



FEDERAL REGISTER

Vol. 80

Monday,

No. 225

November 23, 2015

Part II

Federal Communications Commission

47 CFR Parts 2, 15, 27, et al.

Unlicensed Use of TV Band and 600 MHz Band Spectrum; Final Rule

FEDERAL COMMUNICATIONS COMMISSION**47 CFR Parts 2, 15, 27, 74, and 95**

[ET Docket No. 14–165; FCC 15–99]

Unlicensed Use of TV Band and 600 MHz Band Spectrum**AGENCY:** Federal Communications Commission.**ACTION:** Final rule.

SUMMARY: The Commission recently adopted rules to repurpose broadcast television spectrum for new wireless services via an incentive auction. This document modifies Commission rules for unlicensed wireless devices and wireless microphones in the reconstituted TV bands and the new 600 MHz band. This document modifies the Commission's 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. It adopts technical and operational rules for unlicensed devices and wireless microphones in the 600 MHz guard bands, including the duplex gap, and in the 600 MHz band that will be repurposed for new wireless services. It also adopts rules for fixed and personal/portable white space device operation on channel 37 and for the operation of unlicensed wireless microphones in the TV bands. This document modify the white space database rules to implement certain decisions, including protecting areas where new 600 MHz service licensees commence operation and areas used by incumbent services on channel 37.

DATES: Effective December 23, 2015, except for the amendments to §§ 15.713(b)(2)(iv) through (v), (j)(4), (j)(10), and (j)(11), 15.715(n) through (q), 27.1320, and 95.1111(d), which contain new or modified information collection requirements that require approval by the OMB under the Paperwork Reduction Act (PRA). The Commission will publish a document in the **Federal Register** announcing the effective date when approved by OMB. The incorporation by reference listed in the rules is approved by the Director of the Federal Register as of December 23, 2015.

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SUPPLEMENTARY INFORMATION: This is a summary of the Commission's *Report & Order (R&O)*, ET Docket No. 14–165, FCC 15–99, adopted August 6, 2015, and released August 11, 2015. The full text of this document is available for inspection and copying during normal business hours in the FCC Reference Center (Room CY–A257), 445 12th Street SW., Washington, DC 20554. The full text may also be downloaded at: www.fcc.gov. People with Disabilities: To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an email to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202–418–0530 (voice), 202–418–0432 (tty).

Summary of Report and Order

1. The *R&O* makes rule changes for unlicensed white space devices in the television broadcasting band and the 600 MHz band, while protecting licensed users from harmful interference. It modifies the Commission's part 15 rules to permit fixed and personal/portable devices to use TV channels previously unavailable to them while continuing to protect TV services from harmful interference by adjusting the technical and operational rules. It also adopts rules for white space device operations in the 600 MHz band—including the duplex gap, guard bands, 600 MHz service band and channel 37. White space devices will continue to access the white space databases for channel assignments in the TV bands, as well as in the 600 MHz band and channel 37.

2. The *R&O* also takes actions that will continue to accommodate unlicensed wireless microphone use in the TV bands and the 600 MHz band, while protecting licensed users from harmful interference. By codifying part 15 rules for unlicensed wireless microphone use, it brings these devices under the traditional policy tenets for unlicensed devices, *i.e.*, they are not entitled to interference protection and they must not cause harmful interference to authorized services. Unlicensed wireless microphones will access the white space databases to identify frequencies available for their use in the TV bands, duplex gap, guard bands and 600 MHz service band.

3. The *R&O* reserves four megahertz of spectrum in the duplex gap for wireless microphones licensed under part 74 of the Commission's rules where they can operate on an as-needed basis that is not shared with white space devices. Operation will be limited to the same technical requirements as unlicensed wireless microphones operating in the

guard bands. It also adopts rules to permit, for a limited time, operation of licensed wireless microphones in the new 600 MHz service band.

4. The *R&O* also expands location and frequency information in the white space databases and makes other changes to database procedures. Finally, it adopts transition periods for the certification, manufacturing and marketing of white space devices and unlicensed wireless microphones to comply with the new requirements.

A. TV Bands

5. The Commission modifies the part 15 rules to specify technical requirements for fixed device operation at power levels below four watts permitting them to operate closer to or adjacent to occupied TV channels. The Commission expands the permissible frequencies for fixed operation to include TV channels 3 and 4 and for personal/portable operation to include spectrum below TV channel 20. Both types of devices may also operate on the vacant channels above and below channel 37 that are now available only for wireless microphone use. The Commission also adopts part 15 rules for unlicensed wireless microphone operations in the TV bands. In addition, the Commission modifies the part 15, Subpart H rules to replace the terms “television band device” or “TVBD” with the term “white space device” throughout.

1. Fixed White Space Devices**a. Operation in Less Spectrum**

6. *Adjacent to occupied channels.* The Commission will allow fixed white space devices to operate adjacent to occupied TV channels (within their service contour) at a power level of 40 milliwatts EIRP. This action provides consistent treatment of similarly powered fixed and portable devices and will allow the use of fixed devices in more locations than the current rules allow, *i.e.*, where there are fewer than three contiguous vacant channels, while at the same time protecting licensed users from harmful interference. It will also allow fixed white space devices to operate in the 600 MHz guard band immediately adjacent to the remaining TV spectrum. The Commission will limit the height of 40 milliwatt fixed devices to 10 meters above ground level (AGL) to limit their interference potential to TV reception on adjacent channels. This provides for comparable rules (*i.e.* 40 milliwatts) between fixed and personal portable white space devices for adjacent to TV channel operation. By limiting antenna height to

10 meters AGL rather than 30 meters AGL as the rules currently allow, the Commission can limit the distance at which a fixed white space device could potentially cause interference to television reception.

7. There are additional factors that will limit fixed devices' potential for causing harmful interference to TV reception. The situation where a directional TV antenna and a directional fixed white space device antenna would be oriented such that the maximum white space signal would be received by a TV antenna is a low probability event, and the height disparity between TV receive and white space transmit antennas will ensure some additional discrimination between the two signals. Also, the Commission is requiring 40 milliwatt fixed devices to meet the same out-of-band emission as 40 milliwatt personal/portable devices and to incorporate transmit power control to operate at the minimum power necessary, which will reduce the likelihood of harmful interference to adjacent channel TV reception to short distances, making identification of a fixed device that may be causing harmful interference fairly straightforward since those devices' locations must be registered in the database.

8. *Two contiguous vacant channels.* To increase spectrum efficiency while protecting incumbent TV broadcast operations, the Commission will allow fixed white space devices to operate with a maximum of 100 milliwatts EIRP at locations where there are at least two contiguous vacant TV channels and the white space device's signal occupies one or more six megahertz bands, provided that there is at least three megahertz separating the white space emissions from the edge of lowest and highest vacant TV channels on which it is operating. This corresponds to a white space device operating with 50 milliwatts EIRP in a three megahertz segment of the lowest and highest vacant TV channel being used, leaving a frequency separation of three megahertz between the white space device's operating frequency and the edges of an adjacent TV channel being used for broadcast services.

9. The 100 milliwatt power level that the Commission adopts for operation across multiple vacant TV channels is based on a 2.9 dB lower susceptibility of television receivers to harmful interference from a white space signal three megahertz away from the edge of an occupied television channel than to a white space signal with no frequency separation from an occupied TV channel. This limit (50 milliwatts in a

three megahertz segment of the highest and lowest channel being used) is only 1 dB higher than the 40 milliwatt limit the Commission is allowing for fixed devices operating with no frequency separation from occupied TV channels and is therefore within the margin of additional interference protection provided by the three megahertz separation. The out-of-band emissions limit for white space devices will serve to reduce the amount of out-of-band emissions that appear in the pass-band of a television receiver and further reduce the potential for interference. To provide an additional measure of interference protection to TV reception, the Commission is limiting such operation to antenna heights of 10 meters AGL or less, consistent with its decision to limit 40 milliwatt fixed devices operating adjacent to an occupied TV channel to antenna heights of 10 meters or less.

10. The Commission is not adopting its proposed four watt EIRP limit for white space device operation at the center of two contiguous vacant channels. However, should new studies and information become available in the future showing that higher power operation is possible without causing interference to TV reception, the Commission may revisit this issue.

11. The Commission will allow fixed white space devices to aggregate multiple available channels and transmit at a maximum of 100 milliwatts EIRP per channel so long as the white space signal occupies only three megahertz of the lowest and highest channel and the power spectral density (PSD) requirements, the antenna AGL limit of 10 meters, and all separation criteria are met for each occupied channel. Where available, such operation will greatly increase the data rates available to white space device users.

b. Operation at Lower Power Levels

12. The Commission is providing flexibility for white space device users by defining a number of lower power levels for fixed white space devices with correspondingly shorter separation distances than the current rules allow, and defining maximum conducted, PSD and adjacent channel emission limits at each power level. The Commission is defining 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).

13. The Commission is adopting a requirement to adjust the conducted power limits when higher gain antennas (greater than 6 dBi) are used to limit the maximum radiated emissions. Specifically, it will require that when the maximum gain of a fixed device antenna exceeds 6 dBi, the maximum conducted power, PSD and adjacent channel emission limits for each EIRP level be reduced by the amount in dB that the maximum antenna gain exceeds 6 dBi. This requirement is consistent with the current white space rules and is necessary to limit the maximum radiated power from white space devices. The Commission is also adopting a requirement that when a white space device operates between defined EIRP levels, the conducted power and PSD limits must be linearly interpolated between the defined values. This requirement provides flexibility to operate at precise power levels appropriate for an application while taking advantage of a 6 dBi gain antenna. The Commission is also adopting a requirement that when a white space device operates between two defined power levels, it comply with the adjacent channel emission limit for the higher power level. This requirement is consistent with the adjacent channel emission limits previously adopted by the Commission. The Commission does not believe that a reduction in adjacent channel emission limits will significantly affect equipment costs because the lower emission limits apply only to equipment operating at lower power levels, so there is no increase in the amount of attenuation required to comply with the limits.

14. The Commission will require that fixed white space devices supply their geographic coordinates and antenna height AGL when querying a database for the list of available channels at their location. The database will supply the list of available channels and the maximum power level for each channel. The Commission believes that this approach is more efficient than the proposed requirement that devices specify a power level in advance, because it will allow devices to obtain a list of all available channels at a location along with the maximum permissible power levels in a single query. The Commission will also require that white space devices not contain an interface that would allow users to select higher power levels than the database indicates are available for a channel at a given location.

c. Channel Bonding

15. The Commission is making several rule changes that will enable devices to use multiple contiguous and non-contiguous vacant channels (channel “bonding” or “aggregation”) which will permit the development of devices that transmit at higher data rates, thus making higher speed equipment available to consumers. With respect to channel bonding, the Commission is modifying § 15.709 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. Instead, the Commission will require that white space devices meet 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. It is also modifying the rules to require that a white space device must meet the § 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 when the device uses multiple non-contiguous channels. These requirements will also apply to fixed devices that operate centered on the boundary of two channels as discussed above, since that is a form of channel bonding. With respect to channel aggregation, the modified rules in § 15.709(d)(1) require 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, and with the § 15.209 limits beyond these six megahertz bands.

d. Operation in Less Congested Areas

16. The Commission is modifying the rules to allow fixed white space devices in less congested areas to operate up to 10 watts EIRP to increase their service range. This power increase will provide increased opportunities for white space operators to serve more distant customers at less cost and provide point to point backhaul services, while at the same time protecting authorized operations from harmful interference and avoiding any adverse effect on the ability of white space devices to successfully share spectrum among themselves. The Commission is using the term “less congested” to describe areas where television spectrum is largely available to white space devices,

rather than relying on a population based metric which may not correlate to the same areas. In the TV bands, fixed white space devices will be allowed to operate in the low VHF, high VHF, and UHF bands under the higher power limit in less congested locations where, within the TV band of intended operation, at least half the allocated television channels are unused for broadcast services and available for white space use, and the fixed white space devices are sufficiently separated from protected operations to avoid causing interference to them.

17. The Commission is also allowing operation at up to 10 watts EIRP in the 600 MHz service band in areas where licensees have not yet commenced operation. As this band will have been repurposed from the current television band, it will be similar in propagation characteristics to the UHF television band. The Commission is defining “less congested” areas in this band to be the same areas that will be available in the newly repacked UHF television band. In addition, fixed white space devices in the 600 MHz service band will need to adhere to the separation distances specified in the rules to protect new mobile broadband services.

18. The Commission is not modifying the rule limiting transmitter conducted power to one watt, which necessitates the use of high gain antennas to achieve radiated power levels up to 10 watts in less congested areas. It is also not altering the rules limiting antenna height above ground or HAAT to 30 meters and 250 meters respectively. To ensure that television stations, 600 MHz service licensees, and other protected operations are protected from interference due to a fixed white space device operating at more than four watts EIRP, the Commission is increasing the minimum separation distances between those services and the locations where fixed white space devices operate at higher power. The Commission is not increasing the maximum allowable power for personal/portable white space devices in less congested areas.

19. For purposes of calculating less congested areas, the Commission includes as “broadcast services” broadcast TV—including full power, Class A, low power television, and TV booster stations—and the registered protected receive sites of broadcast auxiliary, TV translator, and Multi-channel Video Programming Distributor (MVPD) services. The Commission does not include non-broadcast services such as land mobile operations in the 11 metropolitan areas where such use is permitted under § 90.303 of the rules, nor any areas where such operations are

permitted by waiver; the offshore radio service; channel 37; or channel 17 in Hawaii. It is not including licensed low power auxiliary devices such as wireless microphones in the definition of broadcast service for this limited purpose because such equipment typically is used on a transient basis and thus is not licensed to a specific transmitter site. White space databases will determine whether a location is a less congested area based on whether at least half the total number of TV channels in the band of intended operation in an area are unused for broadcast services and are available for fixed devices operating with 40 milliwatts at 3 meters HAAT, which will provide the greatest opportunity for operation at the higher power levels.

20. Because white space device operations are controlled by the white space database in all bands, white space devices will be able to operate at higher power in less congested areas that will be allocated and assigned for 600 MHz service after the incentive auction, both during and after the post-auction transition period. The database will be updated to include the required separation distances from base stations or other radio facilities deployed by the 600 MHz service licensees, and, after the licensees provide the polygonal shape encompassing those facilities, the database will be able to determine whether frequencies in the 600 MHz service band are available for white space use at the device’s location. As television stations are repacked and 600 MHz service licensees commence operations, there may be a change in which areas are less congested and on which channels in those areas white space devices are permitted to operate with higher power, but those changes will be transparent to users.

21. The interference potential of fixed white space devices operating at EIRP levels up to 10 watts will extend somewhat farther than that of fixed devices operating at four watts EIRP. Thus, the Commission is adding provisions for the 10 watt EIRP limit in § 15.712 of the rules, which contains the protection criteria and separation distances for each of the services operating in the TV bands. The distances for 10 watt EIRP operation were calculated using the same method that the Commission previously used in calculating the minimum separation distances between white space fixed devices and television contours.

22. Private land mobile radio services (PLMRS) and commercial mobile radio service operations on TV channels 14–20 in 11 major markets and some additional areas under waivers of the

rules are protected from interference from white space devices through circular exclusion zones. Using the same methodology previously used to determine the protection zones for four watt operation, the Commission finds that fixed white space devices operating at 10 watts EIRP in less congested areas must not operate within a circular exclusion zone of 136 kilometers co-channel and 131.5 kilometers adjacent channel for the 11 major markets where PLMRS stations are permitted to operate, and within 56 kilometers co-channel and 51.5 kilometers adjacent channel from PLMRS base stations operating outside the 11 major markets under a waiver.

23. The rules also protect the receive sites of broadcast auxiliary service (BAS) facilities, TV translators, low power TV stations, Class A TV stations and multichannel video program distributors (MVPDs) by prohibiting white space devices from operating within a keyhole shaped exclusion zone with the long end of the keyhole aligned between the protected receiver and its associated transmitter. To protect these sites from white space devices that are located outside the main beam of the receive antenna (*i.e.*, the long end of the keyhole), the Commission is adjusting those distances to prohibit fixed devices operating at 10 watts EIRP from operating within 10.2 kilometers co-channel and 2.5 kilometers adjacent channel from the protected received site.

24. To protect sensitive radio astronomy operations and safety-of-life wireless medical telemetry devices that use channel 37, the Commission is not allowing fixed devices to operate with EIRP higher than four watts on channel 37 or channels 36 and 38 at any locations.

2. Calculating White Space Device Separation Distances From a TV Station Contour

a. Fixed and Personal/Portable Devices

25. The Commission is amending the table of separation distances in § 15.712(a)(2) to reflect a range of fixed device power levels below four watts EIRP and modifying the separation distances for personal/portable devices based on 40 milliwatts and 100 milliwatts EIRP at the lowest antenna HAAT. The Commission is also specifying separate tables for co-channel and adjacent channel separation distances and adding entries showing which separation distances apply to personal/portable devices. The changes the Commission is adopting will permit fixed white space devices to operate in

more locations than the current rules allow without causing harmful interference, *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 of four watts. In addition, since the current separation distances for personal/portable devices were also based on four watts EIRP, 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. Thus, these changes will also permit personal/portable devices to operate in more locations.

26. The Commission declines to allow the use of the Longley-Rice methodology or other alternative methodologies for determining white space channel availability as a number of parties requested. The Commission did not propose any change in the use of the F(50,50) and F(50,90) curves for calculating the protected contours of TV stations, and stated that the use of the Longley-Rice methodology was not appropriate for determining whether a white space device would cause harmful interference to TV reception as it is computationally intensive and would significantly slow the ongoing real-time determination of available TV channels by the white space databases. No parties provided technical analyses showing how other alternative methodologies could be used to determine white space channel availability.

27. The Commission declines to allow white space device operators and databases to consider the directivity of fixed white space device antennas in determining channel availability since there is not sufficient information in the record to show how it could be used without causing harmful interference to authorized services. The Commission could consider this issue again in the future if parties are able to develop a standard to address implementation and the Commission gains experience with the more flexible, but more complex, rules it is adopting herein.

b. Mode I Operation

28. The Commission finds that its decision to allow lower power white space devices to operate at closer distances to TV station contours necessitates some modifications to the rules for Mode I devices. By adopting more realistic separation distances based on a range of operating power, the separation distances for lower power operations become shorter than those

currently in the rules, and thus the location uncertainty inherent in a Mode I device becomes more significant. That is, because their controlling station may now operate closer to TV contours than under current rules, the Mode I device could locate such that it is even closer to those same TV contours, increasing its potential to cause harmful interference to TV reception. The Commission will require that a fixed or Mode II device that provides a list of available channels to a Mode I device comply with slightly greater separation distances from the TV contours of stations on the channel or channels that it indicates are available to the Mode I device.

29. The rules require white space devices to operate with the minimum power necessary for communications. Under this condition, to have a balanced link, the Commission assumes that Mode I devices communicating with Mode II devices will operate at similar power levels. Thus, the necessary separation to protect TV reception from a Mode I device will be identical to the necessary separation for the controlling Mode II device. Given the location uncertainty of a Mode I device, the Commission can ensure that a Mode I device complies with the separation distance rules by requiring the Mode II controlling device to operate at twice the required distance in the table of separation distances for a personal/portable white space device at the allowed power levels. In this manner, a Mode I device operating at its maximum range from a controlling Mode II device should still comply with the minimum distance separation required to protect TV reception. This action will ensure that Mode I devices operate sufficiently far outside the protected contours of co-channel TV stations to prevent harmful interference. The Commission will similarly require Mode II personal/portable white space devices to double the adjacent channel separation distance when operating at 100 milliwatts and serving Mode I devices.

30. The Commission finds that increasing the separation distance from a co-channel protected TV contour by a factor of two for a fixed device controlling a Mode I personal/portable white space device would be overly protective since Mode I devices are portable and would operate at low antenna heights, thus limiting the range at which they could communicate with a fixed device. Instead, the Commission will increase the separation distances that a fixed device must meet on channels provided to a Mode I device by the same amount as added for a controlling Mode II device, *i.e.*, 1.7

kilometers greater for 100 milliwatt Mode I devices and 1.3 kilometers greater for 40 milliwatt Mode I devices. Similarly, the Commission will require such fixed devices to also exceed the adjacent channel separation distances specified in the table by 0.1 kilometers. The Commission is not changing the requirement that only fixed devices with an HAAT of 106 meters or less may provide lists of available channels to Mode I devices.

c. Location Accuracy

31. The Commission will allow fixed and Mode II personal/portable devices to use location technologies that have a lower degree of accuracy than ± 50 meters. This change will expand the areas in which white space devices may operate without causing harmful interference to licensed services by permitting their use at indoor or other locations where a GPS signal that can provide location information to ± 50 meters is not available. The Commission will require fixed and Mode II devices to inform the database of their location uncertainty with a 95% confidence level when requesting a list of available channels, and require that the database consider this uncertainty in determining the list of available channels at the device's location. This requirement is consistent with the standard adopted for use across Europe and implemented by Ofcom in the United Kingdom. The Commission anticipates that its adoption of the same requirement will lead to harmonized devices and lower equipment costs for consumers.

