior to the service commencement date when determining which channels are available for white space devices. Some licensees may not wish to make available details of their intended plans far in advance, and they could register their information closer to the actual date when they intend to commence operations. In doing so, they should keep in mind the time period needed for the white space databases to share information and the frequency with which white space devices are required to check for available channels.[238]

d. Private Land Mobile Radio Service (PLMRS)

182. We are proposing to modify the information required to be included in the white spaces databases for PLMRS/CMRS base station operations located more than 80 kilometers from the geographic centers of the 13 metropolitan areas defined in Section 90.303(a) of the rules (*e.g.* , in accordance with a waiver).[239] Section 15.713(h)(4) currently requires that the database include the transmitter location, effective radiated power, antenna height above ground and average terrain, and call sign for each PLMRS/CMRS base station.[240] These stations are protected to a distance of 54 kilometers

[236] *See* 47 C.F.R. § 27.15(b). FCC Form 603, Appendix C, which is used for partitioning cases, contains space to enter 120 coordinate pairs (latitude and longitude).

[237] *See* 47 C.F.R. § 15.715(l).

[238] *See infra* paras. 188-195.

[239] *See* 47 C.F.R. § 15.713(h)(4).

[240] *See* 47 C.F.R. §§ 15.713(h)(4)(i)-(v).

from co-channel white space devices, and 51 kilometers from adjacent channel white space devices.[241] However, Section 15.713(h)(4) does not require the database to include the TV channel number on which the PLMRS/CMRS station operates, which is information that needs to be included in the database to determine when a station needs protection.[242] In addition, there does not appear to be any need to include the effective radiated power or antenna heights above ground and average terrain for each base station in the database. The protection criteria for base stations is based on a geographic separation from the transmitter location, and the power and antenna height information are not necessary for the database to calculate the separation distance. Accordingly, we propose to modify Section 15.713(h)(4) to require the TV bands database to include the TV channel number on which a PLMRS/CMRS base station operates, and to remove the requirement to include effective radiated power and antenna height information. We seek comment on this proposal.

e. Canadian and Mexican stations information

183. Because white space devices operate in the same frequency bands and on the same channels as TV stations in Canada and Mexico, the Commission is sensitive to the need to avoid causing harmful interference to TV broadcast operations in those countries. To this end, we committed to discussing with Canada and Mexico how we could include in our white space databases information on Canadian TV stations in the border areas that need to be protected.[243] Currently, the Commission receives this information from Canada and passes it on to our white space database administrators who protect these locations.[244] The Commission is discussing with Canada, which is moving ahead with its own program to permit white space devices on vacant TV channels, how best to have the Canadian and U.S. database administrators share information about stations in each country that need to be protected in the border areas. Some of these facilities may be receive sites that are not listed in Commission or Canadian government licensing databases, and the operators of the receive sites directly register their location information with the databases.[245] We seek comment on how best to accomplish this objective. Should we require our database administrators to share this information directly with Canadian database administrators, or should the Commission be the conduit for passing this information to the Canadian database administrators?

2. Changes to database procedures

a. Wireless microphones

184. Under the current rules, Part 74 licensees operating Low Power Auxiliary Service (LPAS) equipment, including wireless microphones, may register their operating locations, channels and times in the white spaces database.[246] The white spaces database protects these registered locations by requiring fixed devices to operate at least one kilometer from them and requiring personal/portable devices to operate at least 400 meters from them.[247] Licensees may register their information directly with any one of the designated white space database administrators, and the information is then shared with all the other database administrators. In addition, parties operating large numbers of wireless microphones on an unlicensed basis are also allowed to register their operating locations in the white

[241] *See* 47 C.F.R. § 15.712(d).

[242] Because the operating channel number is necessary to protect the PLMRS/CMRS, the white spaces database administrators already include this information in their databases even though it is not specifically required by the rules.

[243] *See White Spaces Second MO&O*, 25 FCC Rcd at 18720, para. 141.

[244] *See* 47 C.F.R. §§ 15.711 (a), 15.712 (g).

[245] *See* 47 C.F.R. § 15.713 (b)(2).

[246] *See* 47 C.F.R. § 15.713(h)(8).

[247] *See* 47 C.F.R. § 15.712(f).

spaces database under certain circumstances.[248] These registered locations are given the same protection from white space devices as licensed LPAS operations. Registration of unlicensed wireless microphones is limited to venues of events and productions and shows that use large numbers of microphones that cannot be accommodated in the two reserved channels and other channels that are not available for use by white space devices at a specific location.[249]

185. We propose to eliminate the Part 15 rule that permits unlicensed wireless microphone users to register the operating locations, channels and times in the white spaces databases to protect these operations from possible interference from white space devices. Thus, unlicensed wireless microphones would no longer be permitted to register their operations in the TV bands, as well as in the 600 MHz Band Plan guard bands or duplex gap. We seek comment on this proposal.

186. We make this proposal in part due to our recent decision to adopt the *Wireless Microphones Second R&O* in which we expanded eligibility for Part 74 LPAS licenses to include professional sound companies and the owners and operators of large venues that routinely use 50 or more wireless microphones,[250] and to permit these eligible entities to register directly in the TV bands database, provided that they obtain a license. We note that the goal in both the *TV Bands Wireless Microphones Second R&O* and in the *TV White Spaces Second MO&O*, in which the Commission adopted rules permitting unlicensed users to register in the TV bands database, was to ensure that entities requiring a large number of wireless microphones are able to register in the TV bands database.[251] Commenters should address the extent to which this decision to expand license eligibility in the *TV Bands Wireless Microphone Second R&O* obviates the need for unlicensed wireless microphone users at "venues of events and productions/shows that use large numbers of wireless microphones" to register in the TV bands database.[252]

187. We also make this proposal in part because in this Notice we are proposing other ways that unlicensed microphones would operate on an equal basis with white space devices in the TV bands, the 600 MHz guard bands, and the portion of the duplex gap where we would allow unlicensed operation. For example, we propose technical rules (*e.g.*, power limits) for unlicensed microphones that are similar to those applicable to white space devices, thus reducing the potential for interference between these different uses. We also propose that unlicensed wireless microphones operating in the 600 MHz Band guard bands and duplex gap must contact the white spaces databases prior to operation to ensure that their intended operating frequencies are available for unlicensed wireless microphones at the location where they will be used. Under the Part 15 rules we propose to adopt, unlicensed wireless microphones, would operate under the same general conditions of operation as white space devices, meaning they may not

[248] *See* 47 C.F.R. § 15.713(h)(9).

[249] Parties filing registration requests must certify that they are making use of all TV channels not available to white space devices and on which wireless microphones can practicably be used. As a benchmark, at least six to eight wireless microphones should be operating in each channel used at such venues. Sites of eligible event venues using unlicensed wireless microphones must be registered with the Commission at least 30 days in advance, and the Commission provides this information to the white spaces database administrators.

[250] *See TV Bands Wireless Microphones Second R&O*.

[251] *See Wireless Microphones Second R&O* at ¶ 21 (the revised eligibility "will enable the newly eligible entities, which generally are able to register for database protection [under the 2010 *TV White Spaces Second MO&O*] as unlicensed users, to obtain protection in the TV bands database in a more administratively efficient manner, through the Part 74 license process"). *See also* Unlicensed Operation in the TV Broadcast Bands and Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz band, ET Docket Nos. 04-186 and 02-380, *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661, 18674-75, para. 31-32.

[252] *See* 47 C.F.R. § 15.713(h)(9).

cause interference to authorized services and must accept any interference received, including interference from other unlicensed devices.[253]

b. White space device re-check interval and databases' sharing of registration information

188. White space devices are required to re-check the database at least once per day to obtain the list of available TV channels at the location where the device operates.[254] If a device is unable to make contact with the database on any given day, it may continue to operate to operate until 11:59 PM on the following day, at which time it must cease operation until it re-establishes contact with the database.[255] The Commission established these timeframes because most protected services listed in its databases do not change on a frequent basis. Further, since the Commission provides updated data to the white spaces database administrators only once every weekday, there is generally no need for white space devices to recheck the database more frequently than once per day.

189. The only protected use for which database information generally changes more frequently than once daily is wireless microphones. A wireless microphone user may register with a single white spaces database, and that database must then share the registration information with the other databases.[256] The rules require such sharing to be done at least once daily, or more often as appropriate.[257] The Commission established two reserved television channels where white space devices cannot operate to ensure that there would be spectrum available for wireless microphones used in applications such as electronic news gathering for which it is not possible to register the operating location in the database at least 24 hours in advance.

190. To ensure that wireless microphones used in applications such as electronic newsgathering receive protection in a timely manner, we propose two improvements – an increase in the frequency at which white space devices must re-check the database, and a limit on the time required for an LPAS registration made in one white spaces database to appear in all other white spaces databases. Specifically, we propose to amend Sections 15.711(b)(3)(i) and 15.711(b)(3)(ii) of the rules to require fixed and Mode II personal/portable white space devices to re-check the database at time intervals not to exceed 20 minutes. We also propose to eliminate Section 15.711(b)(3)(iii) which allows a white space device to continue operating until 11:59 PM on the following day if it cannot establish contact with the database. We propose to amend Section 15.715(l) of the rules to require database administrators to share registration information between databases within ten minutes. The effect of these two proposals will be to ensure that a white space device ceases operation on a channel used by a wireless microphone within 30 minutes after a new registration is entered into the database. This 30 minute time interval is consistent with previous requests by NAB and Shure.[258]

191. The Commission previously considered and rejected requests by wireless microphone manufacturers and users to establish a shorter re-check interval than the current 24 hours specified in the

[253] *See* 47 C.F.R. § 15.5(b).

[254] *See* 47 C.F.R. § 15.711(b)(3)(i)-(ii).

[255] *See* 47 C.F.R. § 15.711(b)(3)(iii).

[256] *See* 47 C.F.R. § 15.715(d) and (l).

[257] *See* 47 C.F.R. § 15.715(l).

[258] *See* Coalition of Wireless Microphone Users reply to opposition to petition for reconsideration in ET Docket No. 04-186 dated May 8, 2009 at 8 (devices should check the database no less frequently than once per hour), and Shure petition for reconsideration in ET Docket No. 04-186 dated March 19, 2009 at 15 (devices should check the database in real-time, near real-time, or a minimum of once per hour).

rules.[259] In rejecting these requests, the Commission noted the steps it had taken to ensure that adequate spectrum in the TV bands remains available for licensed itinerant wireless microphone users by prohibiting personal/portable devices from operating below channel 21, designating two channels in each market from among channels 14-51 where white space devices cannot operate, and prohibiting fixed devices from operating adjacent to occupied television channels.[260]

192. It is now appropriate to revisit the Commission's earlier decision that retained a 24 hour database re-check interval. In the *Incentive Auction R&O*, the Commission decided to no longer designate two vacant television channels exclusively for wireless microphone use.[261] In making this change, the Commission stated that it also planned to make significant improvements to the white spaces databases to help address the concerns of wireless microphone users and accommodate their needs for access to available unused television channels, free from interference from unlicensed devices.[262] There are now multiple white spaces databases in operation, and our experience with them has demonstrated that a channel re-check can be done very rapidly, so it does not appear that more frequent database checks would be unduly burdensome.