32. To implement this requirement, the databases will increase the minimum separation distances from all protected services by the amount that the location uncertainty exceeds ± 50 meters. For example, no increase in separation distances will be required for a device that meets the ± 50 meter level of accuracy, while an adjustment of 50 meters would be required for a device with an accuracy of ± 100 meters. The Commission will work with the white space database administrators to ensure that separation distances are calculated appropriately. It will require that applicants for certification of fixed and Mode II devices provide details regarding the technologies used by a device to determine its location and how, in the case of technologies other than GPS, the location uncertainty is calculated with a 95% confidence level. As part of the certification process, the Commission will test to ensure that these parameters are correctly transmitted to the databases.

3. Frequencies of Operation for White Space Devices

33. *Fixed devices on channels 3 and 4.* The Commission modifies the part 15 rules to permit fixed white space devices to operate on TV channels 3 and 4. This action makes available an additional 12 megahertz of contiguous spectrum for their use in areas where they are not occupied by authorized users. Because this spectrum is immediately adjacent to channel 2, this rule change provides an opportunity for fixed devices to use the lower VHF band at maximum permitted power in areas where all three channels are not occupied.

34. The Commission originally prohibited white space device operation on channels 3 and 4 to protect TV interface devices and TV receivers from direct pickup interference on channels 3 and 4. The number of these devices has been declining 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, and the price of new TV receivers has dropped significantly since that 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.

35. *Personal/portable devices on channels 14–20.* The Commission modifies the part 15 rules to permit personal/portable white space devices to operate on TV channels 14–20, but will not permit them to operate below TV channel 14. This decision will make an additional 42 megahertz of spectrum potentially available for personal/portable devices. In adopting the prohibition on personal/portable white space devices on TV channels 14–20 in 2008, the Commission anticipated that channels 21–51 would provide adequate spectrum resources for personal/portable white space devices. In light of the repurposing of the TV bands, this conclusion is no longer valid. Moreover, the Commission concludes that continuing the prohibition on personal/portable device use on channels 14–20 is not necessary to protect PLMRS/CMRS operations. Several white space databases have become operational over the past few years, and the locations where the PLMRS/CMRS is used are already in the databases since that information is used to protect those

operations from fixed white space operations. Personal/portable devices rely on database access to determine their list of available channels, so they can protect the PLMRS/CMRS in the same manner as fixed devices.

36. The Commission will not permit personal/portable white space devices to operate below channel 14, including channels 3 and 4, as requested by many unlicensed proponents. The Commission believes that it is better to maintain the current overall scheme, which limits the frequencies where both personal/portable and fixed white space devices may operate, with personal/portable devices operating in higher frequency channels than fixed devices. Devices that operate at the lower frequencies typically require larger antennas that are better suited for use by fixed white space devices than personal/portable devices; thus there is no clear advantage to permitting personal/portable devices below channel 14.

37. *White space devices on channels above and below channel 37.* The Commission will permit white space devices to operate on the vacant channels above and below channel 37 that are now available only for wireless microphone use, beginning 18 months after the effective date of this rule, but no later than release of the *Channel Reassignment Public Notice (PN)* at the conclusion of the incentive auction. Before this rule change becomes effective, the Commission will have implemented the revised procedures for the immediate reservation and notification of wireless microphone use of vacant channels that it adopts in this proceeding. This will ensure that licensed wireless microphone users, particularly broadcasters and others who cover breaking news events, will have a procedure in place that will enable them to get immediate access to needed spectrum.

38. The Commission does not revisit its decision in the *Incentive Auction R&O* to permit unlicensed white space devices to operate on these two vacant channels. NAB's suggestion that the Commission hold out two vacant TV channels until the end of the post-auction transition period is not practical because the Commission will not know until after the incentive auction how much spectrum will be repurposed and which frequency bands will remain allocated to broadcasting services. The transition from broadcasting to wireless services will occur market by market over a period of time, and the now vacant TV channels for microphone use will be phased out as markets transition, making it impossible to identify

channels in each market for exclusive microphone use. The Commission concludes that it is better to modify the procedures for microphone users to reserve vacant TV channels for immediate use because such a procedure is adaptable to the changing circumstances across the TV bands and the 600 MHz band during the post-auction transition period.

4. Unlicensed Wireless Microphones

39. *Definition of unlicensed wireless microphones in part 15.* The Commission adopts its proposed definition of 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. The Commission also adopts its proposals that wireless microphones may be used for cue and control communications and synchronization of TV camera signals as defined in section 74.801 of the rules, and that the definition of wireless microphone does not include auditory assistance devices as defined in § 15.3(a) of the rules. This definition encompasses the types of wireless microphones that currently operate within the TV bands, but is not so broad as to encompass other types of unlicensed devices that already have provisions in part 15 for operation outside the TV bands. The Commission declines the request of the Nuclear Energy Institute and Utilities Telecom Council to expand the definition of unlicensed wireless microphone to specifically include wireless headsets used at nuclear power plants for bi-directional audio communications between and among personnel. To the extent that a party wishes to use wireless microphones for specialized uses that would not be acceptable under the Commission's definition, such uses would be more appropriately authorized through a waiver rather than by adopting a broader definition of wireless microphone.

40. *Permissible frequencies of operation.* The Commission will 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. This action will make the maximum number of TV channels available for unlicensed wireless microphones. The Commission is also adding an advisory to the rules indicating that the highest channel available for unlicensed wireless

microphones will ultimately be determined by the outcome of the incentive auction, and the rules will be modified consistent with the auction results. Consistent with the rules for wireless microphones licensed under part 74, the Commission will require unlicensed wireless microphones to operate at least four kilometers outside the protected service contours of co-channel TV stations as defined in the final rules.

41. The Commission will not prohibit the operation of wireless microphones on channels 14–20 to protect the Private Land Mobile Radio and Commercial Mobile Radio Services (PLMRS/CMRS) because both licensed and unlicensed wireless microphones have operated on these channels for years without interference to the PLMRS/CMRS.

42. *Technical requirements for unlicensed wireless microphones.* Consistent with the current technical rules that apply to unlicensed wireless microphones under the existing part 15 waiver, the Commission will permit wireless microphones to operate with a power level of up to 50 milliwatts EIRP in both the VHF and UHF TV bands. The Commission is specifying the power limit in terms of EIRP, which it bases on a 50 milliwatt conducted power limit and an assumed antenna gain of 0 dBi. The Commission expects that this power level is appropriate for most users, particularly because parties using part 15 wireless microphones will commonly be entities operating in smaller venues that do not require the longer range operation that higher power allows. The Commission is specifying EIRP rather than conducted power as proposed in the Notice of Proposed Rule Making (NPRM) for several reasons. First, specifying the power limit in terms of EIRP ensures uniformity in the maximum radiated power for all unlicensed wireless microphones. If the Commission were to specify a conducted power limit without any antenna gain requirement, different devices operating at the same conducted power level could in fact be radiating at higher or lower power levels depending on their antenna gain. Specifying the power limit in terms of EIRP will be particularly beneficial in the VHF band, where the efficiency of antennas is lower due to the longer radio wavelengths, since this approach will allow manufacturers to adjust the radiated power to partially compensate for low antenna efficiency. Also, specifying EIRP is consistent with other part 15 rules, which generally specify radiated emission limits in a form that considers both power and antenna gain, e.g., field strength, EIRP, or a

combination of conducted power and antenna gain. To reduce the compliance burden on wireless microphone operators, the Commission is specifying power limits for these devices only in terms of EIRP, rather than allowing the use of either EIRP or conducted measurements as Shure suggests.

43. As proposed in the NPRM, the Commission will require unlicensed wireless microphones to comply with the same channelization, frequency stability, and bandwidth requirements as part 74 wireless microphones. Specifically, it will 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. The Commission will permit the combination of multiple adjacent 25 kHz segments within a TV channel to form an operating channel with a maximum bandwidth not to exceed 200 kHz. Consistent with the measurement requirements for other part 15 transmitters, the Commission will require that the frequency tolerance be maintained over a temperature variation of –20 degrees to +50 degrees C at normal supply 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. The 25 kHz offset requirement will prevent wireless microphones from operating at the edge of a TV channel where they could interfere with TV stations on adjacent channels, and the frequency tolerance requirement will 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 the operation of multiple microphones within a TV channel.

44. The Commission will require that unlicensed wireless microphones comply with the same emission mask as licensed part 74 wireless microphones. Specifically, it will require that emissions from analog and digital unlicensed wireless microphones comply with the emission masks in section 8.3 of ETSI EN 300 422–1 v1.4.2 (2011–08), *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*. 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. Outside of the

frequency range where the ETSI masks are defined (one megahertz above and below the wireless microphone carrier frequency), the Commission will require that emissions comply with same limit as the edge of the ETSI masks, specifically, 90 dB below the level of the unmodulated carrier. The Commission is incorporating the ETSI EN 300 422-1 standard into the part 15 rules by reference and adding it to the list of measurement procedures in §§ 15.31 and 15.38.

B. 600 MHz Guard Bands and Duplex Gap

1. Guard Bands

a. Protecting Adjacent TV Bands

45. *White space devices.* The Commission is adopting its proposal to allow fixed and personal/portable white space devices to operate at 40 milliwatts EIRP in a six megahertz frequency band within the guard bands and duplex gap. This power level and bandwidth will be useful for unlicensed devices, and the Commission's analysis shows that operation at this power level will not cause harmful interference to television services in adjacent bands. As discussed fixed white space devices can operate in the TV bands with a power level of 40 milliwatts EIRP and an antenna height of 10 meters AGL on channels immediately adjacent to occupied TV channels. The Commission will therefore also allow fixed white space devices to operate in the guard band adjacent to the remaining TV spectrum at the same power level and antenna height as in the TV bands. In the event that market variation necessitates placing TV stations in the guard bands in some markets, the Commission will require that white space devices operating in the guard bands comply with the same requirements (*e.g.*, minimum separation distances) that apply to white space devices operating in the TV bands.

46. *Wireless microphones.* The Commission will allow wireless microphones to operate in the guard bands and duplex gap with a maximum power of 20 milliwatts EIRP. Consistent with the treatment of unlicensed wireless microphones in the TV bands, the Commission is specifying the power limit in terms of EIRP rather than conducted power. However, wireless microphone power limits in the guard bands will be lower than the levels permitted under the current part 74 rules (50 milliwatts in the VHF TV band and 250 milliwatts in the UHF TV band) or under the part 15 waiver (50 milliwatts in both the VHF and UHF TV bands). This power level is necessary to

protect adjacent band wireless downlink services from harmful interference. Where the guard band is immediately adjacent to TV spectrum, wireless microphones operating at 20 milliwatts EIRP or less will not cause harmful interference to TV reception because they already operate in such a manner (*i.e.*, with no frequency separation) at the higher 50 milliwatt power level without causing interference.

b. Protecting Adjacent Wireless Downlink Bands

(i) White Space Devices

47. The Commission is adopting its proposal to require that white space devices operating at 40 milliwatts EIRP in a six megahertz frequency band within the guard bands provide at least a three megahertz frequency separation from wireless downlink spectrum. The Commission is selecting three megahertz as the minimum frequency separation because filter attenuation increases beyond a three megahertz frequency separation, thus reducing the potential for white space devices to cause harmful interference to wireless downlink services. In addition, the out-of-band emissions from white space devices, which are a potential source of harmful interference to wireless handsets, tend to fall further below the limits required by the rules as the frequency separation from a white space device increases. Thus, a frequency separation of three megahertz will reduce the likelihood of a wireless handset receiving harmful interference.

48. As explained the rules the Commission is adopting create an environment where the potential for white space devices to cause harmful interference to adjacent wireless downlink bands is low. Accordingly, the Commission finds no basis to adopt significantly tighter out-of-band emission limits, lower power levels, or a five megahertz frequency buffer to protect wireless downlink receivers from harmful interference from white space devices, as advocated by CTIA and AT&T.

49. The Commission assesses the potential for harmful interference from 40 milliwatt white space devices to wireless downlink services in adjacent bands. Because there are neither 600 MHz band wireless devices nor portable white space devices currently available, the analyses are based on the predicted performance of such equipment. The analyses also rely on predictions of other factors, including propagation and body losses, which affect whether harmful interference will occur. These losses can vary significantly in practice,

so the Commission must make reasonable assumptions concerning these factors based on its experience. The purpose of the analyses is to determine whether the rules the Commission is adopting comply with the Spectrum Act's requirement that the Commission not permit any use of a guard band that it determines would cause harmful interference to licensed services.

50. Harmful interference is defined by the Commission's part 2 rules as "interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Regulations." The Commission finds it appropriate to use the existing definition of harmful interference. Applying this definition to the Spectrum Act, the Commission finds that it may not permit any use of the guard bands that it determines would cause serious degradation, obstruction, or repeated interruption to new 600 MHz service. The Commission further finds that it need not set technical rules so restrictive as to prevent all instances of interference, as opposed to harmful interference. Determining *ex ante* when operations in one band will seriously degrade, obstruct, or repeatedly interrupt operations in another band necessarily involves the Commission examining the particular interference scenario that is likely to arise and exercising its predictive judgment. In this circumstance, the Commission establishes technical rules for white space devices and microphones that will permit their use without causing harmful interference (although not necessarily eliminating all interference) to new 600 MHz service licensees.

51. The Commission's analyses show little potential for harmful interference to wireless handsets from portable white space devices. It believes that portable devices represent the worst case for harmful interference because these types of devices would operate in the closest proximity to each other. By contrast, the Commission expects that white space devices used in fixed applications, such as access points or for providing point-to-point communications, would typically have a greater physical separation distance from licensed wireless handsets, thus posing even less risk of harmful interference. The Commission first considers the impact of out-of-band emissions from white space devices into the frequency bands that are received by wireless handsets, since out-of-band emissions from a transmitter in an

adjacent band appear as co-channel emissions within the band of a service potentially receiving harmful interference. Second, the Commission considers the effect of “blocking” from a white space transmitter to wireless receivers in the adjacent wireless downlink band. Blocking interference occurs because a receiver has limits on the level of adjacent channel emissions it can tolerate due to the selectivity of its internal filters.

52. *Out-of-band emission interference.* With respect to harmful interference to wireless handsets from white space device out-of-band emissions, the Commission makes several assumptions detailed below. For the reference sensitivity of the handset receiver, the Commission used -97 dBm at the antenna input as specified in the applicable 3GPP standard. This is the weakest signal level at which a receiver can meet a minimum specified throughput. It is not unreasonable to assume that a handset will typically operate at a level that is at least 10 dB higher than the minimum. Thus, using the -97 dBm reference sensitivity specified in the 3GPP standard is conservative.

53. An LTE handset will typically use an antenna with a gain of less than 0 dBi due to size and efficiency constraints, so the Commission assumes an antenna gain of -6 dBi. Antennas built into deployed equipment are often mass produced and do not conform to the same exacting specification as a 0 dBi reference antenna, and embedded handset antennas can experience several dBs of loss because they are not one hundred percent efficient. In addition, antennas may also experience some loss due to impedance mismatch, and the radiation pattern of an antenna is not uniform in all directions and will have less than the maximum gain (or loss) in many directions. For these reasons, the Commission believes that assuming -6 dBi of antenna gain represents a realistic representation of the embedded antenna that will be installed on LTE handsets in the 600 MHz band.

54. Because the separation distances between unlicensed and licensed devices the Commission is considering are short (*i.e.*, on the order of several meters maximum), a free space signal propagation model is appropriate. Free space path loss is the propagation loss that results from a line of sight path through space. When the transmitter and receiver are very close together, there is a high probability that they have a clear line of sight, and free space path loss provides a bound on the loss of the transmission system.

55. The Commission assumes several other factors will attenuate the signal transmitted from the unlicensed device. First, it assumes that there will be 2 dB signal loss due to polarization mismatch between transmit and receive antennas due to the orientation of transmit and receive antennas not being in the same plane. Second, the Commission assumes that there will be 3 dB body loss at both the unlicensed transmitter and at the LTE handset since the analysis considers portable devices that are typically held in the hand or carried on a person. In the case where a device may be placed on a table and not held, other losses, such as absorption and reflection from the table, often in excess of the 6 dB assumed here (3 dB each for the white space device and the LTE device) substitute for body loss. Third, the Commission assumes that there will typically be 3.5 dB or more in propagation losses due to multipath (0.5 dB) and shadowing (3 dB) from nearby walls, objects or persons in the room. Taken together, the losses described will be present to varying degrees and in most cases at values above the conservative values chosen for analysis purposes.

56. To account for the reduction in emissions level of white space devices in the LTE channel, the Commission conservatively assumes a 3 dB slope loss. The white space out-of-band emission mask requires the emissions to attenuate to the § 15.209 levels within six megahertz of the channel on which it is operating, so these emissions will attenuate over the three, to five megahertz buffer provided by the guard bands and duplex gap to a level below the Commission's limit before reaching the edge of the LTE channel.

57. The Commission believes that using a 3 dB desensitization level as the interference threshold is more appropriate than a 1 dB level. The Commission stated in the H Block Order, WT Docket No. 12-357, 78 FR 50214, August 16, 2013, that a 1 dB desensitization criterion is too restrictive for modern cellular systems. It further noted that the 3GPP standard for UMTS and LTE devices specifies an in-band blocking requirement that sets the interfering signal level 6 dB or more above the reference sensitivity level. In that proceeding, for determining mobile interference, the Commission found that the 3 dB desensitization level is a more appropriate metric for determining the presence of harmful interference.

58. Based on the foregoing assumptions, and using the out-of-band emission limits for 40 milliwatt white space devices, the Commission calculates that for a 3 dB desensitization

level, interference could begin to occur at 0.8 meters. In the interest of completeness, the Commission notes that this distance rises to 1.7 meters for a 1 dB desensitization level. Thus, the Commission believes that using even the more stringent 1 dB desensitization criterion, the probability of harmful interference occurring would be an extremely unlikely event due to a variety of factors that would need to occur simultaneously. For example, a wireless device would have to be receiving in a frequency block immediately adjacent to the guard band or duplex gap, the received wireless signal would have to be at an extremely low level, a white space device would have to be located in very close proximity to a wireless device, the antenna patterns of both the transmitter and receiver would have to be closely aligned to maximize the white space device signal at the receiver, and there would have to be very low body and other propagation losses. While situations like this could occur, the Commission believes that the probability is very low. Even in such situations, there are other mitigating factors that could prevent harmful interference from occurring. For example, white space devices must incorporate transmit power control, so they often operate below the maximum allowable power, and wireless networks manage operating channels and handset power in noisy conditions to ensure the best possible quality of service. Thus, the Commission believes that the criteria it is adopting for white space devices will protect the 600 MHz service from harmful interference.

59. *Blocking interference.* With respect to blocking interference, the Commission also considers interference between portable devices. Blocking interference results from limitations on a receiver's ability to reject signals in an adjacent band. The Commission once again assumes a reference sensitivity for the LTE receiver of -97 dBm/5 MHz. The Commission also considered the 3GPP standard which specifies a minimum receiver adjacent channel selectivity of 33 dB. The Commission further assumed an additional 10 dB for adjacent channel selectivity beyond the edge of the channel in which a white space device operates (three to five megahertz removed from the edge of the wireless downlink band).

60. The Commission makes many of the same assumptions as in the out-of-band emission interference analysis, including the use of a free space propagation model, 2 dB for antenna polarization mismatch, 3 dB body loss at both the white space device and the

wireless handset, 3.5 dB loss for shadowing and multipath, 3 dB for OOB slope loss, and a receiver antenna gain of -6 dBi. Consistent with the analysis above, the Commission also assumed that real-world devices would operate with a 10 dB stronger signal than the minimum in the 3GPP standard. Using a 3 dB desensitization criterion, the Commission assumes that interference will begin to occur to a handset at a level greater than -54 dBm (the reference sensitivity plus the adjacent channel selectivity plus 10 dB). The Commission calculates that an LTE handset would receive an adjacent channel signal level of -54 dBm at a distance of 3.4 meters. For a 1 dB desensitization level, this distance would increase to 6.8 meters. This result requires some context. First, the 3GPP standard defines blocking as the point at which throughput falls below 95% of the maximum throughput. As Google showed in their measurements, variations of greater than 5% throughput typically occur under normal usage conditions. This can be due to a variety of reasons, such as movement of a handset and a continuously changing electromagnetic environment. Therefore, even though an LTE handset may experience some blocking interference from a white space device as close as 3.4 meters (or even 6.8 meters), the Commission does not believe this rises to the level of harmful interference as the LTE handset will continue to function, just at a slightly slower data rate, which it believes in the vast majority of instances would not be perceptible to the user, since a user would likely experience similar fluctuations in data rates under normal usage conditions.

61. In sum, the Commission finds that the likelihood of harmful interference from 40 milliwatt white space devices to wireless downlink services is extremely low. It is not possible to ensure that harmful interference will never occur, as wireless interests apparently request. The part 15 rules recognize this fact, indicating that the limits in part 15 will not prevent harmful interference under all circumstances and that it is the obligation of the unlicensed device to eliminate the interference or cease operations. Nevertheless, as described above, the Commission finds that actual harmful interference from white space devices to wireless systems at the technical limits it is adopting would be an extremely unlikely event due to a variety of factors that would need to occur simultaneously. For example, one factor noted above is that white space devices must incorporate transmit

power control, so they often operate below the maximum allowable power to conserve battery power. The Commission does not believe it is appropriate to establish technical requirements for white space devices based on the absolute worst case situation which will happen only rarely in the real world.

62. While the Commission's technical analysis shows that there is a low probability that unlicensed devices will cause harmful interference to licensed wireless services, it nonetheless reminds parties that the rules prohibit unlicensed devices from causing harmful interference, even devices that comply with the technical rules. In the event white space devices cause harmful interference to licensed wireless services, there are steps that the Commission could take to eliminate the interference. If a licensed wireless service provider believes that an unlicensed device is causing harmful interference to its licensed service, the Commission requires all relevant parties to work collaboratively and in good faith to address those concerns in a timely manner. To that end, the Commission plans on providing guidance in the future about how a licensed wireless service provider can contact a party responsible for the unlicensed device to discuss interference concerns. In addition, a licensed wireless provider can ask the Commission to adjudicate any claims of harmful interference and the Commission can take immediate corrective action upon determining that there is harmful interference, including by directing the database administrator(s) to deny the offending device(s) access to spectrum.

63. Finally, the Commission concludes that because its analysis shows that out-of-band emissions from white space devices have a low probability of causing harmful interference to wireless services, there is no need for tighter out-of-band emissions from white space devices. Additionally, the Commission observes that the out-of-band emission limits that licensed wireless handsets must meet are higher than the out-of-band emission limits it is requiring white space devices to meet. No party has addressed the inconsistency of why these higher out-of-band emission limits from handsets are not problematic while white space device emissions will allegedly cause harmful interference. Therefore, the Commission finds it both unnecessary and inequitable to require white space devices to meet even tighter out-of-band emission limits.

64. The Commission further concludes that based on its analysis, it need not designate any 600 MHz service spectrum blocks as "impaired" due to the potential presence of unlicensed white space devices operating in the guard bands or duplex gap. The analysis provided above shows that 600 MHz service licensees will not experience harmful interference due to the presence of unlicensed devices operating in the guard bands or duplex gap. The Commission believes licensees operating on those bands will enjoy a similar spectrum environment as 600 MHz service licensees operating on non-adjacent spectrum blocks and be able to deliver competitive broadband service to the U.S. public free from harmful interference.

(ii) Wireless Microphones

65. The Commission will allow unlicensed wireless microphones to operate in the guard bands with a maximum power of 20 milliwatts EIRP and at least one megahertz frequency separation from wireless downlink spectrum. This power level will be useful for wireless microphone operators because many wireless microphones operate at power levels between 10 and 20 milliwatts. The Commission finds that this power limit for wireless microphones is necessary in the guard bands and duplex gap to protect licensed wireless services outside these frequency bands. In addition, because the Commission is allowing white space devices to operate in the guard bands and duplex gap at power levels of 40 milliwatts EIRP, 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. The fact that the Commission is specifying wireless microphone power in terms of EIRP, rather than conducted power as proposed in the *NPRM*, will benefit wireless microphone manufacturers by ensuring that they can design equipment that operates with a maximum radiated power of 20 milliwatts, even if the design of a device requires the use of a less efficient antenna.

66. The Commission rejects arguments that a nine megahertz frequency buffer is necessary to protect wireless downlink spectrum from wireless microphones. It is requiring a one megahertz buffer because the ETSI out-of-band emission limits that it is requiring wireless microphones to meet specifies that out-of-band emissions roll off over a one megahertz frequency

span. Thus, a one megahertz buffer ensures that wireless microphone out-of-band emissions will be at or below the ETSI limits in the wireless downlink band. The Commission performed analyses on the interference potential of wireless microphones to wireless downlinks that are similar to those for white space devices. Specifically, the Commission considered both interference from out-of-band emissions as well as blocking interference.

67. *Out-of-band emissions interference.* With respect to harmful interference to wireless handsets from wireless microphone out-of-band emissions, the Commission uses many of the same assumptions it used in its analysis of white space device emissions into the wireless downlink band. Specifically, it uses a handset receiver reference sensitivity of -97 dBm at the antenna input and assumes a handset antenna gain of -6 dBi. It also uses a free space signal propagation model and assumes that several factors will act to attenuate the signal transmitted from the wireless microphone, including a 2 dB signal loss due to polarization mismatch between the transmit and receive antennas, 3.5 dB in propagation losses due to multipath and shadowing from nearby walls, objects or nearby people, and 3 dB of body loss at the wireless handset. Based on information submitted into the record regarding wireless microphone body loss, the Commission assumes a larger body loss for a wireless microphone (8 dB for a body worn wireless microphone and 18 dB for a handheld wireless microphone) than it assumes for a white space device (3 dB). In addition, a wireless microphone's frequency band of operation will be at least one megahertz removed from the LTE downlink band where emissions are at the ETSI limit. The Commission expects that wireless microphone emissions will continue to roll-off beyond the ETSI limit as frequency separation continues, but because equipment certification measurement reports do not currently contain measurement data based on the ETSI limits, the Commission is not assuming a 3 dB slope loss for wireless microphones as it does for white space devices. Finally, as with white space devices, the Commission bases its analysis on an interference criterion of a 3 dB rise in the noise floor.

68. Based on the foregoing assumptions, and using the ETSI -90 dBc out-of-band emission limits for a 20 milliwatt (13 dBm) 200 kilohertz wireless microphone at a frequency separation of one megahertz and greater, the Commission calculates the distance

at which the interference criterion is exceeded. These distances (less than a tenth of a meter) are so short that the Commission believes OOB interference from wireless microphones poses little risk of causing harmful interference to 600 MHz service downlinks even when multiple wireless microphones are used in close proximity. Because the necessary separation distances are so short, it is unlikely that multiple wireless microphones could be used in such close proximity to a 600 MHz service band handset. Even if several microphones were to be used near a wireless handset, they could not all use the same frequency in order to avoid causing interference to other wireless microphones. As wireless microphones spread throughout the guard bands and duplex gap, they will use frequencies farther from wireless downlink spectrum and the Commission predicts that out-of-band emissions from those additional wireless microphones will decline as the emission levels roll-off due to increased frequency separation.

69. *Blocking interference.* With respect to blocking interference from wireless microphones, the Commission again assumes a reference sensitivity for the LTE receiver of -97 dBm and an adjacent channel selectivity of 33 dB. Because the Commission is allowing wireless microphones to operate at a closer frequency separation than white space devices (one megahertz instead of three megahertz), it is assuming a conservative handset receive filter rejection of 3 dB. In addition, the Commission makes many of the same assumptions as in the out-of-band emission interference analysis for wireless microphones, including the use of a free space propagation model, 3 dB body loss at the wireless handset, 8 dB of body loss for body worn wireless microphones and 18 dB of body loss for handheld wireless microphones, 3.5 dB loss for shadowing and multipath, and a receiver antenna gain of -6 dBi. Consistent with the analyses above, the Commission also assumes that real world devices would operate with a 10 dB stronger signal than the minimum specified in the 3GPP standard. Also, the Commission assumes a 3 dB rise in the noise floor as the appropriate interference criterion. In this case, the distances at which the interference criterion may be exceeded are 6.6 meters for body worn microphones, and 2.1 meters for hand held microphones. For a 1 dB rise in the noise floor, the distances at which the interference criterion may be exceeded are 13.2 meters for body worn microphones and 4.2 meters for hand held microphones.

70. As with white space devices, this result requires some context. The Commission again points out that the 3GPP standard defines blocking as the point at which throughput falls below 95% of the maximum throughput, and as Google showed in their measurements, variations of greater than 5% throughput typically occur under normal usage conditions. Therefore, even though an LTE handset may experience some blocking interference from a wireless microphone as close as 6.6 meters, the Commission does not believe this rises to the level of harmful interference. Handsets will continue to function, albeit at a slightly slower data rate, which the Commission believes would generally not be perceptible to the user as that user would likely experience similar fluctuations in data rates under normal usage conditions. In addition, the Commission does not believe that even with multiple microphones operating within a close area, 600 MHz service handsets would experience harmful interference. First, the wireless microphones would themselves need to spread over many different frequencies to avoid interfering with each other. Thus, it is unlikely that more than one microphone would be operating at the frequency next to the one megahertz buffer in the guard bands or duplex gap within a given area. Second, to conserve battery power, wireless microphones, like white space devices and mobile handsets, generally operate below the maximum allowable power which reduces the likelihood of interference. Third, as with the analysis for white space devices, the analysis here considers the worst case which is unlikely to actually occur. Aside from the analysis assuming the wireless microphone is operating at maximum power, inherent in the worst case situation is that the mobile handset is operating at the edge of coverage near its sensitivity level, on the frequency closest to the guard bands or duplex gap, the antenna patterns of both the wireless microphone and wireless receiver would have to be closely aligned to maximize the wireless microphone signal at the receiver, and there would have to be *de minimis* body and other propagation losses; a scenario that is not likely to occur often, if at all. Finally, the Commission notes that wireless microphones are generally used in specific places—theaters, arenas, churches, etc. and not likely to be found in all areas where mobile handsets are in heavy use. Even at breaking news events, where there may be a mix of mobile handsets and wireless microphones, the Commission believes

it unlikely that all the factors needed to cause interference would occur simultaneously. Thus, the Commission finds that the likelihood of wireless microphones in the guard bands and duplex gap causing harmful interference to 600 MHz wireless downlink service to be very low.

c. Frequencies of Operation

71. *White space devices.* In the case of a nine megahertz guard band, a white space device with three megahertz separation from wireless downlink spectrum will be immediately adjacent to a TV channel. Such operation is consistent with the analysis detailed above showing that a three megahertz guard band will protect wireless handsets from white space devices and that no guard band is needed to protect adjacent channel TV operations. If the guard band is 11 megahertz, the Commission will apportion the spectrum such that white space devices will be required to operate at the lower end of the guard band, immediately adjacent to TV spectrum and five megahertz from wireless handsets. This will correspondingly provide a contiguous four megahertz block of spectrum not shared with white space devices for wireless microphone use and a one megahertz guard band between wireless microphones and wireless handsets. Distributing usage across an 11 megahertz guard band reduces the burden on white space devices, which will always operate in the same portion of the guard band, thus making channel availability checks simpler than if white space devices could operate anywhere within the guard band where they maintain at least a three megahertz separation from wireless downlink spectrum. Finally, this plan is consistent with the plan the Commission is adopting for the 11 megahertz duplex gap.

72. The Commission is also adopting rules to allow white space device operation in a seven megahertz guard band. It will permit 40 milliwatt white space devices to operate in the lower four megahertz portion of a seven megahertz guard band, *i.e.*, the portion immediately adjacent to television spectrum. This will leave a three megahertz frequency separation from wireless downlink spectrum above the guard band. The Commission will require that white space devices operating under these provisions comply with the same technical requirements as 40 milliwatt white space devices in nine or 11 megahertz guard bands, with the exception of the channel bandwidth and the PSD limit. The current PSD limit would prevent a

white space device in a four megahertz channel from attaining the full 40 milliwatts EIRP because the power is concentrated in a narrower bandwidth than was used in establishing the limit. The Commission will therefore allow such devices to comply with a PSD limit of 0.6 dBm/100 kHz EIRP. It will also require that a 40 milliwatt fixed device operating in a four megahertz channel comply with a conducted PSD limit of -5.4 dBm, since the conducted power limit for fixed devices is 6 dB less than the EIRP limit. These limits are about 2 dB higher than the limits for white space devices in a six megahertz channel. Because the out-of-band emission limits are not being modified for this narrower white space channel, the total radiated power adjacent to TV remains at 40 milliwatts. The Commission also maintaining the three megahertz separation to 600 MHz band wireless downlinks. Thus, Commission does not believe that white space devices operating in a seven megahertz guard band will cause harmful interference to either television reception or wireless downlinks.

73. The Commission does not adopt rules to allow white space devices to operate in a three megahertz guard band adjacent to channel 37. A guard band that size would be too small to permit white space device operation, because at least a three megahertz frequency separation is required to protect wireless downlink services.

74. *Wireless microphones.* The Commission will allow unlicensed wireless microphones to operate in certain segments of the guard bands. In the guard band between television and wireless downlink spectrum, the Commission will allow unlicensed wireless microphones to operate across the guard band regardless of its eventual size (determined by the results of the auction) 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. If the guard band is 11 megahertz wide, unlicensed wireless microphones will be allowed to operate in the lower ten megahertz segment of the band; if the guard band is nine megahertz wide, unlicensed wireless microphones will be allowed to operate in the lower eight megahertz segment; and if the guard band is seven megahertz wide, unlicensed wireless microphones will be allowed to operate in the lower six megahertz segment.

75. In the three megahertz guard bands adjacent to channel 37, the Commission will 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. Wireless microphones currently operate on channels 36 and 38 at up to 250 milliwatts without causing harmful interference to WMTS and RAS operations on channel 37. The Commission thus concludes that there is no need for any frequency separation between unlicensed wireless microphones operating in the guard bands and channel 37 because it is limiting the maximum permitted power in this spectrum to 20 milliwatts to protect wireless downlink services.

2. Duplex Gap

a. Protecting Adjacent Wireless Downlink and Uplink Bands

76. Wireless downlink bands will be protected from harmful interference by requiring that unlicensed white space devices operate at 40 milliwatts EIRP with at least three megahertz frequency separation from wireless downlink bands and that wireless microphones operate at 20 milliwatts EIRP with at least one megahertz separation from wireless downlink bands. The Commission will require that licensed wireless microphones operating in the duplex gap comply with the same technical requirements as unlicensed wireless microphones in the guard bands. The split of the duplex gap described below will provide for a one megahertz frequency separation between licensed wireless microphones and wireless downlink spectrum. It will also provide for a frequency separation of five megahertz, rather than three megahertz, from wireless downlink spectrum. Thus, wireless downlink services will be protected from harmful interference.

77. Regarding wireless uplink bands, the Commission concludes that that it is not necessary to provide any frequency separation between white space devices and unlicensed wireless microphones and wireless uplink spectrum to prevent harmful interference to base station receivers. Base station antennas are generally mounted high on a tower, providing distance separation between them and white space devices and wireless microphones. Also, base stations can take advantage of better receive filters to minimize the potential for adjacent channel interference. These factors lead to very little risk of harmful interference to wireless base stations even when white space devices and unlicensed wireless microphones operate immediately adjacent to wireless uplink spectrum.

b. Frequencies of Operation

78. The Commission is adopting the proposed 1–4–6 split of the duplex gap. A six megahertz band for unlicensed devices, which will be used by both unlicensed white space devices and unlicensed wireless microphones, is supported by the record and is consistent with the current white space device rules. Additionally, a four megahertz segment of the duplex gap is designated for licensed wireless microphones users only, thus enabling them to access spectrum for quick-breaking events without having to reserve channels in the white space databases. This plan maximizes the frequency separation between the six megahertz segment of the duplex gap for white space device use and wireless downlink spectrum, thereby reducing the risk of harmful interference to those adjacent band services as required by the Spectrum Act. The one megahertz buffer at the lower end of the duplex gap provides a margin of interference protection to wireless handsets from licensed wireless microphones. The Commission will allow unlicensed wireless microphones to operate in the same six megahertz portion of the duplex gap as white space devices, and licensed wireless microphone use will be permitted in the four megahertz segment of the lower duplex gap designated for their operation. This plan balances the spectrum needs of unlicensed white space and wireless microphone users, by making spectrum available for both wireless microphones and white space devices, while minimizing the likelihood of harmful interference to licensed wireless services.

79. The Commission concludes that it is not necessary to provide a guard band between the four megahertz designated for licensed wireless microphones and the six megahertz designated for unlicensed white space devices and unlicensed wireless microphones. Recognizing that the rules require low emissions from white space devices outside their channel of operation, the record indicates that the risk of adjacent channel interference to licensed wireless microphones is low. Wireless microphones currently operate adjacent to white space devices as well as full power television stations with no adverse effects as their narrow bandwidths and receiver selectivity provide interference protection. Thus, there is a low risk of unlicensed white space devices or unlicensed wireless microphones causing harmful interference to licensed wireless microphones in the adjacent band.

80. The Commission disagrees with parties requesting a one megahertz buffer at the upper end of the duplex gap to protect white space devices from possible interference from wireless uplinks (handset transmitters) in the adjacent band. As discussed, a one megahertz frequency separation is necessary to protect licensed operations in wireless downlink spectrum (handset receivers) from wireless microphones operating in an adjacent frequency band, and the Commission declines to eliminate this buffer from the lower end of the duplex gap. To add a one megahertz buffer at the upper end of the duplex gap would reduce the spectrum available for licensed wireless microphones in order to maintain six megahertz for white space devices. Given the Commission's objective to balance the interests of different users, it is not reducing the amount of spectrum designated for licensed wireless microphones in the duplex gap.

3. Database Access

81. The Commission will require that unlicensed white space devices and unlicensed wireless microphones operating in the 600 MHz guard bands, including the duplex gap, rely on database access to identify vacant channels for their use. This requirement is necessary because the Spectrum Act requires that unlicensed use of the guard bands "must rely on a database or subsequent methodology as determined by the Commission." The Commission concludes 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. The Commission will not require that licensed wireless microphone users in the duplex gap rely on the white space databases to determine if those frequencies are available for their use at their location prior to operation.

82. Because the Spectrum Act does not define the terms "rely on a database" or "subsequent methodology," the Commission concludes that the Spectrum Act gives it discretion to determine how unlicensed white space devices and unlicensed wireless microphone users should "rely on" the white space databases to identify available frequencies in the guard bands for their use. Unlicensed white space devices will rely on a database for identifying channels available for their use in the guard bands and duplex gap as they do now in the TV bands.

83. The Commission concludes that unlicensed wireless microphone users can satisfy the Spectrum Act's requirement to "rely on" a database by manually checking it via a separate Internet connection which can be done using a smart phone, laptop, or other similar telecommunications devices. The Commission will require that unlicensed microphone users check the databases prior to beginning operation at a given location (*e.g.*, prior to beginning a performance). Because the databases will identify available channels based on the location where a microphone will be used (latitude and longitude), the user will need to re-check the databases for available channels if it moves from the earlier location.

84. The Commission will not require licensed wireless microphone users of the four megahertz segment in the duplex gap to access a database before beginning operation. During the post-auction transition period while TV stations are in the process of vacating their channels in the 600 MHz band, a licensed wireless microphone user may need to determine whether the duplex gap is available in an area. After the end of this transition period, the duplex gap will generally be available nationwide, except possibly in a limited number of locations if the auction outcome necessitates repacking some TV stations into the duplex gap. Broadcasters 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. Since the Commission is limiting operation in this four megahertz segment to licensed users, the Spectrum Act's requirement that unlicensed devices rely on database access or a subsequent methodology as determined by the Commission does not apply.

C. 600 MHz Service Band

1. White Space Devices

a. Permissible Types of Operation

85. The Commission will allow fixed, Mode I and Mode II white space devices to operate in the 600 MHz service band under the same technical requirements (*e.g.*, power, antenna height, database access) that apply to operation in the TV bands. Additionally, it will require that white space devices comply with separation distances from the areas where a wireless licensee has commenced operations.

86. The Commission rejects arguments that white space devices in the duplex gap and 600 MHz service band should have the same power limit.

White space devices will be limited to 40 milliwatts in the duplex gap because they will operate in the same geographic areas where 600 MHz service licensees have commenced operation, and on frequencies adjacent to wireless uplink and downlink spectrum with small or no frequency separations and, potentially, at short physical separation distances from wireless handsets. In contrast, white space devices will be allowed to operate in the 600 MHz service band only at locations where a wireless licensee has not commenced operations, so the Commission can allow higher power levels for white space devices in the 600 MHz service band than in the duplex gap. Issues pertaining to the definition of "commence operations" will be addressed separately in response to the *Commence Operations PN*.

87. The Commission rejects arguments that the Spectrum Act prohibits unlicensed use of the 600 MHz service band. The Spectrum Act specifically permits unlicensed use of the guard bands, but does not contain any prohibition on continued unlicensed use of the 600 MHz service spectrum prior to a 600 MHz service licensee commencing operations. Thus, the Commission finds that such operations are not prohibited by the Spectrum Act.

b. Protection Criteria

(i) Wireless Uplinks

88. The Commission adopts the proposed minimum separation distances that white space devices must meet when operating in spectrum that is also used for licensed 600 MHz wireless uplinks or downlinks. While these distances were calculated by determining the minimum separation from base stations that white space devices must meet to avoid causing harmful interference, consistent with the proposals in the *Notice*, the Commission is requiring that white space devices comply with these distances from any point along the edge of the polygon representing the outer edge of base station deployment, rather than from just the points that define the polygon in the database. This requirement is necessary because the points defining a polygon could in some instances be farther apart than the protection distances, thus possibly under-protecting base stations that are just inside the polygon and between the defined points. The co-channel and adjacent channel separation distances to protect wireless uplinks are listed in the final rules.

89. The Commission adopts its proposals to define co-channel operation as any frequency overlap between a TV channel used by a white space device and a five megahertz spectrum block used by a 600 MHz service licensee, and adjacent channel operation as 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 600 MHz service licensee. Consistent with the rules for operation in the duplex gap, the Commission is not requiring adjacent channel separation distances to protect wireless uplink services from white space devices operating at 40 milliwatts since it determined that adjacent channel separation distances are not necessary in that case. However, the Commission is requiring adjacent channel separation distances for white space devices operating at higher power levels.