193. We seek comment on our proposals. In particular, we seek comment on whether 20 minutes is an appropriate re-check interval, or whether the interval should be longer or shorter. We also seek comment on how a white space device should respond in the event that it cannot contact a database at the specified re-check interval. Should the device simply be required to cease transmitting, or should it be permitted to operate for a longer time so it can retry contacting the database? How much more time should be permitted, if any?

194. In addition, we seek comment on the appropriateness of the proposed ten minute time limit for sharing information between databases. Section 15.715(l) requires the sharing of registration information for fixed devices and MVPD receive sites in addition to wireless microphones.[263] We seek comment on whether there is a need to require faster sharing of these other types of registration information, or whether any new requirements should apply only to wireless microphones.

195. Sections 15.711(b)(3)(i) and (ii) require that a fixed or personal/portable white space device that accesses the database must obtain wireless microphone scheduling information for a 48 hour period beginning from the time that the device accesses the database for a list of channels.[264] This requirement is necessary because a white space device is only required to access the database once every 24 hours, and it may continue to operate for an additional 24 hours if it is unable to contact the database. However, if we require white space devices to contact the database every 20 minutes, it appears that this 48 hour time period could be reduced. We propose to require that a white space device must obtain wireless microphone scheduling information for a period of 60 minutes beginning from the last time it accesses a database. We seek comment on this proposal.

196. Finally, we believe that these proposals, if adopted, should provide assurance to wireless microphone users that they will be able to access channels when and where they need them on short notice, without having to reserve multiple channels for every day/all day over extensive time periods. On several occasions we have seen microphone registrations that have been abusive of our rules[265] and their

[259] *See Second Memorandum Opinion and Order* in ET Docket Nos. 02-380 and 04-186, 25 FCC Rcd 18661, 18706-18707, paras. 108-111 (2010).

[260] *Id.* at 18707, para. 111.

[261] *See Incentive Auction R&O,* 29 FCC Rcd at 6701-6702, para. 310.

[262] *See Incentive Auction R&O,* 29 FCC Rcd at 6702, para. 311.

[263] *See* 47 C.F.R. § 15.715(l).

[264] *See* 47 C.F.R. §§ 15.711(b)(3)(i)- (ii).

[265] *See* 47 C.F.R. §§ 15.713(h)(8), (h)(9).

intent to provide a fair opportunity for all microphone and white space device users to access available channels and make the most efficient use of spectrum. We seek comment on whether there are other steps we should take to curb such abusive practices.[266]

c. Database Registration and Fees

197. Under the current Part 15 rules, fixed white space devices must register with the white space databases, providing the geographic coordinates, antenna height and certain identifying information.[267] We propose to clarify our rules to ensure that fixed white space devices register with the databases if they would operate not only in TV bands but also in the repurposed 600 MHz Band, the guard bands and duplex gap, and Channel 37. We also propose to modify our rule that permits the white spaces database administrators to charge a fee for providing lists of available channels to white space devices and to register fixed white space devices to clearly state that this rule provision applies to white space devices that would operate in the TV bands, the repurposed 600 MHz Band, the 600 MHz guard bands, including the duplex gap, and Channel 37.[268] We also propose that, if we adopt the proposal in this Notice that unlicensed wireless microphones operating in the 600 MHz guard bands and duplex gap must contact the white spaces databases to identify operating frequencies available for their use, the database administrators may charge a fee for providing this information. We seek comment on these proposals.

198. The Commission permits the database administrators to assess fees to support the creation and operation of the databases, and these fees may be imposed on the operators of the white space devices in order to access the database and/or on the manufacturers of the white space devices.[269] We believe that both white space devices and unlicensed wireless microphones in the 600 MHz guard bands and duplex gap should be equally responsible for supporting the ongoing operation of the databases. Both types of uses benefit equally from the information provided by the databases. Should wireless microphone users also register their devices in the white space databases? Should database administrators assess a fee for microphone registration, as they do with fixed white space devices? Would a registration program facilitate the assessment of fees for obtaining channel lists? Commenters should address the feasibility of assessing database fees on unlicensed wireless microphone operators or manufacturers.

199. Regarding the registration of fixed white space devices in the white space databases, the Commission has stated that devices that do not check the database for three months to update their channel lists will be removed from the databases, but it did not codify this requirement.[270] Fixed devices that are re-registered later would be subject to a new registration fee. We seek comment on whether we should continue this requirement, and whether it should apply to wireless microphones if we adopt a similar registration requirement for them. What purpose is served by removing a fixed device registration if it has not updated its channel list over a certain period of time? In this Notice, we are proposing to significantly increase the frequency for white space devices to re-check the database for a list of available channels. If we continue this requirement, is a three month inactive period appropriate?

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[266] For example, the rules for unlicensed microphone registration state that if users file inaccurate or incomplete information, we would deny the registration in the database, remove the information from the database, or take other sanctions as appropriate. *See* 47 C.F.R. § 15.713(h)(9).

[267] *See* 47 C.F.R. §§ 15.713 (b)(2)(iii), (f)(3).

[268] *See* 47 C.F.R. § 15.714(a) (fees may be charged for providing a list of available channels).

[269] *See White Spaces Second R&O* 23 FCC Rcd at 16884-16885, para. 223.

[270] *See White Spaces Second R&O*, 23 FCC Rcd at 16880, para. 211.

D. Equipment certification and marketing

200. Most Part 15 intentional radiators, including white space devices and wireless microphones, must be authorized through the certification procedure before they can be imported into or marketed within the United States.[271] Part 74 wireless microphones must also be authorized through the certification procedure.[272] This procedure requires the filing of an application with either the Commission or a designated Telecommunications Certification Body (TCB) that includes test data demonstrating that the device complies with the appropriate technical rules.[273] A grant of equipment certification does not normally specify an importation or marketing cutoff date, so it remains valid indefinitely unless revoked or withdrawn, rescinded, surrendered, or a termination date is otherwise established by the Commission.[274]

201. We are proposing rule changes in this Notice that would give greater flexibility for fixed and personal/portable white space device operation in the TV bands. The majority of these changes are permissive, meaning that manufacturers of approved white space devices are not required to incorporate them into their equipment. However, the proposed requirement for white space devices to re-check a database at more frequent intervals would require changes to previously approved devices. In addition, we are proposing to adopt rules for unlicensed wireless microphones that operate in the TV bands and for unlicensed devices and for licensed and unlicensed wireless microphones that operate in the guard bands and duplex gap. These devices will be affected by the transition provisions adopted in the *Incentive Auction R&O*. We address certification, marketing and operational requirements for white space devices and unlicensed wireless microphones below.

1. Fixed and personal/portable devices

202. Our proposal to require fixed and Mode II personal/portable devices to check the database more frequently and to obtain scheduling information for wireless microphones over a shorter time period would require changes to devices that were previously approved, since the frequency of checking the database is a function of a device.[275] We believe that this change can be implemented with a minor software update, so only short transition time periods are necessary. Accordingly, we propose to require that devices for which a certification application is filed beginning 30 days after the effective date of the rules comply with the new re-check requirements. We also propose to require that within 90 days after the effective date of the rules, all white space devices imported and marketed within the United States must comply with the new re-check requirement, regardless of when they were certified. We further propose to require that white space devices that do not comply with the new re-check requirements must cease operating within 180 days of the effective date of the rules. We seek comment on these proposals.

2. Wireless microphones

203. All wireless microphones that now operate in the TV bands are certified as compliant with Part 74, Subpart H of the Commission's rules. The Commission decided in the *Incentive Auction*

[271] *See* 47 C.F.R. §§ 2.1204(a)(1) and 15.201(b).

[272] *See* 47 C.F.R. § 74.851.

[273] *See* 47 C.F.R. § 2.907(a). The Commission proposed in another proceeding that all equipment certification applications be processed by TCBs, but has not yet taken action on that proposal. We are not addressing that proposal in this proceeding. *See Amendment of Parts 0, 1, 2, and 15 of the Commission's Rules regarding Authorization of Radiofrequency Equipment and Amendment of Part 68 regarding Approval of Terminal Equipment by Telecommunications Certification Bodies, Notice of Proposed Rulemaking*, ET Docket No. 13-44, 28 FCC Rcd 1606 (2013).

[274] *See* 47 C.F.R. § 2.927(a).

[275] *See supra* para. 190 and 195.

R&O that all wireless microphones that operate in the portion of the TV bands that will be repurposed for licensed wireless services may continue to operate in that spectrum during the post-auction transition period but must cease those operations no later than 39 months after release of the *Channel Reassignment PN*.[276] At the end of this post-auction transition period, licensed microphones will be permitted to operate in a portion of the duplex gap, and unlicensed wireless microphones will be permitted to operate in the guard bands and duplex gap.

204. Because of these future changes in the permitted operating frequency range for wireless microphones, plus the rule changes for these devices that we propose in this Notice and in the Wireless Microphone NPRM, we need to establish cutoff dates for the certification, manufacturing and marketing of wireless microphones in the guard bands and repurposed 600 MHz Band spectrum to ensure that manufacturers cease making and marketing equipment that cannot be legally used after a certain date. Cutoff dates will encourage manufacturers to concentrate on developing wireless microphones that operate in compliance with new Part 74 and Part 15 rules. Because similar technical requirements would apply to both licensed and unlicensed wireless microphones,[277] we propose to apply to both the same transition rules for certification, manufacturing and marketing. This approach would be the least disruptive to wireless microphone manufacturers and users. In this Notice, we propose rules for unlicensed wireless microphones; proposed rules for Part 74 licensed wireless microphones are in the Wireless Microphone NPRM.

205. Although we encourage wireless microphone manufacturers to come into compliance as soon as possible with new or revised technical rules, it may be preferable to have the transition period align as closely as possible with the post-auction transition schedule. Manufacturers and users will not know until after the auction which band plan will be in effect and where wireless microphones will be permitted to operate at the end of the post-auction transition period. The auction results will determine the size and frequency range of the 600 MHz Band guard bands, duplex gap, and repurposed spectrum. Our goal is to establish transition periods that are flexible and do not impose multiple re-certification requirements over a relatively short period of time.

206. Currently, unlicensed wireless microphones operate in the TV bands under Part 15 of the Commission's rules pursuant to waivers.[278] These devices must operate in compliance with certain technical requirements set forth in the *TV Bands Wireless Microphones R&O and FNPRM* and be certified under the applicable rules under Part 74, Subpart H.[279] The waiver limits unlicensed wireless microphone operations to no greater than 50 milliwatts, but otherwise the technical requirements (*e.g.*, 200 kHz bandwidth limit) for their operations are the same as Part 74 wireless microphones.[280] Unlicensed microphone operations can continue in the core TV bands under this waiver until the effective date of final rules for their operation on an unlicensed basis under Part 15. The rules we propose in this Notice allow the certification of unlicensed wireless microphones that operate on channels 2-51, excluding channel 37.[281] However, some portion of those channels will be repurposed for licensed

[276] *See Incentive Auction R&O,* 29 FCC Rcd at 6846, para. 687.

[277] The maximum power permitted for unlicensed microphones would be lower than that permitted for licensed microphones. Bandwidth and minimum separation distances from co-channel television stations would be the same, and we are proposing to adopt the same out-of-band emission limits for both licensed and unlicensed microphones.

[278] *See supra* para. 3. The Commission waived Section 15.201 which requires intentional radiators operating under Part 15 to be certified for operation this rule part, and Section 15.209 (a) which prohibits operation of Part 15 devices in the TV bands and at field strengths greater than specified in the table unless specifically permitted elsewhere in Part 15. 47. C.F.R. §§ 15.201(b), 15.209(a).

[279] *See TV Bands Wireless Microphones R&O and Further NPRM,* at para. 82.

[280] Wireless microphones certified under Part 74 may operate up to 250 milliwatts in the UHF TV band.

[281] *See supra* para. 149.

wireless services. We thus propose that, after we adopt Part 15 rules for unlicensed wireless microphone operation, we continue to permit unlicensed wireless microphone users to operate Part 74 wireless microphones in the TV bands under the waivers already in place until they must cease those operations no later than 39 months after release of the *Channel Reassignment PN*. We also propose to accept applications to certify wireless microphones under new Part 15 rules as soon as those rules are effective, but not require such applications until after the incentive auction. We seek comment on these proposals.

207. We propose that parties may no longer submit applications to certify under Part 15 wireless microphones that operate in repurposed TV spectrum beginning nine months after the release of the *Channel Reassignment PN*. We also propose a manufacturing and marketing cutoff on wireless microphones that would not comply with the 600 MHz Band of 18 months after release of the *Channel Reassignment PN*. We seek comment on these proposals. In particular, we seek comment on the appropriateness of the proposed cutoff dates. Should we provide longer or shorter time periods? Should we also require that, in any event, parties may not submit applications to certify wireless microphones that operate in repurposed TV spectrum later than 24 months after the effective date of the service rules we adopt in this proceeding, and microphones that do not comply with the new rules may not be manufactured and marketed later than 33 months after the effective date of the service rules we adopt in this proceeding?[282] Are any other requirements necessary, such as requiring advisory labeling or other information to the user about the operational cutoff date?

208. Unlike wireless microphones operating in the repurposed 600 MHz Band, operation of unlicensed wireless microphones in the guard bands and duplex gap is not affected by the post-auction transition requirements. To ensure that we can distinguish which wireless microphones may be legally operated after the transition from those that cannot, we propose the following requirements. A wireless microphone that is certified to operate only in the guard bands and duplex gap may continue to be marketed and operated with no cutoff date. However, if a wireless microphone is certified to operate in any portion of the repurposed 600 MHz Band, we propose that it may no longer be marketed or operated after the specified cutoff dates, even if it could be tuned to operate outside the repurposed 600 MHz Band. This approach will allow use of the FCC identification number to identify which wireless microphones may be legally marketed and operated, rather than having to determine the precise frequency to which a specific wireless microphone is tuned, which may not be indicated on the device.[283] We seek comment on this proposal.

IV. PROCEDURAL MATTERS

A. Paperwork Reduction Analysis

209. The NPRM contains proposed new information collection requirements. The Commission, as part of its continuing effort to reduce paperwork burdens, invites the general public and OMB to comment on the proposed information collection requirements contained in this document, as

[282] For example, we could require that parties may no longer submit applications to certify under Part 15 wireless microphones that operate in repurposed TV spectrum beginning nine months after the release of the *Channel Reassignment PN* or no later than 24 months after the effective date of the service rules we adopt in this proceeding, whichever occurs first. Similarly, we could establish a manufacturing and marketing cutoff on wireless microphones that would not comply with the 600 MHz Band of 18 months after release of the *Channel Reassignment PN* or no later than 33 months after the effective date of the service rules we adopt in this proceeding, whichever occurs first.

[283] Manufacturers commonly certify wireless microphones to operate over a relatively wide frequency range, then market units that operate over only a portion of the authorized frequency range. A wireless microphone must be labeled with an FCC identification number that allows us to locate its certification records, including the authorized frequency range, but there is no requirement to label each individual wireless microphone with the exact frequency range over which it is tuned. Thus, a visual inspection of a wireless microphone may not show whether it is tuned to operate in the repurposed 600 MHz band.

required by the PRA. In addition, pursuant to the Small Business Paperwork Relief Act, we seek specific comment on how we might further reduce the information collection burden for small business concerns with fewer than 25 employees.

B. Initial Regulatory Flexibility Analysis

210. As required by the RFA, the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on small entities of the policies and rules proposed in the FNPRM. The analysis is found in Appendix B. We request written public comment on the analysis. Comments must be filed in accordance with the same deadlines as comments filed in response to the NPRM, and must have a separate and distinct heading designating them as responses to the IRFA. The Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of this Notice of Proposed Rulemaking, including the IRFA, to the Chief Counsel for Advocacy of the Small Business Administration.

C. Filing Requirements

211. Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS). *See Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the ECFS: http://fjallfoss.fcc.gov/ecfs2/.

- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing. If more than one docket or rulemaking number appears in the caption of this proceeding, filers must submit two additional copies for each additional docket or rulemaking number.

  Filings can be sent by hand or messenger delivery, by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.

  - All hand-delivered or messenger-delivered paper filings for the Commission's Secretary must be delivered to FCC Headquarters at 445 12th St., SW, Room TW-A325, Washington, DC 20554. The filing hours are 8:00 a.m. to 7:00 p.m. All hand deliveries must be held together with rubber bands or fasteners. Any envelopes and boxes must be disposed of before entering the building.

  - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9300 East Hampton Drive, Capitol Heights, MD 20743.

  - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 445 12th Street, SW, Washington DC 20554.

212. People with Disabilities: To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (tty).

213. *Availability of Documents*. Comments, reply comments, and ex parte submissions will be publically available online via ECFS.[284] These documents will also be available for public inspection during regular business hours in the FCC Reference Information Center, which is located in Room CY-

[284] Documents will generally be available electronically in ASCII, Microsoft Word, and/or Adobe Acrobat.

A257 at FCC Headquarters, 445 12th Street, SW, Washington, DC 20554. The Reference Information Center is open to the public Monday through Thursday from 8:00 a.m. to 4:30 p.m. and Friday from 8:00 a.m. to 11:30 a.m.

214. *Additional Information*. For additional information on this proceeding, contact Hugh L. Van Tuyl of the Office of Engineering and Technology, Hugh.VanTuyl@fcc.gov, (202) 418-7506.

V. ORDERING CLAUSES

215. IT IS ORDERED that pursuant to Sections 1, 4(i), 7(a), 301, 303(f), 303(g), 303(r), 307(e) and 332 of the Communications Act of 1934, as amended, 47 U.S.C. Sections 151, 154(i), 157(a), 301, 303(f), 303(g), 303(r), 307(e), and 332, this Notice of Proposed Rule Making IS ADOPTED.

216. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Notice of Proposed Rule Making, including the Initial Regulatory Flexibility Analysis to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

Proposed Rules

Part 15 of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

1. The authority citation of Part 15 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302, 303, 304, 307, 336, and 544A.

2. Section 15.37 is amended by adding new paragraphs (h) and (i) to read as follows:

§ 15.37 Transition provisions for compliance with the rules.

* * * * *

(h) Certification may no longer be obtained for wireless microphones that operate in the repurposed TV spectrum beginning nine months after release of the Channel Reassignment Public Notice issued pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014). Manufacturing and marketing of wireless microphones that operate in the repurposed TV spectrum must cease 18 months after release of this public notice, and operation of these wireless microphones must cease 39 months after release of this public notice.

(i) Fixed and Mode II personal/portable white space devices for which an application for certification is filed beginning [30 days after the effective date of the rules] must comply with the database re-check requirements in § 15.711(b)(3)(i) and (ii) of this part. Fixed and Mode II personal/portable white space devices that are marketed beginning [90 days from the effective date of the rules] must comply with these requirements. Previously approved white space devices that do not comply with these requirements must cease operating no later than [180 days of the effective date of the rules].

3. A new Section 15.236 added to read as follows:

§ 15.236 Operation of wireless microphones in the bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz.

(a) *Definitions*. The following definitions apply in this section.

(1) *Wireless Microphone*. An intentional radiator that converts sound into electrical audio signals that are transmitted using radio signals to a receiver which converts the radio signals back into audio signals that are sent through a sound recording or amplifying system. Wireless microphones may be used for cue and control communications and synchronization of TV camera signals as defined in § 74.801 of this chapter. Wireless microphones do not include auditory assistance devices as defined in § 15.3(a) of this part.

(2) *600 MHz duplex gap.* An 11 megahertz guard band that separates wireless uplink and downlink frequencies within the 600 MHz Band as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(3) *600 MHz guard band.* Designated frequency bands within the 600 MHz Band that prevent interference between licensed services as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(4) *Repurposed 600 MHz Band*. Frequencies that will be reallocated and reassigned for Part 27 600 MHz Band services as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(b) Operation under this section is limited to wireless microphones as defined in this section.

(c) Operation is permitted in the following bands.

(1) Channels allocated and assigned for broadcast television service.

(2) Television channels in the repurposed 600 MHz Band. Operation on these channels must cease no later than 39 months after release of the Channel Reassignment Public Notice issued pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014). Operation must cease immediately if harmful interference occurs to a 600 MHz Band licensee.

(3) The upper six megahertz segment of the 600 MHz Band duplex gap.

(4) The 600 MHz guard band between television and wireless downlink services, excluding the upper one megahertz segment.

(5) The 600 MHz guard bands adjacent to channel 37, excluding the one megahertz segments furthest from channel 37.

(6) Microphone operation in the frequencies identified in paragraphs (c)(3)-(5) of this section shall prior to operation rely on the white space databases in Part 15, Subpart H to determine that their intended operating frequencies are available for unlicensed wireless microphone operation at the location where they will be used.

(d) The unmodulated carrier power at the antenna input may not exceed the following values.

(1) In the bands allocated and assigned for broadcast television and in the repurposed 600 MHz Band: 50 mW

(2) In the 600 MHz Band guard bands including the duplex gap: 20 mW

(e) Operation is limited to locations separated from licensed services by the following distances.

(1) Four kilometers outside the following protected service contours of co-channel TV stations.

Type of station	Protected contour		
	Channel	Contour (dBu)	Propagation curve
Analog: Class A TV, LPTV, translator and booster	Low VHF (2-6)	47	F(50,50)
	High VHF (7-13)	56	F(50,50)
	UHF (14-51)	64	F(50,50)
Digital: Full service TV, Class A TV, LPTV, translator and booster	Low VHF (2-6)	28	F(50,90)
	High VHF (7-13)	36	F(50,90)
	UHF (14-51)	41	F(50,90)

(2) The following distances outside of the area where a 600 MHz Band licensee has commenced operations.