90. In addition, consistent with the rules for operation in the TV bands, the Commission is requiring that a fixed or Mode II device that supplies a list of available channels to a Mode I device must comply with increased separation distances on any channels that are indicated as available to the Mode I device. As with operation in the TV bands, the Commission will base the increases in separation distance on the minimum co-channel separation distances at 40 and 100 milliwatts. Therefore, if a Mode I device operates at greater than 40 milliwatts, the co-channel and adjacent channel separation distances must be increased by 6 kilometers and 0.14 kilometers, respectively. Similarly, if a Mode I device operates 40 milliwatts or less, the co-channel separation distance must be increased by 5 kilometers.

91. The Commission rejects arguments that use of the TM-91-1 model is inappropriate due to the range of distances and antenna heights over which it is defined. While TM-91-1 was specifically developed for a limited range of distances and antenna heights, it has a broader range of application by the virtue of the fact that it is identical to the Egli model, which is valid over a greater range of distances and antenna heights than specified in TM 91-1.

92. The Commission also rejects arguments that it should use the Longley-Rice model instead of the TM-91-1 model for consistency with the ISIX methodology. The Longley-Rice methodology uses detailed, site specific terrain information and performs complex, computational intensive calculations to determine signal coverage. In contrast, the Commission

here develops a general table of separation distances that can be used by the white space databases to protect licensed wireless services in a wide variety of locations, so the simpler TM-91-1 model is more appropriate for this purpose. The Commission rejects arguments that it should protect wireless base stations from white space devices at distances beyond 60 kilometers and no specific larger distances were suggested in the record.

(ii) Wireless Downlinks

93. The Commission adopts the proposed minimum separation distances of 35 kilometers (co-channel) and 31 kilometers (adjacent channel) between white space devices operating in spectrum used by 600 MHz band wireless downlinks and the boundary of a polygon representing the outer edge of base station deployment. The Commission also adopts the same definitions of co-channel and adjacent channel operation that apply with respect to wireless uplinks. The separation distances that the Commission adopts do not vary with EIRP or HAAT because analysis showed that increasing the EIRP or HAAT has only a small effect on the total required separation distance. These distances are also sufficient to provide protection from white space devices operating at 10 watts EIRP.

94. The Commission will require 40 milliwatt white space devices to meet adjacent channel separation distances from the service areas where a wireless licensee has commenced operations, at any frequency separation from zero to four megahertz from wireless downlink spectrum. This is because the Commission is allowing fixed devices to operate with antenna heights of up to 250 meters HAAT, which increases their potential for causing harmful interference to wireless services. As discussed, white space devices operating in the guard band adjacent to wireless downlink spectrum at low antenna heights (10 meters or less AGL) and a minimum frequency separation of three megahertz will not cause harmful interference to wireless handsets and thus do not specify a separation distance for such operations. While the Commission could allow for operation of such white space devices in the 600 MHz service band without an adjacent channel separation distance, it adopts a different approach in order to reduce the compliance burdens and provide for bright-line rules for the 600 MHz service band. Specifically, for the 600 MHz service band, the Commission will require all white space devices to comply with a single adjacent channel

separation distance, independent of white space device power, antenna height or frequency offset.

2. Wireless Microphones

95. The Commission will require that licensed and unlicensed wireless microphones operating in the 600 MHz service band comply with minimum co-channel and adjacent channel separation distances from the areas where 600 MHz service licensees are operating because this requirement is necessary to protect licensed wireless operations in the 600 MHz service band. However, the Commission agrees with Sennheiser that the separation distances proposed in the *NPRM* are larger than necessary to protect licensed wireless services in some instances. The Commission is reducing the required separation distance for wireless microphones operating in the portion of the 600 MHz service band used for wireless uplinks, *i.e.*, base station receive frequencies. However, it is not reducing the proposed separation distances in the portion of the 600 MHz service band used for wireless downlinks (35 kilometers co-channel, 31 kilometers adjacent channel). The reason is that the primary component of those distances is an assumed base station communication radius of 30 kilometers, so the reduction in these separation distances would be relatively small if recalculated assuming a lower power for wireless microphones. While the Commission could allow for operation of wireless microphones in the repurposed 600 MHz downlink band without any adjacent channel separation distance in some cases similar to its actions in the guard bands and duplex gap, it adopts a different approach in order to reduce the compliance burdens and provide for bright-line rules for the 600 MHz service band. Specifically, for the 600 MHz service band, the Commission will require all wireless microphones to comply with the same adjacent channel separation distance as white space devices.

96. With regard to protecting wireless uplinks, the Commission assumes a lower total power for wireless microphones than 4,000 milliwatts. While licensed wireless microphones are permitted to operate with power levels of up to 250 milliwatts, most wireless microphones operate with a power level of less than 50 milliwatts. Based on ten wireless microphones operating at 50 milliwatts, the total power in a six megahertz channel would be less than 500 milliwatts. The actual EIRP that could affect a wireless system would be less than that for two reasons. First, wireless spectrum blocks are five

megahertz wide, so depending on the overlap between a repurposed six megahertz TV channel and a wireless spectrum block, the maximum power that could fall into a five megahertz block would be 5/6 of the total, or 417 milliwatts. In most cases, a smaller overlap would occur and the power that could fall into a five megahertz block will be less than 417 milliwatts. Second, the EIRP of an individual wireless microphone is often less than the 50 milliwatt conducted power limit due to antenna efficiency limitations, and because wireless microphones are often operated using less than the maximum allowable power to achieve greater battery life and spectral efficiency. Because these two conditions are likely to create a situation where the overlapping power is much less than 417 milliwatts, the Commission will base the separation distances that wireless microphones must meet to protect wireless uplinks on the nearest white space device power level that is less than 417 milliwatts, which is 250 milliwatts. The co-channel and adjacent channel separation distances that apply at that power level with a three meter antenna height are 7 kilometers and 0.2 kilometers. While the Commission could allow for operation of wireless microphones in the repurposed 600 MHz uplink band without any adjacent channel separation distance in some cases similar to its actions in the duplex gap, the Commission adopts a different approach in order to reduce the compliance burdens and provide for bright-line rules for the 600 MHz service band. Specifically, for the 600 MHz service band, the Commission will require all wireless microphones to comply with the same adjacent channel separation distance as white space devices.

97. Licensed and unlicensed wireless microphones can continue to operate in the 600 MHz service band during the post-auction transition period, consistent with their secondary or unlicensed status, provided they do not cause harmful interference to incumbent TV services or new wireless services. However, they have a hard date by which they must cease operating in the band. The white space databases will enable unlicensed wireless microphone users to determine whether their operating location is at least four kilometers outside the protected contour of TV stations that continue to operate in that band and also to identify areas where 600 MHz service licensees are operating so they can avoid causing harmful interference to them. The 600 MHz service 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 dynamic set of circumstances that necessitates periodic checking of the databases to identify the appropriate locations where wireless services are protected from harmful interference as required by the *Incentive Auction R&O*. The Commission will require that unlicensed wireless microphone users rely on the white space databases to ensure that their intended operating frequencies in the 600 MHz service band are available at the locations where they will be used. Operation in the 600 MHz service band requires that unlicensed wireless microphone users check the databases more frequently than they would in the guard bands and duplex gap, *i.e.*, always prior to beginning operation at a given location and not just if the microphone user moves from an earlier location.

D. Channel 37

1. Power Limits and Separation Distances

a. General Technical Requirements and Power Limits

98. The Commission will allow fixed devices to operate on channel 37 at power levels up to four watts and with antennas ranging up to 250 meters HAAT. It will also allow both Mode I and Mode II personal/portable devices to operate at power levels up to 100 milliwatts. As with the rules described above that require an adjustment in separation distance when fixed or Mode II devices are controlling a Mode I device, the Commission will require the same here.

99. Although the Commission will allow fixed devices at up to four watts, the results of the incentive auction along with the white space rules will determine the maximum power allowed on channel 37. If the incentive auction recovers exactly 84 megahertz of spectrum, there will be a three megahertz guard band above channel 37, and if more than 84 megahertz is recovered, there will be a three megahertz guard band on each side of channel 37. In either case, only a three megahertz guard band will separate white space devices operating on channel 37 from the mobile handset receive band, so consistent with the rules for the duplex gap and the guard bands, white space device operation on channel 37 would be limited to 40 milliwatts to protect mobile handsets. If the incentive auction recovers less than 84 megahertz, then channels 36 and 38 would remain available for TV, allowing

a fixed white space device to operate at power levels above 100 milliwatts. Finally, if channels 36 and/or 38 remain available for TV, a white space device could operate at up to 100 milliwatts so long as it straddles channels 36 and 37 or channels 37 and 38 and it meets the separation distances being adopted for channel 37 as well as all other protection requirements specified in the rules. The Commission will not permit, at this time, white space devices operating on channel 37 in less congested areas to operate with higher power than four watts since there should already be sufficient spectrum available in those areas to operate at higher power on other channels. As the Commission gains experience with higher power operations, it could revisit this issue and adjust the rules accordingly so long as WMTS and RAS are protected from harmful interference.

b. Determination of WMTS Separation Distances

100. In consideration of the most recent information filed to the record and the Commission's goal to be conservative in the determination of protection distances to protect WMTS, the Commission is basing its analysis on a -100 dBm receiver sensitivity level and a 12.5 kilohertz bandwidth. Using these criteria ensures that the analysis provides sufficient protection for WMTS devices produced by all manufacturers.

101. The Commission believes that the TM-91-1 propagation model is the most appropriate model to use for determining the separation distances necessary to protect WMTS systems from white space devices at the various power/antenna height combinations permitted by the rules. The TM-91-1 model, which has been used previously to model white space interference potential, was developed for modelling propagation loss at relatively short distance to provide capability where the F curves are no longer appropriate. The Commission believes this model, which predicts propagation loss in excess of free space loss, is appropriate in this case as free space loss will underestimate actual signal loss. In addition, signals from white space devices will generally suffer from additional loss due to ground clutter, multipath effects and building penetration losses. To balance the use of this model and its loss predictions against the WMTS proponents' claim that health care facilities often have distributed antenna systems (DAS) installed near windows where there may be little building penetration loss, the Commission set the building penetration loss parameter of the model

to zero. There will still be some building loss even for a DAS installed near clear windows, but the Commission uses zero here to ensure that the results are conservative and will protect WMTS systems from harmful interference. The Commission believes that this is likely to be unrealistic in many cases, but given that this is the first time it is authorizing co-channel operation of unlicensed portable devices on channel 37, it elects this conservative approach. To the extent that this results in unreasonably large separation distances in individual cases, parties can seek a waiver, as discussed below. Finally, with respect to the TM-91-1 model, it was developed based on suburban area data and that usage in urban areas with more densely packed buildings is likely to experience losses beyond those predicted here. While the model in general may under predict losses for rural areas, the Commission's implementation, such as setting the building penetration loss parameter to zero should offset the effects of some longer line-of-sight distances between white space devices and WMTS systems.

102. The Commission also rejects the argument that the TM-91-1 model is inappropriate to use because it is not valid at the antenna heights and distances under consideration here and returns results based on a median signal level. Although the TM-91-1 model was developed to study a particular range of distances and antenna heights, it is based on the Egli model which has an applied range of up to 40 miles from the transmitter, a transmit antenna height of 5000 feet and a receive antenna height of 1000 feet. A comparison of the TM-91-1 model, equation 5, and Egli's model, equation 2 shows that they are identical when compared in the same units. Thus, while TM-91-1 was specifically developed for limited range by the virtue of the fact that it is identical to Egli's model, it has a broader range of application than stated in the report. In addition, the TM-91-1 model may actually overstate the interference potential somewhat because it does not account for terrain features, buildings, and land cover that have an effect on the strength of received signals, nor does it consider multipath effects. In particular, a comparison between predicted free space path loss and actual measured path loss for several test sites at two hospitals submitted by the WMTS coalition shows that in many cases the actual path loss is substantially more than the prediction and compares

favorably with the predictions of the TM-91-1 model.

103. The Commission calculated the minimum co-channel separation distances that would be required for white space devices to protect WMTS devices based on the assumptions stated, basing protection on receiver sensitivity of -100 dBm, a 12.5 kHz bandwidth, and a frequency of 611 MHz (the center of the WMTS channel). The Commission also assumes an antenna aggregation gain of 3 dB to account for the possibility of multiple antennas receiving a WMTS signal. To provide additional protection, the Commission will not assume any additional building penetration loss for WMTS signals, using 0 dB, which is in addition to setting the building penetration loss variable in the model to 0. The Commission assumes an aggregate 2 dB of loss due to antenna mismatch, polarization effects, line loss, etc., which it believes to be reasonable for modelling WMTS protection and less than losses likely to be experienced in actual system deployments. Finally, to protect WMTS, the Commission assumes an I/N value of -6 , providing for a 1 dB rise in the noise floor. The Commission 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.

104. The Commission used the same range of HAAT currently specified in the rules for fixed white space devices and assumed that the WMTS receiver would be at a 10 meter height AGL. The Commission concludes that a large number of WMTS devices using channel 37 are installed at or below the assumed 10 meter height. To assume a greater height in the analysis would be unreasonable because it would produce greater separation distances than are needed to protect WMTS devices in many cases. Moreover, multipath and other reflections off the walls of a taller facility would result in more of the signal being reflected, which were not accounted for in the analysis.

105. The results of the analysis, as shown in the final rules, provide for slightly longer separation distances than those proposed. The Commission believes these values represent a conservative evaluation of providing protection to WMTS, and along with the procedures discussed below, provide opportunity for white space devices to deploy using channel 37. The distances provided in the rules will apply to fixed devices and Mode II personal/portable devices that are communicating with other fixed and/or Mode II devices. However, to account for some location

uncertainty for Mode I devices, the Commission will, consistent with its decision for the duplex gap and guard bands, require that these distances be doubled when the controlling device is a Mode II personal portable device, and increased by 380 meters and 480 meters for fixed white space devices serving 40 milliwatt and 100 milliwatt personal/portable Mode I white space devices, respectively.

106. The Commission is also adopting separation distances to protect WMTS systems from adjacent channel white space device operations on channels 36 or 38. It is basing the adjacent channel protection distances on an analysis similar to that used to determine co-channel separation distance (10 meter WMTS antenna height, 3 dB antenna aggregation, 3 dB antenna mismatch, 0 dB building attenuation). For the out-of-band interference analysis, the Commission used the same -100 dBm/12.5 kHz receiver sensitivity and I/N protection criteria of -6 . For the blocking interference analysis, because the white space device would be operating immediately adjacent to channel 37, the Commission assumed 0 dB loss due to the receive filter and a blocking threshold of -37.8 dBm/MHz. The analysis showed that the protection distances to protect from blocking interference were larger than to protect from out-of-band interference, so the Commission is basing the adjacent channel protection distances on the distances shown in the final rules that were calculated to protect WMTS from blocking interference.

107. The Commission adopts adjacent channel protection distances that apply for any antenna height at a given power level. Because the distances are so short, the Commission assumes that it is likely that the transmitter and receiver are both at approximately the same antenna height. Thus, under the assumed condition of the WMTS receiver being 10 meters AGL, if a white space device was operating at the maximum of 30 meters AGL allowed by the rules, they would be at most 20 meters apart. Under these conditions, that separation distance is larger than necessary to provide protection. However, to reduce compliance burdens and to ensure that WMTS receivers are protected in all cases, such as when the antennas are closer in height above ground level, the Commission adopts the calculated values for all instances at the various power levels.

108. Finally, as with co-channel separation distance, the Commission is providing additional distance to be added to fixed and Mode II white space device separation distances when they

are controlling Mode I devices. When a Mode II or fixed white space device is providing channel lists for Mode I white space devices, they must comply with separation distances to 16 meters and 26 meters when serving 40 milliwatt and 100 milliwatt devices, respectively.

109. Because the white space databases are already designed to provide for polygonal exclusion zones, and a building perimeter is a polygon that can be defined as a series of latitude and longitude coordinates, these distances will apply from the perimeter of each health care facility containing channel 37 WMTS systems (or if several facilities containing channel 37 WMTS systems are clustered closely together, the Commission will allow them to be defined as a single entity). Obtaining the coordinates defining the perimeter of a facility will be a simple, straightforward process.

110. Several commenters suggested that a more nuanced approach that takes into account site-specific propagation conditions may best balance the competing interests of health care facilities and white space proponents. The separation distance and protection procedures set out here is a default approach. There is ongoing dialogue among the stakeholders and should those parties reach a consensus that differs from this approach, the Commission invites those parties to submit an alternative approach for streamlined consideration. The Commission will monitor the use of channel 37 and may adjust the separation distances as experience is gained. If parties believe a distance other than that provided in the rules either over or under protects WMTS systems, they may file waiver requests with the Commission to modify the distance for a particular facility or group of similarly situated facilities. To ensure that WMTS systems are protected from the potential for harmful interference, the Commission will immediately require the database administrators to expand the separation distance for reasonable requests for a particular facility, until it has completed its analysis and can render a final decision on the waiver. The Commission commits to expeditiously resolving any such waiver request.

111. To implement the necessary protection, the Commission has strived to provide a procedure that is simple, straightforward, and easy to implement for all parties. A health care facility will register a representation of the perimeter the building to a white space database administrator. That information will be entered into the database and shared with the other white space database

administrators. White space system operators will then avoid operating within the protection zones of health care facilities through instructions from the database.

112. While the Commission will not generally prohibit operation in rural areas, it recommends that unlicensed devices should only operate in channel 37 in areas where there are fewer than three channels available for unlicensed use between the UHF channels and the 600 MHz guard bands, including the duplex gap. The Commission expects rural areas, where there are already plenty of channels available for white space devices, will continue to have channels available after the incentive auction. Thus, prioritizing the available channels in this manner will balance the interference protection needs of WMTS facilities against the needs of white space system operators to have sufficient spectrum on which to operate.

113. The distances the Commission is setting to protect WMTS systems will generally protect against harmful interference, but adjustments may be necessary based on the unique characteristics of a health care facility and path loss relative to the potential locations of the white space deployment. The Commission underscores for white space device operators that in all cases, they always have the obligation to protect WMTS systems from harmful interference and to eliminate such interference if it should occur. As an added measure of protection, the Commission will work with the interested parties to explore procedures whereby if interference to WMTS occurs, white space devices would be excluded from operating near that health care facility until such time as the interference has been fully resolved.

114. To ensure that the separation distances and procedures the Commission adopts will provide the intended protection to WMTS systems, the Commission intends to limit initial deployment of white space devices using channel 37 to one or two areas. By limiting initial roll-out to just a few areas, the Commission jointly with the FDA can work with white space device operators and health care facilities to validate and, if needed, adjust the approach so that critical WMTS systems do not experience harmful interference. Once the rules become effective and the deadline for health care facility registration has passed, the Commission encourages parties interested in deploying white space devices on channel 37 to contact OET to discuss the intended deployment and a test plan. At the successful conclusion of

testing of these initial deployments, the Commission will issue a public notice to inform interested parties that they may deploy white space devices nationwide on channel 37.

c. Determination of RAS Separation Distances

115. The Commission is adopting criteria to protect the ten very long baseline array (VLBA) radio astronomy observatories. The Commission agrees with commenters that a site specific terrain based protection criteria is better than a single fixed distance for each site because these sites are often in rural areas and constructed to take advantage of terrain features to provide a very low noise environment for radio observations. To conduct the analysis, the Commission used the Longley-Rice version 1.2.2 propagation model and the protection criteria of ITU-R RA-769-2 (-212 dB (W/m² Hz)) which assuming an isotropic receive antenna equates to -131 dB (W/m² 6 MHz) or a receiver interference threshold of 1.54 dBuV/m along with F(50,2) propagation. For each VLBA receive site, the Commission used the coordinates specified in § 15.713(h) and a radio astronomy receive antenna height of 27 meters AGL. To perform the analysis, the Commission assumed white space transmitters with 40 milliwatts EIRP, 3 meters antenna height AGL, 611 MHz transmitter frequency, and an omni-directional transmit antenna pattern every 2 kilometers along 72 radials spaced every 5 degrees extending from the Radio Astronomy (RA) receiver site out to 300 kilometers. Using F(50,2) propagation along the path from each white space transmitter to the radio astronomy site, the Commission could determine, based on the terrain profile of each path, which transmit sites produced a field strength above the protection criteria at the radio astronomy receiver. Those transmit sites are used to determine the site specific protection zone for each VLBA site. The use of the F(50,2) propagation statistics for this analysis provides a conservative determination of protection zones to ensure that VLBA sites do not receive interference from white space devices.

116. For each site, the Commission provides a best fit polygon connecting the farthest points from each site beyond which the protection criteria is always satisfied. The Commission is using this best fit polygon rather than connecting a point along each radial to reduce the burdens in implementation. The Commission does not believe that there would be much difference in available spectrum for white space devices if it were to create the polygons

based on connecting a point on each radial (for a total of 72 points per polygon). To avoid overprotecting VLBA sites by prohibiting white space devices within a large circle centered on each site, the Commission is instead requiring that white space devices be prohibited from transmitting within a polygon that encompasses only those areas that are predicted to have the potential to cause harmful interference. The polygon approach is not burdensome to implement, and white space databases already possess the capability to provide polygonal exclusion zones. The final rules provide the coordinates defining each polygon.

117. The Commission disagrees that it needs to consider white space device signal aggregation when fashioning the separation distances. The VLBA is comprised of 25-meter dish antennas which have very high gain and very narrow beamwidth, and these antennas generally are aimed skyward. However, in the instance that an antenna is pointed towards the horizon, its antenna beam is still so narrow that it is unlikely that it will see more than a single white space device.