Type of station	Separation distance in kilometers	
	Co-channel	Adjacent channel
Base	15	0.4
Mobile	35	31

(f) The operating frequency within a permissible band of operation as defined in paragraph (b) must comply with the following requirements.

(1) The frequency selection shall be offset from the upper or lower band limits by 25 kHz or an integral multiple thereof.

(2) One or more adjacent 25 kHz segments within the assignable frequencies may be combined to form a channel whose maximum bandwidth shall not exceed 200 kHz. The operating bandwidth shall not exceed 200 kHz.

(3) The frequency tolerance of the carrier signal shall be maintained within +/- 0.005% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. Battery operated equipment shall be tested using a new battery.

(g) Emissions within the band from one megahertz below to one megahertz above the carrier frequency shall comply with the emission mask in Section 8.3 of ETSI EN 300 422-1, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement.* Emissions outside this band shall comply with the limits in § 15.209.

4. The title to subpart H of part 15 is revised to read as follows:

   Subpart H—White Space Devices

5. Section 15.701 is revised to read as follows:

§ 15.701 Scope.

This subpart sets forth the regulations for unlicensed intentional radiators that operate on available channels in the frequency bands at 54-72 MHz (TV channel 2-4), 76-88 MHz (TV channels 5-6), 174-216 MHz (TV channels 7-13), and 470-698 MHz (TV channels 14-51).

6. Section 15.703 is amended by revising paragraphs (a), (c), (i), (m), (n) and adding new paragraphs (k), (o), (p), (q) and (r) to read as follows:

§ 15.703 Definitions.

(a) *Available channel.* A channel which is not being used by an authorized service at or near the same geographic location as an unlicensed device and is acceptable for use by the device under the provisions of this subpart.

* * * * *

(c) *Fixed device.* A device that transmits and/or receives radiocommunication signals at a specified fixed location. A fixed device may select channels for operation itself from a list of available channels provided by a white spaces database, and initiate and operate a network by sending enabling signals to one or more fixed devices and/or personal/portable devices.

* * * * *(i) *Personal/portable device.* A device that transmits and/or receives radiocommunication signals on available channels at unspecified locations that may change.

* * * * *

(k) *Repurposed 600 MHz Band*. Frequencies that will be reallocated and reassigned for Part 27 600 MHz Band services as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(l) *Sensing only device*. * * *

(m) *Spectrum sensing*. * * *

(n) *Television bands.* The portions of the broadcast television frequency bands at 54-72 MHz (TV channels 2-4), 76-88 MHz (TV channels 5-6), 174-216 MHz (TV channels 7-13), 470-608 MHz (channels 14-36) and 614-698 MHz (channels 38-51) that will be allocated and assigned to broadcast television licensees consistent with the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(o) *White space device.* An intentional radiator that operates in the television bands, the 600 MHz Band or on channel 37 accordance with the provisions of this subpart.

(p) *White spaces database.* A database system that maintains records of all authorized services in the television and 600 MHz frequency bands, is capable of determining the available channels as a specific geographic location and provides lists of available channels to unlicensed devices that have been certified under the Commission's equipment authorization procedures. White spaces databases that provide lists of available channels to unlicensed devices must receive approval by the Commission.

(q) *600 MHz duplex gap.* An 11 megahertz guard band that separates wireless uplink and downlink frequencies within the 600 MHz Band as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

(r) *600 MHz guard band.* Designated frequency bands within the 600 MHz Band that prevent interference between licensed services as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

7. Section 15.707 is revised to read as follows:

§ 15.707 Permissible channels of operation.

(a)(1) Fixed and personal/portable white space devices may operate on available channels in the frequency bands 470-608 (TV channels 14-36), 512-608 MHz (TV channels 21-36) and 614-698 MHz (TV channels 38-51), subject to the interference protection requirements in §§15.711 and 15.712.

(2) Fixed and personal/portable devices may operate on frequencies in the repurposed 600 MHz Band in areas where Part 27 600 MHz Band licensees have not commenced operations, as defined in part 27 of this chapter.

(b) Only fixed devices that communicate with other fixed devices may operate on available channels in the bands 54-72 MHz (TV channel 2-4), 76-88 MHz (TV channels 5 and 6) and 174-216 MHz (TV channels 7-13) subject to the interference protection requirements in §§15.711 and 15.712.

(c) Fixed and Mode II personal/portable devices shall operate only on available channels as identified in paragraphs (a) and (b) of this section and as determined by a white spaces database in accordance with the interference avoidance mechanisms of §§15.711 and 15.712.

(d) Mode I personal/portable devices shall operate only on available channels as identified in paragraph (a)(1) of this section and provided from a fixed or Mode II device in accordance with §15.711(b)(3)(iv).

(e) Fixed and personal/portable devices may operate in the upper six megahertz segment of the 600 MHz duplex gap.

(f) Fixed and personal/portable devices may operate in the 600 MHz guard band between television and wireless downlink services, excluding the upper three megahertz segment, provided this guard band is at least nine megahertz wide.

8. Section 15.709 is amended by revising paragraphs (a) and (c) to read as follows:

§ 15.709 General technical requirements.

(a) *Power limits for white space devices.* (1) The maximum EIRP for fixed white space devices operating in the television bands and repurposed 600 MHz Band shall not exceed the following values:

(i) If the device complies with the minimum separation distances outside adjacent channel television service contours in §15.712(a): four watts (36 dBm) per six megahertz of bandwidth on which the device operates

(ii) If the device operates within a six megahertz band centered on the boundary between two available channels: four watts (36 dBm) per six megahertz of bandwidth on which the device operates

(iii) If the device operates adjacent to an occupied television channel, *i.e.,* within its protected service contour: 40 mW (16 dBm) per six megahertz of bandwidth on which the device operates

(2) The maximum EIRP for personal/portable white space devices operating in the television bands and repurposed 600 MHz Band shall not exceed the following values:

(i) If the device complies with the minimum separation distances outside adjacent channel television service contours in §15.712(a): 100 mW (20 dBm) per six megahertz of bandwidth on which the device operates

(ii) If the device operates adjacent to an occupied television channel, *i.e.,* within its protected service contour: 40 mW (16 dBm) per six megahertz of bandwidth on which the device operates

(3) The maximum EIRP for fixed and personal/portable white space devices operating in the 600 MHz guard band and duplex gap shall not exceed 40 mW (16 dBm)

(4) The maximum EIRP for fixed white space devices operating on channel 37 shall not exceed the following values:

(i) If channels 36 and 38 are allocated and assigned for television broadcasting and the device complies with the minimum separation distances outside adjacent channel television service contours in §15.712(a): four watts (36 dBm) per six megahertz of bandwidth on which the device operates

(ii) If channels 36 and 38 are allocated and assigned for television broadcasting and the device operates within a six megahertz band centered on the boundary between channel 37 and an available adjacent channel: four watts (36 dBm) per six megahertz of bandwidth on which the device operates

(iii) If channels 36 and 38 are allocated and assigned for television broadcasting and the device operates adjacent to an occupied television channel, *i.e.,* within its protected service contour, or if one or both of the adjacent bands are designated as 600 MHz guard bands: 40 mW (16 dBm) per six megahertz of bandwidth on which the device operates

(5) Mode I personal/portable devices that operate on available channels provided by a Mode II device that operates within the protected service contour of an adjacent channel television station are limited to a maximum EIRP of 40 milliwatts (16 dBm) per six megahertz of bandwidth on which the device operates

(6) Fixed devices with a four watt EIRP limit may operate closer to co-channel and adjacent channel television stations and other protected services at reduced power levels. The following table shows the power levels at which separation distances are defined. Devices operating at a particular EIRP level must comply with the limit on conducted power to the antenna. The power delivered to the transmitting antenna is the maximum conducted output power reduced by the signal loss experienced in the cable used to connect the transmitter to the transmit antenna. The conducted power limits are based on a maximum transmitting antenna gain of 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. Operation is permitted at EIRP levels between the values in this table, provided the conducted power limit is interpolated between the values shown.

EIRP (6 MHz)	**Conducted power limit (6 MHz)**
16 dBm (40 mW)	10 dBm (10 mW)
20 dBm (100 mW)	14 dBm (25 mW)
24 dBm (250 mW)	18 dBm (63 mW)
28 dBm (625 mW)	22 dBm (158 mW)
32 dBm (1600 mW)	26 dBm (400 mW)
36 dBm (4000 mW)	30 dBm (1000 mW)

(7) Maximum conducted output power is the total transmit power over the occupied bandwidth delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative

modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(8) White space devices shall incorporate transmit power control to limit their operating power to the minimum necessary for successful communication. Applicants for equipment certification shall include a description of a device's transmit power control feature mechanism.

(9) The power spectral density from a white space device shall not be greater than the following values when measured in any 100 kHz band during any time interval of continuous transmission.

(i) Fixed devices: The values shown in the following table. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted power level shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. If the conducted power of the device is between two defined levels, then the PSD limit must be interpolated between the values shown.

Conducted power limit (6 MHz)	Conducted PSD limit (100 kHz)
10 dBm (10 mW)	-7.4 dBm
14 dBm (25 mW)	-3.4 dBm
18 dBm (63 mW)	0.6 dBm
22 dBm (158 mW)	4.6 dBm
26 dBm (400 mW)	8.6 dBm
30 dBm (1000 mW)	12.6 dBm

(ii) Personal/portable device operating at 40 mW: −1.4 dBm EIRP.

(iii) Sensing-only devices operating at 50 mW: −0.4 dBm EIRP.

(iv) Personal/portable devices operating at 100 mW: 2.6 dBm EIRP.

(10) White space devices shall incorporate adequate security measures to prevent the devices from accessing databases not approved by the FCC and to ensure that unauthorized parties cannot modify the device or configure its control features to operate in a manner inconsistent with the rules and protection criteria set forth in this subpart.

* * * * *

(c) *Emission limits for white space devices.* (1) In the six megahertz bands immediately adjacent to the channel or group of contiguous channels in which the device is operating, emissions from the device shall not exceed the following levels.

(i) Fixed devices: The values shown in the following table. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted power level shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. If a device operates between two defined power levels, it must comply with the limit for the higher power level.

Conducted power limit (6 MHz)	Adjacent channel emission limit (100 kHz)
10 dBm (10 mW)	-62.8 dBm
14 dBm (25 mW)	-58.8 dBm
18 dBm (63 mW)	-54.8 dBm

22 dBm (158 mW)	-50.8 dBm
26 dBm (400 mW)	-46.8 dBm
30 dBm (1000 mW)	-42.8 dBm

(ii) Personal/portable devices operating at 40 mW EIRP: −56.8 dBm EIRP.

(iii) Sensing-only devices operating at 50 mW EIRP: −55.8 dBm EIRP.

(iv) Personal/portable devices operating at 100 mW: −52.8 dBm EIRP.

(2) Emission measurements in the adjacent bands shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.

(3) At frequencies beyond the six megahertz bands immediately adjacent to the channel or group of contiguous channels in which the device is operating, the radiated emissions from devices shall meet the requirements of §15.209. If a white space device transmits on multiple non-contiguous channels simultaneously, it must comply with the adjacent channel emission limits in the six megahertz bands above and below each of the single channels or channel groups used by the white space device, and the requirements of §15.209 beyond these six megahertz bands.

(5) White space devices connected to the AC power line are required to comply with the conducted limits set forth in §15.207.

* * * * *

9. Section 15.711 is amended by removing paragraph (b)(3)(iii) and revising the introductory text, paragraphs (a), (b)(3)(i), (b)(3)(ii) and (b)(3)(v) to read as follows:

§ 15.711 Interference avoidance methods.

Except as provided in §15.717, television channel availability for a white space device is determined based on the geo-location and database access method described in paragraphs (a) and (b) of this section.

(a) *Geo-location and database access.* A white space device shall rely on the geo-location and database access mechanism to identify available channels consistent with the interference protection requirements of §15.712. Such protection will be provided for the following authorized and unlicensed services: digital television stations, digital and analog Class A, low power, translator and booster stations; translator receive operations; fixed broadcast auxiliary service links; private land mobile service/commercial radio service (PLMRS/CMRS) operations; offshore radiotelephone service; low power auxiliary services authorized pursuant to §§74.801 through 74.882 of this chapter, including licensed wireless microphones; MVPD receive sites; wireless medical telemetry service (WMTS); radio astronomy service (RAS) and Part 27 600 MHz Band licensees where they have commenced operations. In addition, protection shall be provided in border areas near Canada and Mexico in accordance with §15.712(g).

(b)* * *

(3)(i) Fixed devices must access a white spaces database over the Internet to determine the channels that are available at their geographic coordinates, taking into consideration the fixed device's antenna height and operating power, prior to their initial service transmission at a given location. Operation is permitted

only on channels that are indicated in the database as being available for their use. Fixed devices shall access the database at least once every 20 minutes to verify that the operating channels continue to remain available. Operation on a channel must cease immediately if the database indicates that the channel is no longer available. Fixed devices must adjust their use of channels in accordance with channel availability schedule information provided by their database for the 60 minute period beginning at the time of the device last accessed the database for a list of available channels.

(ii) Mode II personal/portable devices must access a white spaces database over the internet to determine the channels that are available at their geographic coordinates, taking into account the device's operating power, prior to their initial service transmission at a given location. Operation is permitted only on channels that are indicated in the database as being available for personal/portable devices. A Mode II device must access the database for a list of available channels each time it is activated from a power-off condition and re-check its location and the database for available channels if it changes location during operation by more than 100 meters from the location at which it last accessed the database. A Mode II device that has been in a powered state shall re-check its location and access the database every 20 minutes to verify that the operating channel(s) continue to be available. Mode II devices must adjust their use of channels in accordance with channel availability schedule information provided by their database for the 60 minute period beginning at the time of the device last accessed the database for a list of available channels. A Mode II device may load channel availability information for multiple locations around, *i.e.,* in the vicinity of, its current location and use that information in its operation. A Mode II device may use such available channel information to define a geographic area within which it can operate on the same available channels at all locations, for example a Mode II device could calculate a bounded area in which a channel or channels are available at all locations within the area and operate on a mobile basis within that area. A Mode II device using such channel availability information for multiple locations must contact the database again if/when it moves beyond the boundary of the area where the channel availability data is valid, and must access the database once every 20 minutes even if it has not moved beyond that range to verify that the operating channel(s) continue to be available. Operation must cease immediately if the database indicates that the channel is no longer available.

(iii) [removed]

* * *

(v) Device manufacturers and database administrators may implement a system that pushes updated channel availability information from the database to white space devices. However, the use of such systems is not mandatory, and the requirements for white space devices to validate the operating channel at least once every 20 minutes continue to apply if such a system is used.

* * * * *

10. Section 15.712 is amended by revising paragraphs (a), (f) and (h) and by adding new paragraphs (i) and (j) to read as follows:

§ 15.712 Interference protection requirements.

(a) Digital television stations, and digital and analog Class A TV, low power TV, TV translator and TV booster stations:

(1) *Protected contour.* White space devices must protect digital and analog TV services within the contours shown in the following table. These contours are calculated using the methodology in §73.684 of this chapter and the R-6602 curves contained in §73.699 of this chapter.

Type of station	Protected contour		
	Channel	Contour (dBu)	Propagation curve
Analog: Class A TV, LPTV, translator and booster	Low VHF (2-6)	47	F(50,50)
	High VHF (7-13)	56	F(50,50)
	UHF (14-69)	64	F(50,50)
Digital: Full service TV, Class A TV, LPTV, translator and booster	Low VHF (2-6)	28	F(50,90)
	High VHF (7-13)	36	F(50,90)
	UHF (14-51)	41	F(50,90)

(2) *Required separation distance.* White space devices must be located outside the contours indicated in paragraph (a)(1) of this section of co-channel and adjacent channel stations by at least the minimum distances specified in the following tables. If a device operates between two defined power levels, it must comply with the separation distances for the higher power level. Fixed and personal/portable devices operating at an EIRP of 40 mW or less are not required to meet adjacent channel separation distances.

Antenna height above average terrain of unlicensed device	Required separation in kilometers from co-channel digital or analog TV (full service or low power) protected contour					
	16 dBm (40 mW)	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Personal/portable	1.3	1.7	N/A	N/A	N/A	N/A
Less than 3 meters	1.3	1.7	2.1	2.7	3.3	4.0
3-Less than 10 meters	2.4	3.1	3.8	4.8	6.1	7.3
10-Less than 30 meters	4.2	5.1	6.0	7.1	8.9	11.1
30-Less than 50 meters	5.4	6.5	7.7	9.2	11.5	14.3
50-Less than 75 meters	6.6	7.9	9.4	11.1	13.9	18.0
75-Less than 100 meters	7.7	9.2	10.9	12.8	17.2	21.1
100-Less than 150 meters	9.4	11.1	13.2	16.5	21.4	25.3
150-Less than 200 meters	10.9	12.7	15.8	19.5	24.7	28.5
200-250 meters	12.1	14.3	18.2	22.0	27.3	31.2

Antenna height above average terrain of unlicensed device	Required separation in kilometers from adjacent channel digital or analog TV (full service or low power) protected contour				
	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Personal/portable	0.1	N/A	N/A	N/A	N/A
Less than 3 meters	0.1	0.1	0.1	0.1	0.2
3-Less than 10 meters	0.1	0.2	0.2	0.2	0.3
10-Less than 30 meters	0.2	0.3	0.3	0.4	0.5
30-Less than 50 meters	0.3	0.3	0.4	0.5	0.7

50-Less than 75 meters	0.3	0.4	0.5	0.7	0.8
75-Less than 100 meters	0.4	0.5	0.6	0.8	1.0
100-Less than 150 meters	0.5	0.6	0.8	0.9	1.2
150-Less than 200 meters	0.5	0.7	0.9	1.1	1.4
200-250 meters	0.6	0.8	1.0	1.2	1.5

(3) The antenna height above ground for a fixed device may not exceed 30 meters.

* * * * *

(f) *Low power auxiliary services, including wireless microphones:* Fixed devices are not permitted to operate within 1 km, and personal/portable white space devices will not be permitted to operate within 400 meters, of the coordinates of registered low power auxiliary station sites on the registered channels during the designated times they are used by low power auxiliary stations.

* * * * *

(h) *Radio astronomy services:* (1) Operation of fixed and personal/portable devices is prohibited within 2.4 kilometers at the following locations.

(i) The Naval Radio Research Observatory in Sugar Grove, West Virginia at 38 30 58 N and 79 16 48 W.

(ii) The Table Mountain Radio Receiving Zone (TMRZ) at 40 08 02 N and 105 14 40 W.

(iii) The following facilities:

Observatory	Latitude (deg/min/sec)	Longitude (deg/min/sec)
Arecibo Observatory	18 20 37 N	066 45 11 W
Green Bank Telescope (GBT)	38 25 59 N	079 50 23 W
Very Long Baseline Array (VLBA) Stations:		
Pie Town, NM	34 18 04 N	108 07 09 W
Kitt Peak, AZ	31 57 23 N	111 36 45 W
Los Alamos, NM	35 46 30 N	106 14 44 W
Ft. Davis, TX	30 38 06 N	103 56 41 W
N. Liberty, IA	41 46 17 N	091 34 27 W
Brewster, WA	48 07 52 N	119 41 00 W
Owens Valley, CA	37 13 54 N	118 16 37 W
St. Croix, VI	17 45 24 N	064 35 01 W
Hancock, NH	42 56 01 N	071 59 12 W
Mauna Kea, HI	19 48 05 N	155 27 20 W

(2) White space devices may not operate on channel 37 within the quiet zone at Green Bank WV defined in § 1.924(a) of this chapter or within the quiet zone on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra defined in § 1.924(d) of this chapter.

(i) *WMTS*: Devices operating on channel 37 must comply with the following co-channel and adjacent channel separation distances from WMTS receivers.

Antenna height above average terrain of unlicensed device	Required co-channel separation distances in kilometers from WMTS sites					
	16 dBm (40 mW)	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Less than 3 meters	0.3	0.4	0.5	0.6	0.8	1.0
3-Less than 10 meters	0.6	0.7	0.9	1.1	1.4	1.7
10-Less than 30 meters	1.0	1.2	1.5	1.9	2.7	2.9
30-Less than 50 meters	1.2	1.6	2.1	2.4	3.0	3.8
50-Less than 75 meters	1.5	1.9	2.4	2.9	3.6	4.5
75-Less than 100 meters	1.7	2.2	2.7	3.3	4.2	5.3
100-Less than 150 meters	2.1	2.7	3.1	3.8	5.0	6.5
150-Less than 200 meters	2.5	3.1	3.4	4.3	5.8	7.4
200-250 meters	2.8	3.5	3.7	4.7	6.3	8.0

Antenna height above average terrain of unlicensed device	Required adjacent channel separation distances in kilometers from WMTS sites					
	16 dBm (40 mW)	20 dBm (100 mW)	24 dBm (250 mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 watts)
Personal/portable	0.1	0.1	N/A	N/A	N/A	N/A
Less than 3 meters	0.1	0.1	0.1	0.1	0.1	0.1
3-Less than 10 meters	0.1	0.1	0.1	0.1	0.1	0.1
10-Less than 30 meters	0.1	0.1	0.1	0.1	0.2	0.2
30-Less than 50 meters	0.1	0.1	0.1	0.2	0.2	0.3
50-Less than 75 meters	0.1	0.1	0.2	0.2	0.3	0.3
75-Less than 100 meters	0.1	0.2	0.2	0.2	0.3	0.4
100-Less than 150 meters	0.2	0.2	0.2	0.3	0.4	0.5
150-Less than 200 meters	0.2	0.2	0.3	0.3	0.4	0.6
200-250 meters	0.2	0.2	0.3	0.4	0.5	0.6

(j) *Repurposed 600 MHz band*: Fixed and personal/portable devices operating in the repurposed 600 MHz Band must comply with the following co-channel and adjacent channel separation distances outside the defined polygonal area encompassing the base stations deployed by a Part 27 600 MHz Band licensee that has commenced operation. For the purpose of this rule, co-channel means any frequency overlap between a channel used by a white space device and a five megahertz spectrum block used by a part 27 600 MHz Band licensee, and adjacent channel means a frequency separation of zero to four megahertz between the edge of a channel used by a white space device and the edge of a five megahertz spectrum block used by a Part 27 600 MHz Band licensee.