118. The Commission will not prohibit the use of channel 37 in rural areas and areas where more than 10% of the TV channels are available for white space devices as requested by CORF. As stated above, the Commission is advising that white space systems only use channel 37 in areas where there are fewer UHF channels available for unlicensed devices than would meet that users spectrum requirements. Because most RAS sites are located in rural areas, the Commission expects that in most cases white space device system operators will have access to sufficient spectrum so as to not need to use channel 37. The Commission will continue to require white space devices operating on channels 36 and 38 to comply with a separation distance of at least 2.4 kilometers from VLBA sites.

119. The Commission will prohibit white space devices from operating within the quiet zone around the National Radio Astronomy Observatory at Green Bank West Virginia and on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra. The Commission believes that it would be unreasonable for operators of white space devices to coordinate with these observatories, and the separation distances required to protect these observatories would be extremely large.

2. Guard Bands Adjacent to Channel 37

120. The Commission declines to provide the ability for white space devices to use the three megahertz guard

bands that may be created adjacent to channel 37. The Commission has decided in this proceeding that a three megahertz guard band is necessary to protect new 600 MHz mobile handsets from harmful interference from white space devices. If spectrum is recovered in sufficient quantity to require the creation of these guard bands adjacent to channel 37, they will function to provide this protection and will be unavailable for use by white space devices.

3. Out-of-Band Emission Limits on Channels 36-38

121. The Commission is removing the strict emission mask into channel 37 which also hampers the ability of white space devices to operate on channels 35, 36, 38, and 39. The rules will require all white space devices to meet the same emission mask for all channels in the TV and 600 megahertz bands, including channel 37. The Commission has determined the required separation distances for various power levels and rejects the WMTS Coalition's position that the adjacent channels should have the same separation requirement as for co-channel operations on channel 37. This rule change, which eliminates the need for additional filters to be incorporated into devices, will reduce development and manufacturing costs and lead to lower prices to consumers.

E. White Space Databases

1. Expanding Location and Frequency Information

a. 600 MHz Service Band Operations

122. The Commission is adopting the proposed requirements for entering and storing information on the locations where 600 MHz Band licensees have commenced operation in the white spaces database. Specifically, it is requiring that database administrators allow 600 MHz Band licensees to enter the coordinates of a minimum of eight points and a maximum of 120 points representing the corners of a polygon of the minimum size necessary to encompass all base stations or other radio facilities used to determine the area where a licensee is commencing operations, consistent with the Commission's decision in a separate future proceeding, as well as the frequencies that a licensee will use in that area. The white spaces databases will use this information along with the separation distances described to ensure that white space devices operate at a sufficient distance outside the border of the defined polygon to prevent harmful interference to wireless services. This approach will provide wireless

licensees with sufficient flexibility to describe different areas of operation. For example, a licensee can enter the coordinates of multiple polygons in cases where it plans to commence service in multiple non-contiguous areas. A licensee can also specify shapes more complex than an eight-sided polygon to designate an area that includes irregular boundaries within a PEA or a PEA boundary so that the protected area in the database stops at the edge of a carrier's licensed area.

123. The Commission will also require that a 600 MHz service licensee enter contact information (company name, contact person's name, address, phone number) and the date it plans to commence operations when it registers a polygonal area and operating frequencies with the white space database. Requiring the database to include this data 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 600 MHz service 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.

124. The Commission will not require database administrators to provide a user interface to generate multi-sided polygons for 600 MHz license areas, and instead will require only that database administrators make provisions to allow 600 MHz service licensees to upload the required registration information, including the polygon information which a licensee can generate using readily available software tools. However, database administrators are free to develop a user interface if they choose. The Commission will also require that white space database administrators provide a means to update or to remove and replace a previous registration when it needs to be updated or corrected. The Commission will further require that database administrators share on a daily basis the data registered by 600 MHz licensees, as they do for other services.

125. The Commission disagrees that the requirement for 600 MHz service licensees to notify the white space database of the areas where they are commencing operation is overly burdensome or complicated. This requirement does not diminish a

licensee's rights to provide service anywhere in its licensed areas. It is intended to ensure that licensees receive the interference protection to which they are entitled under the terms of their license. The method the Commission is adopting requires the submission of only a minimal amount of information to the database (geographic coordinates, frequencies of operation, date of commencement of operation, and contact information), and this information is well known to licensees. 600 MHz service licensees will need to update this information as they commence operations in additional areas, but this is something that they will need to do only when they increase their coverage area. No additional information will need to be submitted to the white space database if a licensee adds additional facilities within an area that is already registered with the database, since that entire area would already be protected. The Commission will work with the database administrators as necessary to ensure that this registration process works in an efficient manner for all parties involved.

126. The Commission finds that the safeguards associated with carriers' provision of this information address their concerns about competitively sensitive information. 600 MHz service licensees may provide certain prescribed information—including geographic coordinates specifying their service area, frequencies of operation, date of commencement of operation, and contact information—to the white space database administrator in order to protect their operations from interference from white space devices. The licensees exercise significant discretion as to when they make these disclosures, and may choose to do so directly before they commence operations. The Commission also will direct the database administrators not to make information of the carriers' operational areas publicly available. In addition, database administrators are prohibited from "us[ing] their capacity as a database manager to engage in any discriminatory or anti-competitive practices or any practices that may compromise the privacy of users." The Commission finds that the foregoing factors mitigate concern over the potential for anticompetitive use of 600 MHz service licensees' deployment information.

b. WMTS Location Information

127. The Commission will protect registered WMTS operations on channel 37 from harmful interference from white space devices operating on the same or adjacent channels by requiring the

unlicensed devices to comply with the default separation distances that it is adopting. The separation distances specified in the rules are from the perimeter of each health care facility or from the combined perimeter of several closely-spaced health care facilities. The Commission will permit only the health care facility that has registered with a white space database to update its record if any changes to the coordinates that define its perimeter are warranted. To implement the protection criteria, the Commission will require that health care facilities that operate WMTS networks on channel 37 provide to a white space database the following information:

- Name and address of the health care facility
- Name, address, phone number and email address of a contact person
- Location of each facility where a WMTS network is installed (*i.e.*, multiple latitude and longitude coordinates in NAD 83 that define the perimeter of the facility)

128. The Commission concludes that it cannot rely on the information in the WMTS database to implement the methodology it adopts for separation distances because the WMTS database does not in all cases have the geographic location for each facility where a WMTS network is installed, nor does it have the coordinates that define the perimeter of each facility. The Commission staff will work with the WMTS database coordinator and other parties as necessary to develop a plan for working with healthcare facilities to register their information with the white space databases.

129. Under the current rules, a database administrator does not function as a frequency coordinator and thus is not responsible for resolving interference claims. If there is a claim of harmful interference, a database administrator, upon request from the Commission, must provide the white space device's identifying information. If a device is found to be causing harmful interference, the Commission may then require that the party responsible for the unlicensed device take corrective actions or cease operating the device until the interference is resolved. If a representative of the Commission is unable to contact the person responsible for a device that is causing harmful interference, the Commission may require the white space database to return a message of "no channels available" to the device at its next scheduled re-check to shut it down until the interference can be resolved. The

Commission staff will work with the WMTS database coordinator and other parties as necessary to explore how these procedures may be modified so that a health care facility could notify the database administrators to immediately expand the protection zone around its facility, effectively suspending the operation of unlicensed devices closer to its facility that could be causing harmful interference until the interference has been resolved.

c. RAS Location Information

130. The Commission will require the databases administrators to modify their databases to implement the polygonal exclusion areas on channel 37 specified above, which it believes should be relatively easy to implement. The database administrators will also be able to easily accommodate the requirement to protect the two single dish RAS observatories by excluding white space devices from operating within the National Radio Quiet Zone at Green Bank, WV and on the islands of Puerto Rico, Desecheo, Mona, Vieques and Culebra around the Arecibo observatory. The Commission deletes from rule § 15.712(h)(3) the Allen Telescope Array and the Very Large Array since they do not receive signals in the TV bands or the 600 MHz band.

d. Canadian and Mexican Stations

131. The Commission makes no change to the process by which it receives information on Canadian TV stations in the border areas that need to be protected and passes the information on to the white space database administrators. Canada recently finalized white space device rules but has not yet authorized their use as no databases have yet been approved. Because the Commission has rules that provide for registration and protection of certain operations that are not in a Commission database (e.g., cable headends, BAS receive sites), an efficient method for transferring this data to Canadian database administrators as well as passing such information from Canada to U.S. database administrators is needed to ensure that such operations receive interference protection. The Commission will continue discussions with its counterparts in Canada to develop the most efficient procedures to share registered entity information among various databases and provide information and procedures to the database administrators as agreements are reached. At such time that Mexico develops white space device rules, the Commission will engage with its

counterparts there to work out similar arrangements.

e. Private Land Mobile Radio Service

132. The Commission is adopting its proposal to modify the information required to be included in the white space database to protect PLMRS/CMRS base stations in the TV bands that are located more than 80 kilometers from the geographic centers of the 13 metropolitan areas defined in § 90.303(a) of the rules. Specifically, it is modifying § 15.713(h)(4) of the rules to require the white space databases to include the TV channel number on which a PLMRS/CMRS base station operates, and to remove the requirement for the white space databases to include the effective radiated power and antenna height information for each base station. The Commission finds that the changes are needed to effectively protect the PLMRS/CMRS and to avoid the collection of unnecessary information in the white space databases.

2. Changes to Database Procedures

a. White Space Device Registration and Fees

133. The Commission is adopting its proposed requirement that fixed white space devices must register with the database if they operate in the 600 MHz service band, the guard bands duplex gap, or channel 37. It is also modifying the rule that permits the white space database administrators to charge a fee for providing lists of available channels to white space devices and registering fixed white space devices to clearly state that this rule applies to white space devices that would operate in the TV bands, the 600 MHz service band, and the 600 MHz guard bands, including the duplex gap, and channel 37. The Commission is taking these actions for consistency with the current part 15 rules which require that fixed white space devices operating in the TV bands must register with the white space databases.

134. The Commission is also modifying the rules to require that a fixed white space device registration be removed from the white space databases if the device has not checked the database for at least three months to update its channel list. This rule will help ensure the integrity of the white space databases by requiring the removal of entries for fixed devices that are registered but are no longer in operation. The Commission is also clarifying that a database administrator may charge a new registration fee for a fixed white space device that is

removed from the database under this provision but is later re-registered.

b. Unlicensed Wireless Microphone Registration and Fees

135. The Commission will eliminate the part 15 rule that permits unlicensed wireless microphone users to register their operating locations, channels and times in the white space databases to reserve channels for their use and to protect these operations from possible interference from white space devices. This change will be effective 18 months after the effective date of the rules but in any event no later than the release of the *Channel Reassignment PN* after the conclusion of the incentive auction. Unlicensed wireless microphones will not be permitted to register channels for protection in the TV bands, the 600 MHz guard bands or duplex gap, and the 600 MHz service band.

136. In order for the database administrators to provide unlicensed wireless microphone users with information about available frequencies and required separation distances at the location where they intend to operate, the Commission will require that microphone users register with a database administrator and provide their identifying information and locations. Database administrators will be permitted to charge a fee for providing unlicensed microphone users with information about available frequencies and required separation distances at the locations where they intend to operate.

137. The Commission makes these changes because in 2014 it 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. The Commission also makes these changes because it is adopting new rules for unlicensed wireless microphones that are consistent with rules applicable to white space devices in the 600 MHz guard band, duplex gap and MHz service band. Specifically, wireless microphones will operate with similar technical requirements to white space devices (i.e., maximum power), operate on a non-interference basis to authorized services, and will be required to access a database to determine the available channels at their location. The Commission finds that it would be inequitable to continue to provide interference protection to one unlicensed user over another and it would be unfair to licensed microphone users because it would effectively eliminate any distinction between licensed and unlicensed microphone

users in gaining access to spectrum and interference protection.

138. The purpose of the white space database is two-fold: To protect authorized services and facilities that are entitled to interference protection under the Commission's rules, and to identify for unlicensed devices channels available for their use without causing harmful interference to authorized users. The database administrators incur costs to not only maintain data but also to calculate and provide lists of available channels for unlicensed users. Because both unlicensed white space devices and unlicensed wireless microphone users will benefit equally from the information provided by the databases, the Commission believes that they should be equally responsible for supporting the ongoing operation of the databases. The database administrators may charge fees to register fixed unlicensed white space devices and to provide lists of available channels to white space devices. To enable unlicensed wireless microphone users to register with a database, the Commission will require that they provide a database administrator with the same information that they have provided to reserve a channel under current rule § 15.713(h)(9), namely: (a) Name of the individual or business that owns the unlicensed wireless microphone; (b) an address for the contact person; (c) an email address for the contact person; (d) a phone number for the contact person; and (e) coordinates where the device will be used (latitude and longitude in NAD 83).

c. Frequency of White Space Device Check Times and Databases Sharing Registration Information

139. The Commission finds that requiring all white space devices to re-check a database for a list of available channels every twenty minutes as proposed in the *NPRM* would unnecessarily burden the database administrators and white space device users and is not necessary. The Commission already has in place a procedure whereby licensed wireless microphone users can register with a database and reserve channels for their use well in advance of their intended date of operation. The issue that needs to be addressed is making channels available for licensed wireless microphone use for events that cannot be anticipated, such as late-breaking news events, within minutes or hours of when they occur. When two vacant channels above and below channel 37 are no longer available for exclusive use by wireless microphones, licensed

wireless microphone users will have to contact a database and request channels for immediate use. The Commission concludes that for these occasions, it will require that database administrators "push" information to white space devices in the area where the licensed wireless microphones will be used, notifying them of changes in channel availability, rather than require all white space devices to re-check a database every twenty minutes. This approach balances the needs of both white space device and wireless microphone proponents. It satisfies the objective of the proposal to make spectrum available for licensed wireless microphone use for late-breaking events, but it does not burden all white space users with unnecessary frequent database re-checking in meeting this objective.

140. When a database administrator receives a request for immediate access to channels for licensed wireless microphone use, the Commission will require that the database administrators share licensed wireless microphone's channel registration information among themselves within ten minutes. The Commission will also require that the database administrators "push" information about changes in channel availability for fixed and Mode II personal/portable white space devices within 20 minutes of receiving it, identifying for the white space device other vacant channels that it could use instead. The database administrators need to push this information only to white space devices that are located within the separation distances, specified in rule § 15.712(f)(1), from the location specified by the wireless microphone registrant. To provide the database administrators with sufficient time to modify their systems, the Commission will require their compliance with these requirements 12 months after the effective date of these new rules.

141. The Commission concludes that requiring all white space devices in the country to re-check channel availability in their area every twenty minutes would unnecessarily burden the white space databases, drive up costs for database management and white space devices users, and is overly-broad in satisfying the objective of the original proposal to ensure that white space devices clear a channel needed for licensed wireless microphone users for late-breaking events in a specific area. The Commission also rejects the suggestion to designate a few "fast polling" channels because it could not determine until after the post-auction transition period which vacant channels will be available for wireless

microphones and white space devices in any given area. Also, because only a few channels would be designated for "fast polling," this approach is less flexible in meeting the needs of wireless microphone users for immediate access to spectrum.

142. By adopting a requirement for "push" notifications to white space devices of wireless microphone registrations to enable more immediate protection when reserving channels, such as for late-breaking events, the Commission concludes that it does not need to eliminate § 15.711(b)(3)(iii) which allows a white space device to continue operating until 11:59 p.m. on the following day if it cannot establish contact with the database. The Commission will continue to require that white space devices re-check the database at least once per day to obtain the list of available TV channels at the location where the device operates. This way the channel lists they receive each day will include those channels that wireless microphone users reserve in advance, and they will be able to continue to operate on any of those available channels unless they receive a "push" notification. The Commission emphasizes that the "push" procedure should only be used by wireless microphone users when circumstances prevent them from reserving vacant channels in advance of their expected use, because unnecessary and frequent use of the "push" procedure would be disruptive to broadband services being provided by white space devices.

F. Equipment Certification and Marketing

1. White Space Devices

143. The changes that the Commission is adopting to require fixed and Mode II personal/portable devices to accept updated channel lists "pushed" by the database require changes to devices that were previously approved, since the method that a device uses to communicate with the database is a function of a device. Based on the Commission's experience with certifying fixed white space devices and testing white space databases prior to permitting them to offer service, it believes that this change can be implemented through software updates and no hardware changes, so only a short transition time period is necessary. Also, the Commission wants these procedures in place well before white space devices gain access to the two vacant TV channels now reserved for wireless microphone use, to reassure licensed microphone users requiring access to spectrum for late-breaking

events. Accordingly, it is requiring that devices for which a certification application is filed beginning six months after the effective date of the rules comply with the new channel push requirements. The Commission will also require that within nine months after the effective date of the rules, all white space devices imported and marketed within the United States must comply with these requirements, regardless of when they were certified. It will further require that white space devices that do not comply with the new channel push requirements must cease operating within one year of the effective date of the rules.

2. Wireless Microphones

144. The Commission adopts transition rules for the TV bands, the guard bands (including the duplex gap), and the 600 MHz service band that will allow it to gradually phase out older microphones and introduce new ones that are compliant with the technical rules for unlicensed and licensed wireless microphones that it adopts in this proceeding, and for licensed wireless microphone that it adopts in the Wireless Microphone R&O. The Commission is aligning the transition periods as closely as possible with the post-auction transition schedule because this will ensure compliance with the post-auction 600 MHz Band Plan and be less disruptive to wireless microphone manufacturers and users.

145. Regarding unlicensed wireless microphones, the Commission will permit users of such equipment to operate part 74 wireless microphones in the TV bands under the waivers already in place and in the 600 MHz service band until they must cease those operations no later than 39 months after release of the *Channel Reassignment PN*. Although these microphones are certified as compliant with part 74 rules, the waiver requires that they be operated consistent with the part 15 rules which the Commission is adopting in this proceeding. Thus, their continued use in the TV bands and in the 600 MHz band during the post-auction transition period is unlikely to cause harmful interference to licensed services.

146. The Commission will accept applications to certify wireless microphones under new Part 15 rules as soon as those rules are effective, and will require applications to certify wireless microphones under new part 15 rules nine months after the release of the *Channel Reassignment PN* or no later than 24 months after the effective date of the new rules, whichever occurs first. The Commission will require that

manufacturing and marketing of all wireless microphones that would not comply with the rules for operation in the 600 MHz band cease 18 months after release of the *Channel Reassignment PN* or no later than 33 months after the effective date of the new rules, whichever occurs first. If a wireless microphone is certified to operate in any portion of the 600 MHz service band, it may no longer be marketed or operated after the specified cutoff dates by an unlicensed wireless microphone user, even if it could be tuned to operate outside the 600 MHz service band.

147. The Commission recognizes that it is important to provide manufacturers with sufficient time to design new products, obtain equipment certification, and commence manufacturing, and that it is equally important to allow manufacturers to sell existing devices that allow the public to continue providing service until new products are available in the marketplace. The cutoff dates that the Commission adopts for certification, manufacturing and marketing of wireless microphones appropriately balance these two goals. Manufacturers will not know what band plan they need to design and manufacture to until after the incentive auction is concluded, and it would be unreasonable to require that only certification applications complying with the new rules be accepted at the time the *Channel Reassignment PN* is released. Broadcast stations will be vacating the 600 MHz band over a 39 month period after the release of the *Channel Reassignment PN*, and new wireless operations will be built out gradually as broadcast stations leave the band and most likely continuing beyond the 39 month transition period. It would be unreasonable to cut off manufacturing and marketing six months into the 39 month transition period since this would deny the public access to devices that would allow them to continue to provide service. The Commission concludes that the cutoff dates it has chosen will encourage manufacturers to concentrate on developing wireless microphones that operate in compliance with new rules and ensure that manufacturers cease making and marketing equipment that cannot be legally used after a certain date.

148. The Commission is adopting different transition rules for wireless microphones in the 600 MHz service band than for white space devices because in the *Incentive Auction R&O* the Commission decided that wireless microphones would have a hard date for ceasing operations in that band, but that white space devices could continue

operating at locations where wireless licenses have not commenced operations. The Commission understands that consumers may not understand the need to forego the use of equipment in the 600 MHz band that could otherwise be used for many years, but it had to balance this harm to individual users against the need to protect new wireless services from harmful interference.

Procedural Matters

149. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),¹ an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Notice of Proposed Rule Making (NPRM)*.² The Commission sought written public comment on the proposals in the *NPRM*, including comment on the IRFA. This present Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.³

A. Need for, and Objectives of, the Report and Order

150. The Report and Order maximizes unlicensed white space devices' access to spectrum in the television broadcasting band and the 600 MHz band in a number of ways. It modifies the Part 15 rules to permit fixed and personal/portable devices to use TV channels previously unavailable to them while continuing to protect TV services from harmful interference by adjusting power limits, specifying separation distances, and specifying antenna heights. The Report and Order also adopts technical rules for white space device operations in the 600 MHz band—including the duplex gap, guard bands, repurposed 600 MHz band and channel 37—by establishing power limits and specifying frequency and distance separations as needed to protect authorized services in those bands from harmful interference. White space devices will continue to access the white space databases for channel assignments in the TV bands, as well as in the 600 MHz band and channel 37. The Report and Order also adopts rules for unlicensed wireless microphones

¹ See 5 U.S.C. 603. The RFA, see 5 U.S.C. 601 through 612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Public Law 104–121, Title II, 110 Stat. 857 (1996).