(1) On frequencies used by wireless uplink services:

Antenna height above average terrain of unlicensed device	Required co-channel separation distances in kilometers between white space devices in the uplink band and 600 MHz Band base stations					
	16 dBm (40mW)	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4W)
Less than 3 meters	5	6	7	9	12	15
3-Less than 10 meters	9	11	14	17	22	27
10-Less than 30 meters	15	19	24	30	38	47
30-Less than 50 meters	20	24	31	38	49	60
50-Less than 75 meters	24	30	37	47	60	60
75-Less than 100 meters	27	34	43	54	60	60
100-Less than 150 meters	33	42	53	60	60	60
150-Less than 200 meters	39	49	60	60	60	60
200-250 meters	43	54	60	60	60	60

Antenna height above average terrain of unlicensed device	Required adjacent channel separation distances in meters between white space devices in the uplink band and 600 MHz Band base stations					
	16 dBm (40mW)	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4W)
Less than 3 meters	112	141	177	223	282	354
3-Less than 10 meters	204	257	323	407	514	646
10-Less than 30 meters	354	445	560	704	890	1120
30-Less than 50 meters	457	575	723	909	1150	1446
50-Less than 75 meters	560	704	885	1113	1408	1770
75-Less than 100 meters	646	813	1022	1285	1626	2044
100-Less than 150 meters	792	996	1252	1574	1991	2504
150-Less than 200 meters	914	1150	1446	1818	2299	2891
200-250 meters	1022	1285	1616	2033	2571	3232

(2) On frequencies used by wireless downlink services: 35 kilometers for co-channel operation, and 31 kilometers for adjacent channel operation.

11. Section 15.713 is amended by revising the title, removing and reserving paragraph (h)(9), adding new paragraphs (b)(2)(v) and (h)(11) and revising paragraphs (h)(4) and (h)(10) to read as follows:

§ 15.713 White spaces database.

* * * * *

(b) * * *

(2)* * *

(v) WMTS operating locations.

* * * * *

(h) * * *

(4) PLMRS/CMRS base station operations located more than 80 km from the geographic centers of the 13 metropolitan areas defined in §90.303(a) of this chapter (e.g., in accordance with a waiver).

(i) Transmitter location (latitude and longitude in NAD 83) or geographic area of operations.

(ii) TV channel of operation.

(iii) Call sign.

* * *

(9) [Reserved]

(10) 600 MHz Band in areas where the Part 27 600 MHz Band licensee has commenced operations.

(i) Area within a Part 27 600 MHz Band licensee's PEA where it has commenced or will commence operations. This area must be delineated by at minimum of eight and a maximum of 120 geographic coordinates;

(ii) Identification of the frequencies on which the Part 27 600 MHz Band wireless licensee has commenced operations;

(iii) Call sign.

(iv) Date of commencement of operations.

(11) WMTS operating locations obtained from the WMTS frequency coordination database established under § 95.1113(b)(2) of this chapter.

(i) Frequency of operation (i.e., channel 37),

(ii) Geographic coordinates of transmitters, and

(ii) Cross reference to the registration in the WMTS frequency coordination database (e.g., record number).

* * * * *

12. Section 15.714 is amended by revising the title and paragraph (a) to read as follows:

§ 15.714 White spaces database administration fees.

(a) A white spaces database administrator may charge a fee for provision of lists of available channels to fixed and personal/portable devices and for registering fixed devices. This provision applies to devices

that operate in the TV bands, the repurposed 600 MHz Band, the 600 MHz guard bands, including the duplex gap, and Channel 37. White spaces database administrators may also charge fees for providing lists of available channels to users of unlicensed wireless microphones.

* * * * *

13. Section 15.715 is amended by revising the title and paragraph (l) and by adding new paragraphs (n) and (o) to read as follows:

§ 15.715 White spaces database administrator.

* * * * *

(l) If more than one database is developed, the database administrators shall cooperate to develop a standardized process for providing the data collected for the facilities listed in §15.713(b)(2) to all other white spaces databases within ten minutes to ensure consistency in the records of protected facilities.

* * * * *

(n) Establish a procedure for registering the locations, operating frequencies and starting dates for the areas where a Part 27 600 MHz Band licensee has commenced operations.

(o) Establish a procedure for obtaining the locations where the WMTS is used from the WMTS coordination database established under § 95.1117(b)(2).

Part 74 of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

14. The authority citation for Part 74 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 303, 307, 309, 336 and 554.

15. Section 74.801 is amended by adding the following definitions:

§ 74.801 Definitions.

600 MHz duplex gap. An 11 megahertz guard band that separates wireless uplink and downlink frequencies within the 600 MHz Band as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

Repurposed 600 MHz Band. Frequencies that will be reallocated and reassigned for part 27 600 MHz Band services as determined by the outcome of the auction conducted pursuant to *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Report and Order*, GN Docket No. 12-268 (FCC 14-50) (rel. June 2, 2014).

16. Section 74.802 is amended by revising paragraphs (a) and (c) to read as follows:

§74.802 Frequency assignment.

(a) Frequencies within the following bands may be assigned for use by low power auxiliary stations:

26.100-26.480 MHz

54.000-72.000 MHz

76.000-88.000 MHz

161.625-161.775 MHz (except in Puerto Rico or the Virgin Islands)

174.000-216.000 MHz

450.000-451.000 MHz

455.000-456.000 MHz

470.000-488.000 MHz

488.000-494.000 MHz (except Hawaii)

494.000-608.000 MHz

614.000-698.000 MHz

944.000-952.000 MHz

The four megahertz segment from one to five megahertz above the lower edge of the 600 MHz duplex gap.

* * * * *

(c) Specific frequency operation is required when operating within the 600 MHz duplex gap or the bands allocated for TV broadcasting.

(1) * * *

(2) * * *

* * * * *

17. Section 74.861 is amended by revising paragraph (e) and adding a new paragraph (e)(1)(iii) to read as follows:

§ 74.861 Technical requirements.

* * * * *

(e) For low power auxiliary stations operating in the 600 MHz duplex gap and the bands allocated for TV broadcasting, the following technical requirements apply:

(1) * * *

(iii) 600 MHz duplex gap – 20 mW

* * * * *

APPENDIX B

Initial Regulatory Flexibility Analysis

As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities by the policies and rules proposed in this *Notice of Proposed Rule Making* (*NPRM*). Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments on the *NPRM* provided in paragraph 211 of the item. The Commission will send a copy of the *NPRM*, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).[2] In addition, the *NPRM* and IRFA (or summaries thereof) will be published in the Federal Register.[3]

A. Need for, and Objectives of, the Proposed Rules

The *NRPM* proposes rules for unlicensed operations in the frequency bands that are now and will continue to be allocated and assigned to broadcast television services (TV bands), including fixed and personal/portable white space devices and unlicensed wireless microphones. Based on its experience with the development and deployment of white space devices in the TV bands, the Commission is considering changes to the Part 15 rules that will allow for more robust service and efficient spectral use without increasing the risk of harmful interference to authorized users. The *NPRM* also proposes to codify rules for the operation of unlicensed wireless microphones in the TV bands.

The *NPRM* addresses issues that arise from the *Incentive Auction R&O* to repurpose a portion of the broadcast spectrum for new wireless services.[4] The 600 MHz Band Plan adopted in the *Incentive Auction R&O* provides new opportunities for unlicensed white space devices, unlicensed wireless microphones and wireless microphones licensed under Part 74. The *NPRM* proposes rules for their operation that will protect licensed services as spectrum is repurposed to introduce new wireless services.

B. Legal Basis

The proposed action is taken pursuant to Sections 4(i), 301, 302, 303(e), 303(f), 303(r), 304 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), 303(r), 304 and 307.

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rules Will Apply

The RFA directs agencies to provide a description of, and where feasible, an estimate of the number of small entities that may be affected by the proposed rules, if adopted.[5] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small

[1] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601 – 612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[2] *See* 5 U.S.C. § 603(a).

[3] *See* 5 U.S.C. § 603(a).

[4] *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions,* GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567 (2014) (*Incentive Auction R&O*).

[5] *See* 5 U.S.C. § 603(b)(3).

organization," and "small governmental jurisdiction."[6] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[7] A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (SBA).[8]

Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing. The Census Bureau defines this category as follows: "This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment."[9] The SBA has developed a small business size standard for Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing, which is: all such firms having 750 or fewer employees. According to Census Bureau data for 2007, there were a total of 939 establishments in this category that operated for part or all of the entire year. Of this total, 912 had less than 500 employees and 17 had more than 1000 employees.[10] Thus, under that size standard, the majority of firms can be considered small.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

White space devices are unlicensed devices that operate in the TV bands at locations where frequencies are not in use by licensed services. These devices may be either fixed or personal/portable. Fixed devices may operate at power levels up to four watts, and personal/portable devices operate at up to 100 milliwatts, if they are outside the service contours of adjacent channel TV stations. Personal/portable devices may operate with 40 milliwatts if they are within the service contour of an adjacent channel TV station. White space devices are not permitted to operate on channel 37 (608-614 MHz), which is use by the Radio Astronomy Service (RAS) and Wireless Medical Telemetry Service (WMTS). To prevent harmful interference to broadcast television stations and other authorized users of these bands, white space devices must obtain a list of available TV channels that may be used at their location from databases administered by private entities selected by the Commission.

Wireless microphones also operate in the TV bands. Certain entities may be issued licenses under Subpart H of Part 74 of the rules to operate low power auxiliary stations in the TV bands. Because the operators of Part 74 wireless microphones are licensed, they may register the times and locations of their operation in the white spaces databases to obtain interference protection from co-channel white space devices. The Commission also allows the operation of Part 74 certified wireless microphones in the VHF and UHF TV bands on an unlicensed basis under a waiver of the Part 15 rules

[6] *See* 5 U.S.C. § 601(6).

[7] *See* 5 U.S.C. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[8] *See* 15 U.S.C. § 632.

[9] The NAICS Code for this service 334220. *See* 13 C.F.R 121/201. *See also* http://factfinder.census.gov/servlet/IBQTable?_bm=y&-fds_name=EC0700A1&-geo_id=&-_skip=300&-ds_name=EC0731SG2&-_lang=en

[10] *See* http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-fds_name=EC0700A1&-_skip=4500&-ds_name=EC0731SG3&-_lang=en

granted in the 2010 *TV Bands Wireless Microphones R&O and Further NPRM*.[11] Operators of unlicensed wireless microphones are generally not permitted to register in the TV bands database, but parties operating large numbers of wireless microphones on an unlicensed basis at venues of events and productions/shows may register in the TV bands database if they meet certain criteria specified in the rules and obtain Commission approval to do so.