² See 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; ET Docket No. 14–165; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12–268.

³ See 5 U.S.C. 604.

operating in the TV bands, guard bands and duplex, and for licensed wireless microphones operating in the duplex gap.

B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

151. There were no comments filed that specifically addressed the rules and policies proposed in the IRFA.

C. Response to Comments by the Chief Counsel for Advocacy of the Small Business Administration

152. Pursuant to the Small Business Jobs Act of 2010, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration (SBA), and to provide a detailed statement of any change made to the proposed rules as a result of those comments. The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

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

153. 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.⁴ The RFA generally defines the term “small entity” as having the same meaning as the terms “small business,” “small organization,” and “small governmental jurisdiction.”⁵ In addition, the term “small business” has the same meaning as the term “small business concern” under the Small Business Act.⁶ 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).⁷

154. 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.”⁸ 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.⁹ Thus, under that size standard, the majority of firms can be considered small.

155. *Television Broadcasting.* This Economic Census category “comprises establishments primarily engaged in broadcasting images together with sound. These establishments operate television broadcasting studios and facilities for the programming and transmission of programs to the public.”¹⁰ The SBA has created the following small business size standard for Television Broadcasting firms: Those having \$38.5 million or less in annual receipts.¹¹ The Commission has estimated the number of licensed commercial television stations to be 1,388.¹² In addition, according to Commission staff review of the BIA Advisory Services, LLC’s *Media Access Pro Television Database* on March 28, 2012, about 950 of an estimated 1,300 commercial television stations (or approximately 73 percent) had revenues of \$14 million or less.¹³ We therefore estimate that the majority of commercial

television broadcasters are small entities.

156. We note, however, that in assessing whether a business concern qualifies as small under the above definition, business (control) affiliations must be included.¹⁴ Our estimate, therefore, likely overstates the number of small entities that might be affected by our action because the revenue figure on which it is based does not include or aggregate revenues from affiliated companies. In addition, an element of the definition of “small business” is that the entity not be dominant in its field of operation. We are unable at this time to define or quantify the criteria that would establish whether a specific television station is dominant in its field of operation. Accordingly, the estimate of small businesses to which rules may apply does not exclude any television station from the definition of a small business on this basis and is therefore possibly over-inclusive to that extent.

157. In addition, the Commission has estimated the number of licensed noncommercial educational (NCE) television stations to be 396.¹⁵ These stations are non-profit, and therefore considered to be small entities.¹⁶

158. There are also 2,414 low power television stations, including Class A stations and 4,046 television translator stations.¹⁷ Given the nature of these services, we will presume that all of these entities qualify as small entities under the above SBA small business size standard.

159. *Manufacturers of unlicensed devices.* In the context of this FRFA, manufacturers of Part 15 unlicensed devices that are operated in the UHF-TV band (channels 14–51) for wireless data transfer fall into the category of Radio and Television 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 communication equipment. Examples of products made by these establishments are: Transmitting and receiving antennas, cable television

⁸ The NAICS Code for this service 334220. See 13 CFR 121.201. See also http://factfinder.census.gov/servlet/IBQTable?_bm=y&-fds_name=EC0700A1&-geo_id=&-skip=300&-ds_name=EC0731SG2&-lang=en.

⁹ See http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-fds_name=EC0700A1&-skip=4500&-ds_name=EC0731SG3&-lang=en.

¹⁰ U.S. Census Bureau, *2012 NAICS Definitions: 515120 Television Broadcasting*, (partial definition), <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=515120&search=2012> (last visited May 6, 2014).

¹¹ 13 CFR 121.201 (NAICS code 515120) (updated for inflation in 2010).

¹² See *FCC News Release, Broadcast Station Totals as of December 31, 2013* (rel. January 8, 2014), http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0108/DOC-325039A1.pdf.

¹³ We recognize that BIA’s estimate differs slightly from the FCC total given.

¹⁴ “[Business concerns] are affiliates of each other when one concern controls or has the power to control the other or a third party or parties controls or has to power to control both.” 13 CFR 21.103(a)(1).

¹⁵ See *FCC News Release, Broadcast Station Totals as of December 31, 2013* (rel. January 8, 2014), http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0108/DOC-325039A1.pdf.

¹⁶ See generally 5 U.S.C. 601(4), (6).

¹⁷ See *FCC News Release, Broadcast Station Totals as of December 31, 2013* (rel. January 8, 2014), http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0108/DOC-325039A1.pdf.

⁴ See 5 U.S.C. 603(b)(3).

⁵ See 5 U.S.C. 601(6).

⁶ 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**.”

⁷ See 15 U.S.C. 632.

equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment.”¹⁸ The SBA has developed the small business size standard for this category as firms having 750 or fewer employees.¹⁹ According to Census Bureau data for 2007, there were a total of 939 establishments in this category that operated for the entire year.²⁰ Of this total, 912 had less than 500 employees and 17 had more than 1000 employees. Thus, under that size standard, the majority of firms can be considered small.

160. *Radio Broadcasting.* The SBA defines a radio broadcast station as a small business if such station has no more than \$38.5 million in annual receipts.²¹ Business concerns included in this industry are those “primarily engaged in broadcasting aural programs by radio to the public.”²² According to review of the BIA Publications, Inc. Master Access Radio Analyzer Database as of November 26, 2013, about 11,331 (or about 99.9 percent) of 11,341 commercial radio stations have revenues of \$35.5 million or less and thus qualify as small entities under the SBA definition. The Commission notes, however, that, in assessing whether a business concern qualifies as small under the above definition, business (control) affiliations²³ must be included. This estimate, therefore, likely overstates the number of small entities that might be affected, because the revenue figure on which it is based does not include or aggregate revenues from affiliated companies.

161. In addition, an element of the definition of “small business” is that the entity not be dominant in its field of operation. The Commission is unable at this time to define or quantify the criteria that would establish whether a specific radio station is dominant in its field of operation. Accordingly, the

estimate of small businesses to which rules may apply does not exclude any radio station from the definition of a small business on this basis and therefore may be over-inclusive to that extent. Also, as noted, an additional element of the definition of “small business” is that the entity must be independently owned and operated. The Commission notes that it is difficult at times to assess these criteria in the context of media entities and the estimates of small businesses to which they apply may be over-inclusive to this extent.

162. *Radio, Television, and Other Electronics Stores.* The Census Bureau defines this economic census category as follows: “This U.S. industry comprises: (1) Establishments known as consumer electronics stores primarily engaged in retailing a general line of new consumer-type electronic products such as televisions, computers, and cameras; (2) establishments specializing in retailing a single line of consumer-type electronic products; (3) establishments primarily engaged in retailing these new electronic products in combination with repair and support services; (4) establishments primarily engaged in retailing new prepackaged computer software; and/or (5) establishments primarily engaged in retailing prerecorded audio and video media, such as CDs, DVDs, and tapes.”²⁴ The SBA has developed a small business size standard for Electronic Stores, which is: All such firms having \$32.5 million or less in annual receipts.²⁵ According to Census Bureau data for 2007, there were 11,358 firms in this category that operated for the entire year.²⁶ Of this total, 11,323 firms had annual receipts of under \$25 million, and 35 firms had receipts of \$25 million or more but less than \$50 million.²⁷ Thus, the majority of firms in this category can be considered small.

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

163. 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 portable. Fixed devices may operate at power levels up to four watts, and portable devices operate at up to 100 milliwatts if they are outside the service contours of adjacent channel TV stations or 40 milliwatts within the service contour of an adjacent channel TV station. 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.

164. 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. 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 granted in the 2010 *TV Bands Wireless Microphones R&O and Further NPRM*.

165. 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.

166. 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). The Report and Order does not change the

¹⁸ U.S. Census Bureau, 2012 NAICS Definitions: 334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing, <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=334220&search=2012> (last visited Mar. 6, 2014).

¹⁹ 13 CFR 121.201 (NAICS code 334220).

²⁰ U.S. Census Bureau, Table No. EC0731SG3, *Manufacturing: Summary Series: General Summary: Industry Statistics for Subsectors and Industries by Employment Size: 2007* (NAICS code 334220), http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ECN_2007_US_31SG3.

²¹ 13 CFR 121.201, 2012 NAICS code 515112.

²² U.S. Census Bureau, 2012 NAICS Definitions: 515112 Radio Broadcasting, <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=515112&search=2012> (last visited Mar. 6, 2014).

²³ See n.14.

²⁴ U.S. Census Bureau, 2012 NAICS Definitions, 443142 Electronics, <http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=443142&search=2012> NAICS Search (last visited May 6, 2014).

²⁵ 13 CFR 121.201, NAICS code 443142.

²⁶ U.S. Census Bureau, 2007 Economic Census, *Subject Series: Retail Trade, Estab & Firm Size: Summary Statistics by Sales Size of Firms for the United States: 2007*, NAICS code 443142 (released 2010), <http://www2.census.gov/econ2007/EC/sector44/EC0744SSSZ4.zip> (last visited May 7, 2014). Though the current small business size standard for electronic store receipts is \$30 million or less in annual receipts, in 2007 the small business size standard was \$9 million or less in annual receipts. In 2007, there were 11,214 firms in this category that operated for the entire year. Of this total, 10,963 firms had annual receipts of under \$5 million, and 251 firms had receipts of \$5 million or more but less than \$10 million. *Id.*

²⁷ *Id.* An additional 33 firms had annual receipts of \$50 million or more.

authorization procedure for white space devices and wireless microphones. However, it establishes new and modified technical requirements for white space devices and wireless microphones, as well as certification, marketing and operational cutoff dates for certain equipment.

167. With regard to white space devices, the Report and Order permits their operation at lower power levels and closer separation distances to TV stations in all areas, and at higher power with a greater separation distance from TV stations in less congested areas. It also permits the operation of white space devices on additional channels and frequencies where operation is not currently permitted, including TV channels 3 and 4 (fixed devices), channels 14–20 (portable devices), channel 37 (fixed and portable devices), and the 600 MHz guard bands and duplex gap (fixed and portable devices). In addition, the Report and Order allows for the operation of devices with less precise geo-location capabilities. These changes are permissive, meaning that manufacturers of white space devices may implement them in their equipment, but are not required to do so.

168. The Report and Order requires that white space devices and databases incorporate a “push” feature that allows updated channel information to be sent to a white space device in the event that a previously available channel becomes reserved for use by a wireless microphone. White space devices for which a certification application is filed beginning six months after the effective date of the rules must comply with the new channel push requirement. The Report and Order also requires that within nine months after the effective date of the rules, all white space devices imported and marketed within the United States must comply with these requirements, regardless of when they were certified. It further requires that white space devices that do not comply with the new channel push requirements must cease operating within one year of the effective date of the rules.

169. With regard to unlicensed wireless microphones, the Report and Order establishes cutoff dates for the certification, manufacturing and marketing of unlicensed wireless microphones in the TV bands, the guard bands (including the duplex gap), and the 600 MHz service band. It permits unlicensed wireless microphone users to continue to operate part 74 certified wireless microphones in the TV bands under waivers already in place and in the 600 MHz service band until they

must cease those operations no later than 39 months after release of the *Channel Reassignment PN*. The Commission will accept applications to certify wireless microphones under new part 15 rules as soon as those rules are effective, and will require applicants to certify wireless microphones under new part 15 rules nine months after the release of the *Channel Reassignment PN*, or no later than 24 months after the effective date of the new rules, whichever occurs first. The Report and Order also requires that manufacturing and marketing of all wireless microphones that would not comply with the 600 MHz band cease 18 months after release of the *Channel Reassignment PN* or no later than 33 months after the effective date of the new rules, whichever occurs first.

F. Steps Taken To Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

170. 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.”²⁸

171. The rule changes adopted in the Report and Order give greater flexibility for fixed and personal/portable white space device operation in the TV bands. As noted above, the majority of these changes are permissive, meaning that manufacturers of white space devices are not required to incorporate them into previously approved equipment, with the exception of the channel “push” requirement. The Commission adopted this requirement as an alternative to its proposal in the *NPRM* to require that white space devices check the database every 20 minutes to determine which channels are available for use. The Commission determined that the push requirement would be less burdensome on equipment manufacturers, users, and white space database administrators than a 20 minute re-check interval. This change can be implemented in existing devices

through a software update without hardware changes, so only a short transition time period is provided.

172. With regard to wireless microphones, unlicensed users may continue to use Part 74 certified wireless microphones under an existing waiver during the 39 month transition period rather than using part 15 certified equipment. The Commission took this action since manufacturers need time to certify wireless microphones under the new part 15 rules, and to permit users to continue using their existing equipment until the operational cutoff date previously established by the Commission.

173. *Incorporation by Reference*. The Office of Federal (OFR) recently revised the regulations to require that agencies must discuss in the preamble of the rule ways that the materials the agency incorporates by reference are reasonably available to interested persons and how interested parties can obtain the materials. In addition, the preamble of the rule must summarize the material. 1 CFR 51.5(b). In accordance with OFR’s requirements, the discussion in this section summarizes European Telecommunications Standards Institute (ETSI). Copies of ETSI are available free of charge at www.etsi.org, or by requesting the document by mail at the following address: European Telecommunications Standards Institute, 650 Route des Lucioles, F-06921 Sophia Antipolis Cedex, France, or at http://www.etsi.org/deliver/etsi_en/3004000_300499/30042201/01.04.02_60/en_30042201v01010402p.pdf.

ETSI EN 300 422–1 V1.4.2 (2011–08); 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, August 2011, IBR approved for § 15.236(g).

This standard requires wireless microphones to meet certain emission requirements which will protect authorized services in adjacent bands from harmful interference, and will improve spectrum sharing by wireless microphones.

174. *Paperwork Reduction Act Analysis*. This document contains modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104–13. It will be submitted to the Office of Management and Budget (OMB) for review under section 3507(d) of the PRA. OMB, the general public, and other Federal agencies are invited to comment on the new or modified information collection requirements contained in this proceeding. In addition, we note that pursuant to the

²⁸ See 5 U.S.C. 603(c)(1) through (c)(4).

Small Business Paperwork Relief Act of 2002, Public Law 107–198, see 44 U.S.C. 3506(c)(4), we previously sought specific comment on how the Commission might further reduce the information collection burden for small business concerns with fewer than 25 employees.

175. We have assessed the effects of the policies adopted in this Report and Order with regard to information collection burdens on small business concerns, and find that these policies will benefit many companies with fewer than 25 employees by providing unlicensed white space devices and unlicensed wireless microphones with access to spectrum in the television broadcasting band and the 600 MHz band, while at the same time protecting licensed users from harmful interference. In addition, we have described impacts that might affect small businesses, which includes most businesses with fewer than 25 employees, in the Final Regulatory Flexibility Analysis.

176. *Congressional Review Act*. The Commission will send a copy of this *Memorandum Opinion and Order* in a report to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. 801(a)(1)(A).

Ordering Clauses

177. Pursuant to sections 4(i), 302, 303(e), 303(f), and 307 of the Communications Act of 1934, as amended, and sections 6403 and 6407 of the Middle Class Tax Relief and Job Creation Act of 2012, Public Law 112–96, 126 Stat. 156, 47 U.S.C. 154(i), 302, 303(e), 303(f), 307, 1452, and 1454, this *Report and Order* is adopted.

178. Parts 2, 15, 27, 74 and 95 of the Commission’s Rules, are amended, as set forth in the Final Rules. These revisions will be effective December 23, 2015 of this *Report and Order*, except for §§ 15.713(b)(2)(iv) through (v), 15.713(j)(4), 15.713(j)(10), 15.713(j)(11), 15.715(n), 15.715(o), 15.715(p), 15.715(q), 27.1320 and 95.1111(d) which contain new or modified information collection requirements that require approval by the OMB under the PRA and will become effective after the Commission publishes a notice announcing such approval and the relevant effective date.

179. The Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, shall send a copy of the Report and Order, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the U.S. Small Business Administration.

List of Subjects

47 CFR Part 2

Communications equipment, Radio, Reporting and recordkeeping requirements.

47 CFR Part 15

Communications equipment, Incorporation by reference, Radio, Reporting and recordkeeping requirements.

47 CFR Part 27

Communications equipment, Radio, Reporting and recordkeeping requirements.

47 CFR Part 74

Communications equipment, Radio, Reporting and recordkeeping requirements.

47 CFR Part 95

Communications equipment, Radio, Reporting and recordkeeping requirements.

Federal Communications Commission.

Marlene H. Dortch,
Secretary.

Final Rules

For the reasons discussed in the preamble, the Federal Communications Commission amends 47 CFR parts 2, 15, 27, 74, and 95 as follows:

PART 2—FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS

■ 1. The authority citation for part 2 continues to read as follows:

Authority: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

■ 2. Section 2.106 is amended by revising footnote US246 to the table of allocations to read as follows:

§ 2.106 Table of Frequency Allocations.

* * * * *
US246 No station shall be authorized to transmit in the following bands: 73–74.6 MHz, 608–614 MHz, except for medical telemetry equipment¹ and white space devices,² 1400–1427 MHz, 1660.5–1668.4 MHz, 2690–2700 MHz, 4990–5000 MHz, 10.68–10.7 GHz, 15.35–15.4 GHz, 23.6–24 GHz, 31.3–31.8 GHz, 50.2–50.4 GHz, 52.6–54.25 GHz, 86–92 GHz, 100–102 GHz, 109.5–111.8 GHz, 114.25–116 GHz, 148.5–151.5 GHz, 164–167 GHz, 182–185 GHz, 190–191.8 GHz, 200–209 GHz, 226–231.5 GHz, 250–252 GHz.

¹ Medical telemetry equipment shall not cause harmful interference to radio astronomy operations in the band 608–614

MHz and shall be coordinated under the requirements found in 47 CFR 95.1119.

² White space devices shall not cause harmful interference to radio astronomy operations in the band 608–614 and shall not operate within the areas described in 47 CFR 15.712(h).

* * * * *

PART 15—RADIO FREQUENCY DEVICES

■ 3. The authority citation for part 15 continues to read as follows:

Authority: 47 U.S.C. 154, 302a, 303, 304, 307, 336, 544A, and 549.

■ 4. Section 15.37 is amended by adding paragraphs (i) and (j) to read as follows:

§ 15.37 Transition provisions for compliance with the rules.

* * * * *

(i) Wireless microphones for which an application for certification is filed beginning nine months after the release of the *Channel Reassignment PN*, as defined in § 73.3700(a)(2) of this chapter, or no later than December 26, 2017, whichever occurs first, must comply with the requirements of § 15.236. Manufacturing and marketing of wireless microphones that would not comply with the rules for operation in § 15.236 of this part must cease 18 months after release of the *Channel Reassignment PN* or no later than September 24, 2018, whichever occurs first. A wireless microphone that is certified to operate in any portion of the 600 MHz service band as defined in § 15.236(a) may no longer be marketed or operated after the specified cutoff dates, even if it could be tuned to operate on frequencies outside of this band.

(j) White space devices for which a certification application is filed beginning June 23, 2016, must comply with the channel push requirements in § 15.711(i) of this part. White space devices that are imported or marketed beginning September 23, 2016, must comply with this requirement. White space devices that do not comply with this requirement must cease operation no later than December 23, 2016.

■ 5. Section 15.38 is amended by redesignating paragraphs (e) through (g) as paragraphs (f) through (h) and by adding a new paragraph (e) to read as follows:

§ 15.38 Incorporation by reference.

* * * * *

(e) The following document is available from the European Telecommunications Standards Institute, 650 Route des Lucioles, F–06921 Sophia Antipolis Cedex, France,

or at http://www.etsi.org/deliver/etsi_en/300400_300499/30042201/01.04.02_60/en_30042201v010402p.pdf.

(1) ETSI EN 300 422-1 V1.4.2 (2011-08): “*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.*” Copyright 2011, IBR approved for § 15.236(g).

(2) [Reserved]

■ 6. Section 15.205 is amended by adding paragraph (d)(10) to read as follows:

§ 15.205 Restricted bands of operation.

* * * * *

(d) * * *

(10) White space devices operating under subpart H of this part are exempt from complying with the requirements of this section for the 608–614 MHz band.

* * * * *

■ 7. Add § 15.236 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 part 27 600 MHz service uplink and downlink frequencies, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

(3) *600 MHz guard bands.* Designated frequency bands that prevent interference between licensed services in the 600 MHz service band and either the television bands or channel 37, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

(4) *600 MHz service band.* Frequencies that will be reallocated and assigned for 600 MHz services pursuant to part 27, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

Note to paragraphs (a)(2), (3) and (4): The specific frequencies will be determined in light of further proceedings pursuant to GN Docket No. 12–268 and the rules will be updated accordingly pursuant to a future public notice.

(5) *Spectrum Act.* Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (Pub. L. 112–96).

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

(c) Operation is permitted in the following frequency bands.

(1) Channels allocated and assigned for the broadcast television service. The highest channel available will depend on the outcome of the incentive auction.

(2) Frequencies in the 600 MHz service band on which a 600 MHz service licensee has not commenced operations. Operation on these frequencies must cease no later than the

end of the post-auction transition period as defined in § 27.4 of this chapter. Operation must cease immediately if harmful interference occurs to a 600 MHz service licensee.