In the *Incentive Auction R&O*, the Commission decided to repurpose a portion of the UHF TV spectrum for licensed wireless services (the "600 MHz Band"). The Commission's band plan provides for a guard band between television spectrum and 600 MHz downlink services, a guard band between 600 MHz uplink and downlink services (a duplex gap), and guard bands between 600 MHz downlink services and channel 37. In the TV bands that are repurposed for wireless services, the Commission decided to allow white space devices to continue operating indefinitely in areas where a 600 MHz Band licensee has not commenced operations, and to allow wireless microphones to operate for 39 months after release of a public notice announcing channel reassignments as a result of the incentive auction.

Most RF transmitting equipment, including white space devices and wireless microphones, must be authorized through the certification procedure. Certification is an equipment authorization issued by the Commission or by a designated TCB based on an application and test data submitted by the responsible party (*e.g.,* the manufacturer or importer).[12] The NPRM does not propose to change the authorization procedure for white space devices and wireless microphones, but it does propose to establish new technical requirements or modify existing technical requirements for white space devices and wireless microphones.

The NPRM proposes to establish the following new and changed compliance requirements for white space devices, unlicensed wireless microphones and licensed wireless microphones:

White space devices that operate in the TV bands remaining after the incentive auction and channel reassignment

- Allow personal/portable white space devices to operate on channels 14-20 where their operation is currently prohibited.
- Allow fixed white space devices to:
    - Operate at 40 milliwatts on channels adjacent to occupied TV channels.
    - Operate at 4 Watts where there are two contiguous vacant TV channels rather than three as the rules currently require.
    - Operate closer to a TV station contour when the operating power is reduced.

White space devices operating in the 600 MHz guard bands, duplex gap and channel 37

- Allow fixed and personal/portable devices to operate at 40 milliwatts in the guard bands and the upper six megahertz portion of the duplex gap.
- Allow white space devices to operate on channel 37, subject to minimum separation distances enforced by the white spaces databases to protect the WMTS and RAS.

[11] *See* 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, *Report and Order and Further Notice of Proposed Rulemaking*, 25 FCC Rcd 643, 682-87, para. 81-90 (2010).

[12] *See* 47 C.F.R. § 2.907. The Commission or a TCB may test a sample of a device to verify that it complies with the rules before granting approval for the equipment to be marketed. Examples of devices subject to certification include, but are not limited to, mobile phones; wireless local area networking equipment, remote control transmitters; land mobile radio transmitters; wireless medical telemetry transmitters; cordless telephones; and walkie-talkies.

- Require that fixed and personal/portable devices operating in the repurposed 600 MHz Band comply with minimum separation distances from the areas where Part 27 licensees have commenced operations. This would be enforced by the white spaces databases.

Wireless microphones
- Codify new Part 15 rules for unlicensed wireless microphones in the TV bands. Wireless microphones operating on an unlicensed basis are currently certified under the Part 74 rules.
- Allow unlicensed wireless microphones to operate at 20 milliwatts in the 600 MHz guard bands and the upper six megahertz portion of the duplex gap. Unlicensed wireless microphones would have to rely on the white spaces databases to ensure they are operating on channels available for their use.
- Allow licensed wireless microphones to operate at 20 milliwatts in the four megahertz portion of the duplex gap below the six megahertz portion used by white space devices and unlicensed wireless microphones.
- Require wireless microphones operating in the repurposed 600 MHz Band to comply with minimum separation distances from the areas where Part 27 600 MHz Band licensees have commenced operations.

White spaces databases
- Expand the databases to include location/frequency information for additional licensed services such as the WMTS and Part 27 600 MHz Band services.
- Require more frequent database re-checks by white space devices and faster database updates. This would enable wireless microphone users to register, on short notice, in the white spaces databases channels that would be protected from interference from white space devices.
- Eliminate registration in the white spaces databases of channels used by unlicensed wireless microphones for protection from white space devices.

Certification of white space devices and wireless microphones
- White space devices would have to meet the following timetable for compliance with the shorter database re-check interval: 30 days for new equipment certification, 90 days for equipment importation and marketing, 180 days for equipment operation.
- Wireless microphones in the repurposed TV spectrum would have to meet the following cutoff dates, which are from the release of the channel reassignment public notice: 9 months for equipment certification, 18 months for importing and marketing equipment (the 39 month date for ceasing operation in the band was decided in the *Incentive Auction R&O*).

E. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

The RFA requires an agency to describe any significant, specifically small business, alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): "(1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance and reporting requirements under the rule for such small entities; (3) the use of performance rather than design standards; and (4) an exemption from coverage of the rule, or any part thereof, for such small entities."[13]

The rule changes proposed in the NPRM would give greater flexibility for fixed and personal/portable white space device operation. The majority of these changes are permissive, meaning that manufacturers of approved white space devices are not required to incorporate them into their

[13] *See* 5 U.S.C. § 603(c)(1) – (c)(4).

equipment. However, the proposed requirement for white space devices to re-check a database at more frequent intervals would require changes to previously approved devices. We propose a transition period for equipment manufacturers and users to make the change. While we believe that only a short transition period is necessary, the NPRM seeks comment on whether the Commission should allow more time.

Licensed and unlicensed wireless microphones that operate in the TV bands will be affected by the transition provisions adopted in the *Incentive Auction R&O*. The NPRM proposes transition periods that we believe are reasonable to minimize the burden on wireless microphone manufacturers and users, while implementing the Commission's previous decision to transition users out of the repurposed TV spectrum within 39 months. Specifically, we propose to allow manufacturers a period of nine months after the final 600 MHz Band Plan is announced before they may no longer certify wireless microphones that operate in the repurposed TV spectrum, and a period of 18 months before they must cease marketing them. We also propose that parties operating wireless microphones on an unlicensed basis may continue to use Part 74 certified wireless microphones rather than Part 15 certified wireless microphones until the end of the 39 month transition to avoid users having to replace equipment more than once.

The NPRM proposes a number of changes that would require the white space database administrators to make changes to their systems. For example, the NPRM would require the database administrators to implement new protection requirements for the WMTS and Part 27 wireless licensees, and modified protection requirements for TV stations and the RAS. The NPRM seeks information on the costs and burdens the proposed changes would place on the database administrators, and how the database administrators could recoup their costs.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rules

None.

STATEMENT OF
CHAIRMAN TOM WHEELER

Re: *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; 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 Opportunities of Spectrum Through Incentive Auctions*

Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions

The FCC's Incentive Auction is an innovative approach to making efficient, market-driven use of our spectrum resources, which could revolutionize how our airwaves are allocated. We continue to make steady progress toward implementing this historic auction.

In May, the Commission adopted an Incentive Auction Report and Order, and, in the four months since, the Incentive Auction team and multiple bureaus and offices have done tremendous work to advance a number of significant related items, as promised in the Incentive Auction R&O.

The Commission is approving two of those items today.

First, we are proposing to change our Part 15 rules to allow for more robust unlicensed service and efficient spectral use. These changes would extend opportunities for innovative unlicensed use in the 600 MHz band guard bands, Channel 37, and remaining TV bands, while preventing harmful interference to licensed services.

Second, we are exploring how best to address the needs of wireless microphone users over the long term, while encouraging development of technologies that will better facilitate sharing with other wireless uses in an increasingly crowded spectral environment.

Both items bring home once again the fact that both licensed and unlicensed spectrum are critical inputs to our wireless ecosystem. They also recognize the importance of sharing our valuable, but limited, spectrum resources, even when such sharing may not be entirely comfortable – or easy – for incumbent users.

Thank you to the Incentive Auction Task Force, the Office of Engineering and Technology, the Wireless Bureau, and all the Commission staff who worked on these items.

STATEMENT OF
COMMISSIONER MIGNON L. CLYBURN

Re: 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; 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; and Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions

To casual observers, the world's first ever reverse incentive auction is only about broadcast TV stations turning in their spectrum licenses so they can be resold for commercial wireless services. But a successful incentive auction will also impact the amount of spectrum available for other important communications services, such as wireless microphones, wireless medical telemetry and TV White Space services. So I am glad that, when we initiated the incentive auction proceeding in 2012, the FCC took an approach to explore how we could protect as many incumbent services as possible.

These two Notices continue with this commitment. Since the Incentive Auction Order would permit TV White Space devices and wireless microphones to use the duplex gap and other guard bands, the Part 15 NPRM proposes detailed technical rules that would allow those services to operate without interfering with each other or neighboring services. Although there is a proposal to allow TV White Space devices to operate in channels where they were previously excluded, the Notice proposes rules that are intended to protect the incumbent services such as medical telemetry.

There are also a number of great proposals in the companion NPRM on wireless microphones. In that Notice, we are developing a framework to accommodate the current and future needs, of licensed and unlicensed wireless microphones. We are considering rule changes for licensed operations in all the bands, where wireless microphones currently operate. We also identify new spectrum bands, for wireless microphones.

If you review the record in this proceeding, you will notice many presentations from broadcasters and other parties, who manufacture or use wireless microphones, advocates for deployment of unlicensed TV White Spaces, and users of wireless medical telemetry services. All of these presentations have a common refrain. Our technology provides critical services. The prior Commission decisions have taken too much spectrum from us. The technical arguments of our opponents are flawed.

In my opinion, these Notices respond to these charges, in three simple, but important ways. First, we agree that these technologies provide important services. Second, all parties will have to learn to live together in a spectrum constrained environment. Third, and with apologies to the lawyers on my staff and those in the room, now is the time to kick the lawyers out of the room, and let the engineers rule.

STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL

Re: Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 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 Opportunities of Spectrum Through Incentive Auctions

Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions

In this pair of rulemakings the Commission asks a lot of questions about the 600 MHz band. The answers we provide will have historic consequences for broadcasting, broadband, wireless microphones, medical telemetry, radio astronomy—and unlicensed spectrum.

It is this last service—unlicensed spectrum—that I want to focus on now, because I think what we are doing here in the 600 MHz band requires context. So I want to pause for a moment and look back to when this agency first started asking questions about unlicensed spectrum.

Rewind 30 years. Three decades ago the Commission was looking at what to do with a handful underused frequencies, including portions of the 900 MHz, 2.4 GHz, and 5.8 GHz bands. These were airwaves that had been designated for industrial, scientific, and medical uses. But the services we thought would develop in these bands never did, because under our rules they had to contend with interference from some widely used devices, like microwave ovens.

In fact, so little was happening in this spectrum, these airwaves were known as "garbage bands." The conventional wisdom was that they were junk. They were scraps of spectrum where demand for wireless licenses would just be limited. Cue the sighs.

But this is where the Commission did something interesting. Instead of following the traditional route and trying to provide licenses to allow single operators to control in these bands for specific purposes, the agency called for creative ideas.

Once the Commission got started, the questions multiplied—fast. Why should the Commission dictate what technologies should use these frequencies? What if we set some basic technical parameters instead? And what if we gave the public access to these airwaves?

These were not easy questions to answer. There were skeptics who preferred command and control spectrum policy. There were those for whom thinking differently about interference and optimizing the airwaves was outside of their comfort zone. But there were also innovative engineers who believed that with the right technical know-how, they could make these bands work.