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

(4) The 600 MHz guard band between television and 600 MHz service 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) Prior to operation in the frequencies identified in paragraphs (c)(2) through (5) of this section, wireless microphone users shall 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. Wireless microphone users must register with and check a white space database to determine available channels prior to beginning operation at a given location. A user must re-check the database for available channels if it moves to another location.

(d) The maximum radiated power shall not exceed the following values:

(1) In the bands allocated and assigned for broadcast television and in the 600 MHz service band: 50 mW EIRP

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

(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 service licensee has commenced operation.

Type of station	Separation distance in kilometers	
	Co-channel	Adjacent channel
Base	7	0.2
Mobile	35	31

(f) The operating frequency within a permissible band of operation as defined in paragraph (c) 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 V1.4.2 (2011–08) (incorporated by reference, see § 15.38). Emissions outside this band shall comply with the limit specified at the edges of the ETSI mask.

■ 8. Subpart H is revised to read as follows:

Subpart H—White Space Devices

- Sec.
- 15.701 Scope.
- 15.703 Definitions.
- 15.705 Cross reference.
- 15.706 Information to the user.
- 15.707 Permissible channels of operation.
- 15.709 General technical requirements.
- 15.711 Interference avoidance methods.
- 15.712 Interference protection requirements.
- 15.713 White space database.
- 15.714 White space database administration fees.
- 15.715 White space database administrator.
- 15.717 White space devices that rely on spectrum sensing.

§ 15.701 Scope.

This subpart sets forth the regulations for unlicensed white space devices. These devices are unlicensed intentional radiators that operate on

available TV channels in the broadcast television frequency bands, the 600 MHz band (including the guard bands and duplex gap), and in 608–614 MHz (channel 37).

§ 15.703 Definitions.

(a) *600 MHz duplex gap.* An 11 megahertz frequency band that separates part 27 600 MHz service uplink and downlink frequencies, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

(b) *600 MHz guard bands.* Designated frequency bands that prevent interference between licensed services in the 600 MHz service band and either the television bands or channel 37, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

(c) *600 MHz service band.* Frequencies that will be reallocated and assigned for 600 MHz band services pursuant to part 27, in accordance with the terms and conditions established in GN Docket No. 12–268, pursuant to section 6403 of the Spectrum Act.

Note to paragraphs (a), (b) and (c): The specific frequencies will be determined in light of further proceedings pursuant to GN Docket No. 12–268 and the rules will be updated accordingly pursuant to a future public notice.

(d) *Available channel.* A channel which is not being used by an authorized service and is acceptable for use by the device at its geographic location under the provisions of this subpart.

(e) *Contact verification signal.* An encoded signal broadcast by a fixed or Mode II device for reception by Mode I devices to which the fixed or Mode II device has provided a list of available channels for operation. Such signal is for the purpose of establishing that the Mode I device is still within the reception range of the fixed or Mode II device for purposes of validating the list of available channels used by the Mode I device and shall be encoded to ensure that the signal originates from the device that provided the list of available channels. A Mode I device may respond only to a contact verification signal from

the fixed or Mode II device that provided the list of available channels on which it operates. A fixed or Mode II device shall provide the information needed by a Mode I device to decode the contact verification signal at the same time it provides the list of available channels.

(f) *Fixed device.* A white space device that transmits and/or receives radiocommunication signals at a specified fixed location. A fixed device may select channels for operation from a list of available channels provided by a white space database, and initiate and operate a network by sending enabling signals to one or more fixed devices and/or personal/portable devices. Fixed devices may provide to a Mode I personal/portable device a list of available channels on which the Mode I device may operate, including channels on which the Mode I device but not the fixed device may operate.

(g) *Geo-location capability.* The capability of a white space device to determine its geographic coordinates and geo-location uncertainty. This capability is used with a white space database approved by the FCC to determine the availability of spectrum at a white space device’s location.

(h) *Less congested area.* Geographic areas where at least half of the TV channels for the bands that will continue to be allocated and assigned only for broadcast service are unused for broadcast and other protected services and available for white space device use. Less congested areas in the UHF TV band are also considered to be less congested areas in the 600 MHz service band.

(i) *Mode I personal/portable device.* A personal/portable white space device that does not use an internal geo-location capability and access to a white space database to obtain a list of available channels. A Mode I device must obtain a list of available channels on which it may operate from either a fixed white space device or Mode II personal/portable white space device. A Mode I device may not initiate a network of fixed and/or personal/portable white space devices nor may it provide a list of available channels to another Mode I device for operation by such device.

(j) *Mode II personal/portable device.* A personal/portable device that uses an internal geo-location capability and access to a white space database, either through a direct connection to the Internet or through an indirect connection to the Internet by way of fixed device or another Mode II device, to obtain a list of available channels. A Mode II device may select a channel itself and initiate and operate as part of a network of white space devices, transmitting to and receiving from one or more fixed devices or personal/portable devices. A Mode II personal/portable device may provide its list of available channels to a Mode I personal/portable device for operation on by the Mode I device.

(k) *Network initiation.* The process by which a fixed or Mode II white space device sends control signals to one or more fixed white space devices or personal/portable white space devices and allows them to begin communications.

(l) *Operating channel.* An available channel used by a white space device for transmission and/or reception.

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

(n) *Receive site.* The location where the signal of a full service television station is received for rebroadcast by a television translator or low power TV station, including a Class A TV station, or for distribution by a Multiple Video Program Distributor (MVPD) as defined in 47 U.S.C. 602(13).

(o) *Sensing only device.* A personal/portable white space device that uses spectrum sensing to determine a list of available channels. Sensing only devices may transmit on any available channels in the frequency bands 512–608 MHz (TV channels 21–36) and 614–698 MHz (TV channels 38–51).

(p) *Spectrum Act.* Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (Pub. L. 112–96).

(q) *Spectrum sensing.* A process whereby a white space device monitors a television channel to detect whether the channel is occupied by a radio signal or signals from authorized services.

(r) *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). Channels 2–13 are in the VHF band, and channel 14–51 are in the UHF band.

(s) *White space database.* A database system approved by the Commission that maintains records on authorized services and provides lists of available channels to white space devices and unlicensed wireless microphone users.

§ 15.705 Cross reference.

(a) The provisions of subparts A, B, and C of this part apply to white space devices, except where specific provisions are contained in this subpart.

(b) The requirements of this subpart apply only to the radio transmitter contained in the white space device. Other aspects of the operation of a white space device may be subject to requirements contained elsewhere in this chapter. In particular, a white space device that includes a receiver that tunes within the frequency range specified in § 15.101(b) and contains digital circuitry not directly associated with the radio transmitter is also subject to the requirements for unintentional radiators in subpart B.

§ 15.706 Information to the user.

(a) In addition to the labeling requirements contained in § 15.19, the instructions furnished to the user of a white space device shall include the following statement, placed in a prominent location in the text of the manual:

This equipment has been tested and found to comply with the rules for white space devices, pursuant to part 15 of the FCC rules. These rules are designed to provide reasonable protection against harmful interference. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

(1) Reorient or relocate the receiving antenna.

(2) Increase the separation between the equipment and receiver.

(3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

(4) Consult the manufacturer, dealer or an experienced radio/TV technician for help.

(b) In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information

required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

§ 15.707 Permissible channels of operation.

(a)(1) All white space devices are permitted to operate on available channels in the frequency bands 470–698 MHz (TV channels 14–51), subject to the interference protection requirements in §§ 15.711 and 15.712, except as provided in paragraph (a)(2) of this section.

(2) White space devices are not permitted to operate on the first channel above and below TV channel 37 (608–614 MHz) that are available (*i.e.*, not occupied by an authorized service) until June 23, 2017, but no later than release of the Channel Reassignment Public Notice upon completion of the broadcast television spectrum incentive auction, as defined in § 73.3700(a) of this chapter. If a channel is not available both above and below channel 37, operation is prohibited on the first two channels nearest to channel 37. These channels will be identified and protected in the white space database(s).

(3) *600 MHz guard band.* In the 600 MHz guard band between television and 600 MHz service downlink bands, white space devices may only operate immediately adjacent to the television band with a maximum bandwidth of 6 megahertz. White space devices are prohibited from operating in the three megahertz segment adjacent to the 600 MHz service band.

(4) *600 MHz duplex gap.* In the 600 MHz duplex gap, white space devices shall only operate in the 6 megahertz segment immediately adjacent to the 600 MHz service uplink band.

(5) *600 MHz service band.* White space devices may operate on frequencies in the 600 MHz service band in areas where 600 MHz band licensees have not commenced operations, as defined in part 27 of this chapter.

(6) *Channel 37 guard band.* White space devices are not permitted to operate in either three megahertz segment above or below channel 37 if that spectrum is adjacent to the 600 MHz service band.

(b) Only fixed white space devices that communicate only with other fixed white space devices may operate on available channels in the bands 54–72 MHz (TV channels 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.

§ 15.709 General technical requirements.

(a) *Radiated power limits.* The maximum white space device EIRP per 6 MHz shall not exceed the limits of paragraphs (a)(2) through (4) of this section.

(1) *General requirements.* (i) White space devices may be required to operate with less power than the maximum permitted to meet the co-channel and adjacent channel separation requirements of § 15.712 of this part.

(ii) Mode I personal/portable devices are limited to 40 mW, if the white space device that controls it is limited to 40 mW.

(2) *TV bands and 600 MHz service band.* (i) Fixed devices: Up to 4 W (36 dBm) EIRP, and up to 10 W (40 dBm) EIRP in less congested areas in the TV bands and 600 MHz service band at locations where they meet the co-channel and adjacent channel separation distances of §§ 15.712(a)(2) and 15.712(i) of this part, respectively. Operation in the 602–620 MHz band is limited to a maximum of 4 W (36 dBm) EIRP.

(ii) Personal/Portable devices: Up to 100 mW (20 dBm) EIRP.

(3) *608–614 MHz band (channel 37).* (i) Fixed devices: Up to 4 W (36 dBm) EIRP.

(ii) Personal/Portable devices: Up to 100 mW (20 dBm) EIRP.

(4) *600 MHz duplex gap and guard bands.* Up to 40 mW (16 dBm) EIRP.

(b) *Technical limits—(1) Fixed white space devices.* (i) Technical limits for fixed white space devices are shown in the table and subject to the requirements of this section.

(ii) For operation at EIRP levels of 36 dBm (4000 mW) or less, fixed white space devices may operate at EIRP levels between the values shown in the table provided that the conducted power and the conducted power spectral density (PSD) limits are linearly interpolated between the values shown and the adjacent channel emission limit of the higher value shown in the table is met. Operation at EIRP levels above 36 dBm (4000 mW) shall follow the requirements for 40 dBm (10,000 mW).

EIRP (6 MHz)	Conducted power limit ¹ (6 MHz)	Conducted PSD limit (100 kHz)	Conducted adjacent channel emission limit (100 kHz)
16 dBm (40 mW)	10 dBm (10 mW)	–7.4 dBm	–62.8 dBm
20 dBm (100 mW)	14 dBm (25 mW)	–3.4 dBm	–58.8 dBm
24 dBm (250 mW)	18 dBm (63 mW)	0.6 dBm	–54.8 dBm
28 dBm (625 mW)	22 dBm (158 mW)	4.6 dBm	–50.8 dBm
32 dBm (1600 mW)	26 dBm (400 mW)	8.6 dBm	–46.8 dBm
36 dBm (4000 mW)	30 dBm (1000 mW)	12.6 dBm	–42.8 dBm
40 dBm (10000 mW)	30 dBm (1000 mW)	12.6 dBm	–42.8 dBm

¹ The conducted power spectral density from a fixed white space device shall not be greater than the values shown in the table when measured in any 100 kHz band during any time interval of continuous transmission, except that a 40 mW fixed white space device operating in a four megahertz channel within a seven megahertz guard band must comply with a conducted power spectral density limit of –5.4 dBm.

(2) *Personal/Portable white space devices.* Technical limits for personal/portable white space devices are shown

in the table and subject to the requirements of this section.

EIRP (6 MHz)	Radiated PSD limit EIRP ¹ (100 kHz)	Radiated adjacent channel emission limit EIRP (100 kHz)
16 dBm (40 mW)	–1.4 dBm	–56.8 dBm
20 dBm (100 mW)	2.6 dBm	–52.8 dBm

¹ The radiated power spectral density from a personal/portable white space device shall not be greater than the values shown in the table when measured in any 100 kHz band during any time interval of continuous transmission, except that a 40 mW white space device operating in a four megahertz channel within a seven megahertz guard band must comply with a radiated power spectral density limit of 0.6 dBm.

(3) *Sensing-only devices.* Sensing-only white space devices are limited to 17 dBm (50 mW) EIRP and are subject to the requirements of this paragraph and of § 15.717 of this part.

(i) Radiated PSD limit: –0.4 dBm EIRP.

(ii) Adjacent channel emission limit: –55.8 dBm EIRP.

(c) *Conducted power limits.* (1) The conducted power, PSD and adjacent channel limits for fixed white space devices operating at up to 36 dBm (4000 milliwatts) EIRP shown in the table in paragraph (b)(1) of this section 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.

(2) The conducted power, PSD and adjacent channel limits for fixed white space devices operating at greater than 36 dBm (4000 milliwatts) EIRP shown in the table in paragraph (b)(1) of this section are based on a maximum transmitting antenna gain of 10 dBi. If transmitting antennas of directional gain

greater than 10 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 10 dBi.

(3) 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 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.

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

(d) *Emission limits.* (1) The adjacent channel emission limits shown in the tables in paragraphs (b)(1) and (2) of this section apply in the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating.

(2) At frequencies beyond the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating the white space device shall meet the requirements of § 15.209.

(3) 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.

(e) *Transmit power control.* 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 the device's transmit power control feature mechanism.

(f) *Security.* 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.

(g) *Antenna requirements—(1) Fixed white space devices—(i) Above ground level.* The transmit antenna height shall not exceed 30 meters above ground level, except that the antenna height may not exceed 10 meters above ground level for fixed white space devices operating in the TV bands or guard band at 40 mW EIRP or less or operating across multiple contiguous TV channels at 100 mW EIRP or less.

(ii) *Height above average terrain (HAAT).* The transmit antenna shall not be located where the height above

average terrain is more than 250 meters. The HAAT is to be calculated by the white space database using the methodology in § 73.684(d) of this chapter.

(2) *Personal/portable white space devices.* Personal/portable devices shall have permanently attached transmit and receive antenna(s).

(3) *Sensing-only white space devices operating under the provisions of § 15.717 of this subpart.* (i) The provisions of § 15.204(c)(4) do not apply to an antenna used for transmission and reception/spectrum sensing.

(ii) Compliance testing for white space devices that incorporate a separate sensing antenna shall be performed using the lowest gain antenna for each type of antenna to be certified.

(h) *Compliance with radio frequency exposure requirements—(1) Fixed white space devices.* To ensure compliance with the Commission's radio frequency exposure requirements in §§ 1.1307(b), 2.1091 and 2.1093 of this chapter, fixed white space devices shall be accompanied by instructions on measures to take to ensure that persons maintain a distance of at least 40 cm from the device, as well as any necessary hardware that may be needed to implement that protection. These instructions shall be submitted with the application for certification.

(2) *Personal/portable white space devices.* Personal/portable white space devices that meet the definition of portable devices under § 2.1093 of this chapter and that operate with a source-based time-averaged output of less than 20 mW will not be subject to routine evaluation for compliance with the radio frequency exposure guidelines in §§ 1.1307(b), 2.1091, and 2.1093 of this chapter, while devices that operate with a source-based time-average output power greater than 20 mW will be subject to the routine evaluation requirements.

§ 15.711 Interference avoidance methods.

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

(a) *Geo-location required.* White space devices shall rely on a geo-location capability and database access mechanism to protect the following authorized service in accordance with the interference protection requirements of § 15.712: 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); 600 MHz service band licensees where they have commenced operations; and unlicensed wireless microphones used by venues of large events and productions/shows as provided under § 15.713(j)(9). In addition, protection shall be provided in border areas near Canada and Mexico in accordance with § 15.712(g).

(b) *Geo-location requirement—(1) Accuracy.* Fixed white space devices that incorporate a geo-location capability and Mode II devices shall determine their location and their geo-location uncertainty (in meters), with a confidence level of 95%.

(2) *Reference datum.* All geographic coordinates shall be referenced to the North American Datum of 1983 (NAD 83).

(c) *Requirements for fixed white space devices.* (1) The geographic coordinates and antenna height above ground level of a fixed white space device shall be determined at the time of installation and first activation from a power-off condition by either an incorporated geo-location capability or a professional installer. This information may be stored internally in the white space device. In the case of professional installation, the party who registers the fixed white space device in the database will be responsible for assuring the accuracy of the entered coordinates and antenna height. If a fixed white space device is moved to another location or if its stored coordinates become altered, the operator shall re-establish the device's:

(i) Geographic location and antenna height above ground level and store this information in the white space device either by means of the device's incorporated geo-location capability or through the services of a professional installer; and

(ii) Registration with the database based on the device's new coordinates and antenna height above ground level.

(2)(i) Each fixed white space device must access a white space database over the Internet to determine the available channels and the corresponding maximum permitted power for each available channel that is available at its geographic coordinates, taking into consideration the fixed device's antenna height above ground level and geo-

location uncertainty, prior to its initial service transmission at a given location.

(ii) Operation is permitted only on channels and at power levels that are indicated in the database as being available for each white space device. Operation on a channel must cease immediately or power must be reduced to a permissible level if the database indicates that the channel is no longer available at the current operating level.

(iii) Each fixed white space devices shall access the database at least once a day to verify that the operating channels continue to remain available. Each fixed white space device must adjust its use of channels in accordance with channel availability schedule information provided by its database for the 48-hour period beginning at the time the device last accessed the database for a list of available channels.

(iv) Fixed devices without a direct connection to the Internet: A fixed white space device may not operate on channels provided by a white space database for another fixed device. A fixed white space device that has not yet been initialized and registered with a white space database consistent with § 15.713 of this part, but can receive the transmissions of another fixed white space device, may transmit to that other fixed white space device on either a channel that the other white space device has transmitted on or on a channel which the other white space device indicates is available for use to access the database to register its location and receive a list of channels that are available for it to use. Subsequently, the newly registered fixed white space device must only use the channels that the database indicates are available for it to use.

(d) *Requirements for Mode II personal/portable white space devices.*

(1) The geographic coordinates of a Mode II personal/portable white space device shall be determined by an incorporated geo-location capability prior to its initial service transmission at a given location and each time the device is activated from a power-off condition to determine the available channels and the corresponding maximum permitted power for each available channel at its geographic coordinates, taking into consideration the device's geo-location uncertainty. The location must be checked at least once every 60 seconds while in operation, except while in sleep mode, *i.e.*, in a mode in which the device is inactive but is not powered-down.

(2) Each Mode II personal/portable white space device must access a white space database over the Internet to obtain a list of available channels for its

location. The device must access the database for an updated available channel list if its location changes by more than 100 meters from the location at which it last established its available channel list.

(3) Operation is permitted only on channels and at power levels that are indicated in the database as being available for the Mode II personal/portable white space device. Operation on a channel must cease immediately or power must be reduced to a permissible level if the database indicates that the channel is no longer available at the current operating level.

(4) A Mode II personal/portable white space device that has been in a powered state shall re-check its location and access the database daily to verify that the operating channel(s) and corresponding power levels continue to be available. Mode II personal/portable devices must adjust their use of channels and power levels in accordance with channel availability schedule information provided by their database for the 48-hour period beginning at the time of the device last accessed the database for a list of available channels.

(5) A Mode II personal/portable device may load channel availability information for multiple locations, (*i.e.*, in the vicinity of its current location) and use that information to define a geographic area within which it can operate on the same available channels at all locations. For example a Mode II personal/portable white space 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 white space 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.

(e) *Requirements for Mode I personal/portable white space devices.* (1) A Mode I personal/portable white space device may only transmit upon receiving a list of available channels from a fixed or Mode II white space device. A fixed or Mode II white space device may provide a Mode I device with a list of available channels only after it contacts its database, provides the database the FCC Identifier (FCC ID) of the Mode I device requesting available channels, and receives verification that the FCC ID is valid for operation.

(2) A Mode II device must provide a list of channels to the Mode I device that is the same as the list of channels available to the Mode II device.

(3) A fixed device may provide a list of available channels to a Mode I device only if the fixed device HAAT as verified by the white space database does not exceed 106 meters. The fixed device must provide a list of available channels to the Mode I device that is the same as the list of channels available to the fixed device, except that a Mode I device may operate only on those channels that are permissible for its use under § 15.707 of this part. A fixed device may also obtain from a white space database and provide to a Mode I personal/portable white space device, a separate list of available channels that includes adjacent channels available to a Mode I personal/portable white space device, but not a fixed white space device.

(4) To initiate contact with a fixed or Mode II device, a Mode I device may transmit on an available channel used by the fixed or Mode II white space device or on a channel the fixed or Mode II white space device indicates is available for use by a Mode I device. At least once every 60 seconds, except when in sleep mode (*i.e.*, a mode in which the device is inactive but is not powered-down), a Mode I device must either receive a contact verification signal from the Mode II or fixed white space device that provided its current list of available channels or contact a Mode II or fixed white space device to re-verify/re-establish channel availability. A Mode I device must cease operation immediately if it does not receive a contact verification signal or is not able to re-establish a list of available channels through contact with a fixed or Mode II device on this schedule. If a fixed or Mode II white space device loses power and obtains a new channel list, it must signal all Mode I devices it is serving to acquire and use a new channel list.