The Commission ultimately decided to side with these innovators and think differently about this patch of spectrum. As a result, three decades ago the Commission designated its first swath of unlicensed spectrum in these so-called "garbage bands." Now a lot happened in the interim that was important, including the development of a standard known as 802.11. But step back and you can clearly see how this is the spectrum where Wi-Fi was born. And today, the economic impact of unlicensed spectrum has been estimated at as much as $140 billion annually. So in retrospect, the leap the Commission took 30 years ago paid off—in a big way. In fact, it may have been the most important experiment ever in wireless communications.

Back to the present. Thirty years later we are facing the same kind of question, but for the next generation of unlicensed services. In short, can we make unlicensed spectrum—the jet fuel of innovation—work in low band spectrum?

I think the answer is yes. But once again we are going to need to think differently. We can start by discarding the tired notion that more Wi-Fi comes only at the expense of those who want to use the airwaves for licensed services. Because good spectrum policy requires both. Because, let's not forget, nearly one-half of all wireless data connections in this country are now offloaded onto unlicensed spectrum. So it may not be intuitive, but it means that unlicensed spectrum is essential for managing the flow of traffic on licensed airwaves. Moreover, we need to keep an eye on what is coming up next. We have new technologies like dynamic databases can allow multiple services to co-exist harmoniously. And we are seeing new services that can overcome spectral and physical challenges by moving from frequency to frequency, sometimes on spectrum that is licensed and sometimes on spectrum that is unlicensed.

While we plan for this future, we also need to recognize that key services striving for space in the 600 MHz band—like wireless microphones, low power television, medical telemetry, and radio astronomy—deserve attention under the law. Wireless microphones are critical for newsgathering, essential for Broadway productions, and widely-used in churches and schools. These microphones deserve a home. Low power television and translators also play an important role in communities across the country—and can extend the reach of television in rural areas. Plus, lives depend on medical telemetry and radio astronomy helps us understand the universe. That's big stuff. So we need to pay heed. We also need to be creative. Because I think that our engineers—some of the same smart minds who sparked the invention of Wi-Fi 30 years ago—can find ways to make this all work. I think optimism here can pay dividends that will yield not only more services in the 600 MHz band, but more innovation and more Wi-Fi.

So thank you to the Office of Engineering and Technology and the Wireless Telecommunications Bureau for your hard work, past, present, and future—as you wrestle with the questions these rulemakings pose. Thank you also to Chairman Wheeler for keeping our efforts in the 600 MHz band barreling down the track and making sure that unlicensed spectrum is on board.

STATEMENT OF
COMMISSIONER AJIT PAI
APPROVING IN PART AND CONCURRING IN PART

Re: *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; 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 Opportunities of Spectrum Through Incentive Auctions*

The Part 15 Notice of Proposed Rulemaking reminds me of a scene from the 2003 movie *The Matrix Reloaded*. When the Oracle appears to ask Neo a question, he hesitates, wondering whether she's really offering him a choice or if the answer has already been decided. The Oracle replies: "[Y]ou didn't come here to make a choice, you've already made it. You're here to try to understand *why* you made it."

So too it appears with today's NPRM. Why? Well, back in the May *Incentive Auction Order*, the Commission decided to permit white space devices to operate in the 600 MHz guard bands at particular power levels and bandwidths, even though we had yet to tee up the critical engineering questions that we seek comment on today.[1] As I noted at the time, my preference would have been to seek comment in a neutral manner on whether we can permit those types of operations without causing harmful interference to licensed services *before* we decided to allow them.

But that is now in the past, and I am pleased that today we are asking many of the right questions. The record developed in response to this notice will hopefully shed light not only on why we made the choices we did, but whether we got them right.

And while we won't be able to answer the latter point until all of the engineering studies and comments are in, I do think there is reason for concern. The Commission's proposals carry a risk of creating impaired spectrum licenses, depressing auction revenues, and deterring auction participation. But since we are at the beginning of the process, I am reserving judgment until all of the studies are in. As a result, I will be voting to approve in part and concur in part.

* * *

As the record develops on these issues, I am going to continue to apply the same principles that have governed my deliberations during the course of the incentive auction proceeding. Two of those are particularly relevant to today's NPRM. The first is respect for the laws of physics. As I've said, "we must deal with the world the way that it is, not as we might wish it were. The laws of physics aren't liberal or conservative, Democratic or Republican; they are immutable."[2] Or as a young boy told Neo in the original *Matrix*, "Do not try and bend the spoon. That's impossible. Instead, . . . only try to realize the truth."

Second, we must be faithful to the statute. As most relevant here, that means abiding the Spectrum Act's requirement that we not permit any use of the guard bands that would cause harmful interference to licensed services.

Today, it becomes more critical than ever that we hew to each of these principles.

In particular, I am concerned that permitting white space devices to operate in the guard bands, at the power levels and bandwidths proposed here, might impair the adjacent licensed spectrum.

[1] *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567, 6686 para. 273 (2014) (*Incentive Auction Order*).

[2] Opening Remarks of Commissioner Ajit Pai at CTIA 2013's Panel on the Spectrum Incentive Auctions: Step Right Up!, Las Vegas, Nevada, at 1 (May 22, 2013).

Take the NPRM's own analysis. It shows that operating white space devices in the NPRM's proposed configurations could, in the worst-case scenarios, cause harmful interference to wireless devices whenever they are within even 7 meters of each other. That would mean that white space devices could interfere with wireless handsets whenever they are in the same room.

And it could be even worse than that. The FCC's analysis assumes that wireless handsets will use additional filtering above and beyond the 3GPP standard. It also assumes that there will be at least a 3 MHz frequency separation between white space devices and licensed wireless services—yet the guard bands the FCC adopted in the *Incentive Auction Order* won't be large enough in every recovery scenario to provide that amount of separation.

Moreover, our analysis assumes that licensed wireless providers can take steps to manage the "noisy conditions" that might result from permitting the proposed white space operations, such as moving users to different spectrum bands.[3] But if anything, that assumption only helps large, incumbent providers. If you're looking at the 600 MHz auction as a new entrant or a smaller provider, you might not have the spectrum inventory necessary to move consumers to alternate bands. And even if a provider could take those types of steps, would we really be offering fungible licenses if carriers would face drastically different interference scenarios depending on whether the FCC assigns them a license adjacent to a guard band or not? I'm not so sure

Now the NPRM's analysis on these issues is only preliminary, and as it recognizes there are a variety of factors that affect actual deployments that could reduce or eliminate the chances for interference altogether. But all of this just confirms that there is a lot of difficult engineering work ahead.

So where does this leave us? Well, we must do more than persuade ourselves that permitting these types of operations won't cause harmful interference. Our analysis must convince potential bidders that we're not creating impaired licenses. They are the ones that will be valuing the spectrum, deciding whether to participate, and ultimately putting up the capital necessary for the auction to succeed. If they're not convinced, it doesn't really matter what we think or say.

As I said when the Commission adopted the *Incentive Auction Order*, I am all in favor of making more spectrum available for unlicensed use. And if we can do that here, without causing harmful interference to licensed services, that is something we should seriously consider.

But we have to make promises that the laws of physics and of Congress allow us to keep. Remember, the FCC's goal is to offer generic, fungible licenses, so impairing any spectrum around the guard bands will drive down the value of each and every single 600 MHz license and thus deter auction participation. That would mean less spectrum repurposed for mobile broadband and a failure to meet the Spectrum Act's revenue targets, which are critical to both public safety and deficit reduction.

* * *

In the end, when it comes to many of the NPRM's proposals, perhaps Theodore Logan from *Bill and Ted's Excellent Adventure* put it best: "Dude, are you sure we should be doing this?" I look forward to reading some most excellent responses from our commenters and working with my colleagues and the Commission's talented staff on resolving these issues.

[3] *See* NPRM at para. 85.

STATEMENT OF
COMMISSIONER MIKE O'RIELLY

Re: *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 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 Opportunities of Spectrum Through Incentive Auctions*

Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions

Before I begin, let me acknowledge the hard work of the Gentlelady from Connecticut for all that she has done to promote unlicensed spectrum use. Like Commissioner Rosenworcel, I have been and remain a strong supporter of unlicensed wireless use and the unknown possibilities that the creative entrepreneurs that use it will continue to bring to the American people.

These two items, which I will approve, are the direct result of Congress's work to provide for a spectrum incentive auction. That effort, of which I appreciated being a part, has generated both opportunity and concern for many in the communications sector. The area we focus on today is the effect of the incentive auction on the spectrum that can be used for unlicensed wireless devices and wireless microphones, which are not necessarily mutually exclusive groups. I understand the trepidation that these communities and others, including existing broadcasters, have over the reduction in spectrum allocated at 600 MHz for commercial broadcast services.

Over the last many months, I have visited and met with a wide array of interested parties to discuss and learn more about their ideas as to how the Commission might address the needs and spectrum demands of unlicensed wireless device providers and wireless microphones (both licensed and unlicensed). From Broadway to Silicon Valley and in between, each of these meetings was highly informative and somewhat frustrating as there are no easy answers.

At the heart of both of these items is science and fact, or at least it should be. I am generally pleased by the work of the Office of Engineering and Technology to focus on the technical side of the equation in preparing these two items. While I may not agree with every outcome or proposal, the NPRMs have been drafted in way to allow parties to provide comments, including contradictory evidence and technology studies, to frame our work going forward. I expect an ample record that includes the granular data necessary to fully inform our decision making. I am particularly interested in hearing about tests of the technical aspects of the various ideas and proposals. Let's find out, to the best of our abilities, what works and what does not.

There are definitely some areas where we need to look into pushing further, and I appreciate the Chairman and Commission staff incorporating my edits. For instance, I see great value in exploring opportunities for mobile unlicensed operations in Channel 37. To argue that it can't be done in a way that provides protection to incumbent users reminds me of the early debates over even allowing television white space devices. Many of us were right then, and we should allow science and fact to lead us again.

On the opposite side, I have heard from many industry participants that the current proposal regarding wireless mics and unlicensed wireless use in the duplex gap may be infeasible. There are strong views on this, and I am not sure whether all the information needed to make a decision is available yet. This issue needs to be fleshed out further, and I trust the NPRM will allow everyone to debate the merits fully.

I will keep an open mind as the Commission moves ahead to fill out details of the framework set forth in the Incentive Auction Order and refine potentially temporary decisions. To the extent that we receive data that requires the Commission to reconsider or alter the framework's decisions, I trust we will be willing to do so, as necessary and appropriate.

In addition, I am pleased to see today's companion notice, which seeks comment on proposals for treatment of wireless microphones. This notice is comprehensive and asks many of the necessary questions. For instance, we need to encourage wireless mics to be more spectrally efficient and move to frequencies that are not likely to be sought after for commercial purposes. In other words, any new bands that we open to wireless mics should be those that will not require that they relocate again in the future.

I thank the folks in the Office of Engineering and Technology, the Wireless Telecommunications Bureau, and the Incentive Auction Team for your thoughtful, diligent work on these notices.