(f) *Display of available channels.* A white space device must incorporate the capability to display a list of identified available channels and its operating channels.

(g) *Identifying information.* Fixed white space devices shall transmit identifying information. The identification signal must conform to a standard established by a recognized industry standards setting organization. The identification signal shall carry sufficient information to identify the device and its geographic coordinates.

(h) *Continuing operation.* If a fixed or Mode II personal/portable white space device fails to successfully contact the white space database during any given day, it may continue to operate until 11:59 p.m. of the following day at which time it must cease operations until it re-

establishes contact with the white space database and re-verifies its list of available channels.

(i) *Push notifications.* White space device manufacturers and database administrators must implement the push notification requirements of paragraphs (i)(1) and (2) of this section, and may also implement a system that pushes additional updated channel availability information from the database to white space devices.

(1) In response to a request for immediate access to a channel by a licensed wireless microphone user, white space database administrators are required to share the licensed microphone channel registration information to all other white space database administrators within 10 minutes of receiving each wireless microphone registration.

(2) White space database administrators shall push updated available channel lists to fixed and Mode II personal/portable white space devices within 20 minutes of receiving the notification required by paragraph (i)(1) of this section. The information need only be pushed to white space devices that are located within the separation distances, specified in § 15.712(f) of this part, for each licensed wireless microphone registration received.

(3) White space database administrators must update their systems to comply with these requirements no later than December 23, 2016.

(j) *Security.* (1) White space devices shall incorporate adequate security measures to ensure that they are capable of communicating for purposes of obtaining lists of available channels only with databases operated by

administrators authorized by the Commission, and to ensure that communications between white space devices and databases are secure to prevent corruption or unauthorized interception of data. This requirement includes implementing security for communications between Mode I personal portable devices and fixed or Mode II devices for purposes of providing lists of available channels. This requirement applies to communications of channel availability and other spectrum access information between the databases and fixed and Mode II devices (it is not necessary for white space devices to apply security coding to channel availability and channel access information where they are not the originating or terminating device and that they simply pass through).

(2) Communications between a Mode I device and a fixed or Mode II device for purposes of obtaining a list of available channels shall employ secure methods that ensure against corruption or unauthorized modification of the data. When a Mode I device makes a request to a fixed or Mode II device for a list of available channels, the receiving device shall check with the white space database that the Mode I device has a valid FCC Identifier before providing a list of available channels. Contact verification signals transmitted for Mode I devices are to be encoded with encryption to secure the identity of the transmitting device. Mode I devices using contact verification signals shall accept as valid for authorization only the signals of the device from which they obtained their list of available channels.

(3) A white space database shall be protected from unauthorized data input

or alteration of stored data. To provide this protection, the white space database administrator shall establish communications authentication procedures that allow fixed and Mode II white space devices to be assured that the data they receive is from an authorized source.

(4) Applications for certification of white space devices shall include a high level operational description of the technologies and measures that are incorporated in the device to comply with the security requirements of this section. In addition, applications for certification of fixed and Mode II white space devices shall identify at least one of the white space databases operated by a designated white space database administrator that the device will access for channel availability and affirm that the device will conform to the communications security methods used by that database.

§ 15.712 Interference protection requirements.

The separation distances in this section apply to fixed and personal/portable white space devices with a location accuracy of ±50 meters. These distances must be increased by the amount that the location uncertainty of a white space device exceeds ±50 meters.

(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.

(i) If a device operates between two defined power levels, it must comply

with the separation distances for the higher power level.

(ii) White space devices operating at 40 mW EIRP or less are not required to meet the adjacent channel separation distances.

(iii) Fixed white space devices operating at 100 mW EIRP or less per 6 megahertz across multiple contiguous

TV channels with at least 3 megahertz separation between the frequency band occupied by the white space device and adjacent TV channels are not required to meet the adjacent channel separation distances.

(iv) Fixed white space devices may only operate above 4 W EIRP in less

congested areas as defined in § 15.703(h).

MODE II PERSONAL/PORTABLE WHITE SPACE DEVICES

	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)
Communicating with Mode II or Fixed device	1.3	1.7
Communicating with Mode I device	2.6	3.4

FIXED WHITE SPACE DEVICES

Antenna height above average terrain of unlicensed devices (meters)	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 W)	40 dBm (10 W)
Less than 3	1.3	1.7	2.1	2.7	3.3	4.0	4.5
3-10	2.4	3.1	3.8	4.8	6.1	7.3	8.5
10-30	4.2	5.1	6.0	7.1	8.9	11.1	13.9
30-50	5.4	6.5	7.7	9.2	11.5	14.3	19.1
50-75	6.6	7.9	9.4	11.1	13.9	18.0	23.8
75-100	7.7	9.2	10.9	12.8	17.2	21.1	27.2
100-150	9.4	11.1	13.2	16.5	21.4	25.3	32.3
150-200	10.9	12.7	15.8	19.5	24.7	28.5	36.4
200-250	12.1	14.3	18.2	22.0	27.3	31.2	39.5

* When communicating with Mode I personal/portable white space devices, the required separation distances must be increased beyond the specified distances by 1.3 kilometers if the Mode I device operates at power levels no more than 40 mW EIRP or 1.7 kilometers if the Mode I device operates at power levels above 40 mW EIRP.

PERSONAL/PORTABLE WHITE SPACE DEVICES

	Required separation in kilometers from adjacent channel digital or analog TV (full service or low power) protected contour
	20 dBm (100 mW)
Communicating with Mode II or Fixed device	0.1
Communicating with Mode I device	0.2

FIXED WHITE SPACE DEVICES

Antenna height above average terrain of unlicensed devices (meters)	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 W)	40 dBm (10 W)
Less than 3	0.1	0.1	0.1	0.1	0.2	0.2
3-10	0.1	0.2	0.2	0.2	0.3	0.4
10-30	0.2	0.3	0.3	0.4	0.5	0.6
30-50	0.3	0.3	0.4	0.5	0.7	0.8
50-75	0.3	0.4	0.5	0.7	0.8	0.9
75-100	0.4	0.5	0.6	0.8	1.0	1.1
100-150	0.5	0.6	0.8	0.9	1.2	1.3
150-200	0.5	0.7	0.9	1.1	1.4	1.5
200-250	0.6	0.8	1.0	1.2	1.5	1.7

* When communicating with a Mode I personal/portable white space device that operates at power levels above 40 mW EIRP, the required separation distances must be increased beyond the specified distances by 0.1 kilometers.

(3) *Fixed white space device antenna height.* Fixed white space devices must comply with the requirements of § 15.709(g) of this part.

(b) *TV translator, Low Power TV (including Class A) and Multi-channel Video Programming Distributor (MVPD) receive sites.* (1) MVPD, TV translator

station and low power TV (including Class A) station receive sites located outside the protected contour of the TV station(s) being received may be

registered in the white space database if they are no farther than 80 km outside the nearest edge of the relevant contour(s). Only channels received over the air and used by the MVPD, TV translator station or low power/Class A TV station may be registered.

(2) White space devices may not operate within an arc of ± 30 degrees from a line between a registered receive site and the contour of the TV station being received in the direction of the station's transmitter at a distance of up to 80 km from the edge of the protected contour of the received TV station for co-channel operation and up to 20 km from the registered receive site for adjacent channel operation, except that the protection distance shall not exceed the distance from the receive site to the protected contour.

(3) Outside of the ± 30 degree arc defined in paragraph (b)(2) of this section:

(i) White space devices operating at 4 watts EIRP or less may not operate

within 8 km from the receive site for co-channel operation and 2 km from the receive site for adjacent channel operation.

(ii) White Space devices operating with more than 4 watts EIRP may not operate within 10.2 km from the receive site for co-channel operation and 2.5 km from the receive site for adjacent channel operation.

(iii) For purposes of this section, a TV station being received may include a full power TV station, TV translator station or low power TV/Class A TV station.

(c) *Fixed Broadcast Auxiliary Service (BAS) links.* (1) For permanent BAS receive sites appearing in the Commission's Universal Licensing System or temporary BAS receive sites registered in the white space database, white space devices may not operate within an arc of ± 30 degrees from a line between the BAS receive site and its associated permanent transmitter within a distance of 80 km from the receive site

for co-channel operation and 20 km for adjacent channel operation.

(2) Outside of the ± 30 degree arc defined in paragraph (c)(1) of this section:

(i) White space devices operating at 4 watts EIRP or less may not operate within 8 km from the receive site for co-channel operation and 2 km from the receive site for adjacent channel operation.

(ii) White Space devices operating with more than 4 watts EIRP may not operate within 10.2 km from the receive site for co-channel operation and 2.5 km from the receive site for adjacent channel operation.

(d) *PLMRS/CMRS operations.* (1) White space devices may not operate at distances less than those specified in the table below from the coordinates of the metropolitan areas and on the channels listed in § 90.303(a) of this chapter.

White space device transmitter power	Required separation in kilometers from areas specified in § 90.303(a) of this chapter	
	Co-channel operation	Adjacent channel operation
4 watts EIRP or less	134	131
Greater than 4 watts EIRP	136	131.5

(2) White space devices may not operate at distances less than those

specified in the table below from PLMRS/CMRS operations authorized by

waiver outside of the metropolitan areas listed in § 90.303(a) of this chapter.

White space device transmitter power	Required separation in kilometers from areas specified in § 90.303(a) of this chapter	
	Co-channel operation	Adjacent channel operation
4 watts EIRP or less	54	51
Greater than 4 watts EIRP	56	51.5

(e) *Offshore Radiotelephone Service.* White space devices may not operate on channels used by the Offshore Radio Service within the geographic areas specified in § 74.709(e) of this chapter.

(f) *Low power auxiliary services, including wireless microphones.* Fixed white space 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.

(g) *Border areas near Canada and Mexico:* Fixed and personal/portable white space devices shall comply with the required separation distances in § 15.712(a)(2) from the protected contours of TV stations in Canada and Mexico. White space devices are not required to comply with these separation distances from portions of the protected contours of Canadian or Mexican TV stations that fall within the United States.

(h) *Radio astronomy services.* (1) Operation of fixed and personal/portable white space devices is prohibited on all channels 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:		

Observatory	Latitude (deg/min/sec)	Longitude (deg/min/sec)
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) Operation within the band 608–614 MHz is prohibited within the areas defined by the following coordinates (all coordinates are NAD 83):

(i) Pie Town, NM

North latitude (deg/min/sec)	West longitude (deg/min/sec)
35 25 56.28	107 44 56.40
35 15 57.24	107 41 27.60
33 52 14.16	107 30 25.20
33 22 39.36	107 49 26.40
33 57 38.52	109 36 10.80
34 04 46.20	109 34 12.00
34 27 20.88	109 12 43.20
35 15 30.24	108 25 55.20

(ii) Kitt Peak, AZ

North latitude (deg/min/sec)	West longitude (deg/min/sec)
34 08 18.24	111 36 46.80
33 54 10.08	109 38 20.40
32 09 25.56	113 42 03.60
31 29 15.72	111 33 43.20
33 20 36.60	113 36 14.40
34 09 20.52	112 34 37.20

(iii) Los Alamos, NM

North latitude (deg/min/sec)	West longitude (deg/min/sec)
36 25 54.12	106 06 07.20
36 32 26.88	105 59 27.60
36 45 23.40	105 48 03.60
36 48 10.44	105 30 21.60
36 13 37.92	105 26 38.40
35 38 40.92	105 48 36.00
35 36 51.48	105 49 30.00
34 06 17.28	107 10 48.00
34 16 18.12	107 17 16.80
35 21 22.68	106 51 07.20

(iv) Ft. Davis, TX

North latitude (deg/min/sec)	West longitude (deg/min/sec)
30 42 16.92	103 55 22.80
30 35 49.92	103 41 52.80
30 32 35.88	103 43 04.80
30 25 20.64	103 49 48.00
30 24 30.24	103 52 30.00
30 26 14.28	103 57 54.00
30 33 03.60	104 09 10.80
30 40 03.36	104 05 9.60

North latitude (deg/min/sec)	West longitude (deg/min/sec)
30 43 11.28	103 58 48.00

(v) N. Liberty, IA

North latitude (deg/min/sec)	West longitude (deg/min/sec)
42 03 27.00	90 54 16.56
41 59 03.12	90 46 49.44
41 34 19.20	90 51 11.16
41 19 27.12	90 58 58.80
41 02 09.96	91 07 18.84
41 07 51.24	92 03 44.64
41 50 03.12	92 36 20.16
42 28 50.16	91 44 35.16

(vi) Brewster, WA

North latitude (deg/min/sec)	West longitude (deg/min/sec)
48 18 00.36	119 35 27.60
48 16 40.08	119 34 51.60
48 15 20.52	119 34 33.60
48 12 26.64	119 34 08.40
48 07 51.96	119 34 33.60
48 06 44.64	119 34 48.00
47 58 44.40	119 36 03.60
47 55 06.60	119 37 40.80
47 52 48.72	119 39 03.60
48 00 49.68	119 59 06.00
48 26 59.64	119 46 04.80
48 26 08.52	119 43 22.80

(vii) Owens Valley, CA

North latitude (deg/min/sec)	West longitude (deg/min/sec)
37 05 49.56	118 02 13.20
37 03 27.36	118 01 08.40
36 29 09.96	118 06 50.40
36 30 48.60	118 11 56.40
36 37 08.04	118 16 37.20
37 25 12.72	118 41 16.80
37 27 30.24	118 41 02.40
37 44 45.96	118 39 03.60
37 59 49.92	118 32 09.60
37 46 12.72	118 20 09.60

(viii) St. Croix, VI

North latitude (deg/min/sec)	West longitude (deg/min/sec)
18 29 15.36	64 22 38.28
18 06 51.12	64 08 03.84

North latitude (deg/min/sec)	West longitude (deg/min/sec)
18 04 31.44	64 06 12.24
18 02 02.76	64 04 33.96
17 59 26.52	64 03 09.36
17 56 43.80	64 01 59.52
17 53 56.04	64 01 04.80
17 51 03.96	64 00 25.56
17 48 09.72	64 00 02.16
17 42 19.08	63 58 57.36
17 39 07.92	63 58 15.96
17 42 10.44	64 39 37.44
17 43 57.00	64 50 46.32
18 07 24.24	66 02 36.96
18 16 13.80	65 44 56.04

(ix) Hancock, NH

North latitude (deg/min/sec)	West longitude (deg/min/sec)
44 08 59.64	71 32 01.68
43 46 24.60	71 18 57.60
42 58 41.88	71 15 14.04
42 29 25.08	71 52 51.96
42 34 05.88	72 07 08.76
42 34 41.52	72 09 41.76
42 55 47.28	72 55 03.72

(x) Mauna Kea, HI

North latitude (deg/min/sec)	West longitude (deg/min/sec)
20 11 01.32	153 03 43.20
20 00 52.92	152 35 56.40
19 46 42.60	152 35 34.80
19 32 33.36	152 36 28.80
19 18 31.68	152 38 38.40
19 04 44.04	152 42 07.20
18 51 16.56	152 46 51.60
18 38 15.72	152 52 44.40
18 25 46.56	152 59 49.20
18 13 55.20	153 07 55.20
18 02 46.68	153 17 06.00
17 52 26.40	153 27 14.40
17 42 57.96	153 38 16.80
17 35 20.04	153 50 45.60
17 27 52.20	154 03 10.80
17 21 27.00	154 16 15.60
17 16 08.40	154 29 49.20
17 11 57.84	154 43 51.60
17 08 57.48	154 58 08.40
17 07 09.12	155 12 43.20
17 23 53.52	155 27 21.60
19 29 13.92	155 36 21.60
19 47 53.88	155 29 27.60
19 48 52.92	155 27 39.60
19 48 58.68	155 27 14.40

(3) Operation within the band 608–614 MHz is prohibited within the following areas:
 (i) The National Radio Quiet Zone as defined in § 1.924(a)(1) of this chapter.
 (ii) The islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra
 (i) *600 MHz service band.* Fixed and personal/portable devices operating in the 600 MHz Service Band must comply with the following co-channel and adjacent channel separation distances outside the defined polygonal area encompassing the base stations or other

radio facilities deployed by a part 27 600 MHz Service Band licensee that has commenced operation.
 (1) Fixed white space devices may only operate above 4 W EIRP in less congested areas as defined in § 15.703(h).
 (2) If a device operates between two defined power levels, it must comply with the separation distances for the higher power level.
 (3) 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.
 (4) On frequencies used by wireless uplink services:

MODE II PERSONAL/PORTABLE WHITE SPACE DEVICES

	600 MHz band wireless uplink spectrum Minimum co-channel separation distances in kilometers between white space devices and any point along the edge of a polygon representing the outer edge of base station or other radio facility deployment	
	16 dBm (40 mW)	20 dBm (100 mW)
Communicating with Mode II or Fixed device	5	6
Communicating with Mode I device	10	12

FIXED WHITE SPACE DEVICES

Antenna height above average terrain of unlicensed devices (meters)	600 MHz band wireless uplink spectrum Minimum co-channel separation distances in kilometers between white space devices and any point along the edge of a polygon representing the outer edge of base station or other radio facility deployment *						
	16 dBm (40mW)	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 W)	40 dBm (10 W)
Less than 3	5	6	7	9	12	15	19
3–10	9	11	14	17	22	27	34
10–30	15	19	24	30	38	47	60
30–50	20	24	31	38	49	60	60
50–75	24	30	37	47	60	60	60
75–100	27	34	43	54	60	60	60
100–150	33	42	53	60	60	60	60
150–200	39	49	60	60	60	60	60
200–250	43	54	60	60	60	60	60

*When communicating with Mode I personal/portable white space devices, the required separation distances must be increased beyond the specified distances by 5 kilometers if the Mode I device operates at power levels no more than 40 mW EIRP or 6 kilometers if the Mode I device operates at power levels above 40 mW EIRP.

PERSONAL/PORTABLE WHITE SPACE DEVICES

	600 MHz band wireless uplink spectrum Minimum adjacent channel separation distances in kilometers between white space devices and any point along the edge of a polygon representing the outer edge of base station or other radio facility deployment
	20 dBm (100 mW)
Communicating with Mode II or Fixed device	0.1
Communicating with Mode I device	0.3

FIXED WHITE SPACE DEVICES

Antenna height above average terrain of unlicensed devices (meters)	600 MHz band wireless uplink spectrum Minimum adjacent channel separation distances in kilometers between white space devices and any point along the edge of a polygon representing the outer edge of base station or other radio facility deployment*					
	20 dBm (100 mW)	24 dBm (250mW)	28 dBm (625 mW)	32 dBm (1600 mW)	36 dBm (4 W)	40 dBm (10 W)
Less than 3	0.1	0.2	0.2	0.3	0.4	0.4
3-10	0.3	0.3	0.4	0.5	0.6	0.8
10-30	0.4	0.6	0.7	0.9	1.1	1.4
30-50	0.6	0.7	0.9	1.2	1.4	1.8
50-75	0.7	0.9	1.1	1.4	1.8	2.2
75-100	0.8	1.0	1.3	1.6	2.0	2.6
100-150	1.0	1.3	1.6	2.0	2.5	3.1
150-200	1.2	1.4	1.8	2.3	2.9	3.6
200-250	1.3	1.6	2.0	2.6	3.2	4.1

*When communicating with Mode I personal/portable white space devices, the required separation distances must be increased beyond the specified distances by 0.1 kilometers.

(5) On frequencies used by wireless downlink services: 35 kilometers for co-channel operation, and 31 kilometers for adjacent channel operation. (j) *Wireless Medical Telemetry Service.* (1) White space devices operating in the 608-614 MHz band (channel 37) are not permitted to operate within an area defined by the polygon described in § 15.713(j)(11) plus the distances specified in the tables below:

MODE II PERSONAL/PORTABLE WHITE SPACE DEVICES

	Required co-channel separation distances in kilometers from WMTS sites	
	16 dBm (40 mW)	20 dBm (100 mW)
Communicating with Mode II or Fixed device	0.38	0.48
Communicating with Mode I device	0.76	0.96

FIXED WHITE SPACE DEVICES

Antenna height above average terrain of unlicensed devices (meters)	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	0.38	0.48	0.60	0.76	0.96	1.20
3-10	0.70	0.88	1.10	1.38	1.74	2.20
10-30	1.20	1.55	1.95	2.45	3.05	3.80
30-50	1.55	2.00	2.50	3.15	3.95	4.95
50-75	1.90	2.45	3.05	3.85	4.85	6.10
75-100	2.20	2.80	3.55	4.45	5.60	7.05
100-150	2.70	3.45	4.35	5.45	6.85	8.65
150-200	3.15	3.95	5.00	6.30	7.90	9.95
200-250	3.50	4.40	5.60	7.00	8.80	11.00

*When communicating with Mode I personal/portable white space devices, the required separation distances must be increased beyond the specified distances by 0.38 kilometers if the Mode I device operates at power levels no more than 40 mW EIRP, or 0.48 kilometers if the Mode I device operates at power levels above 40 mW EIRP.

(2) White space devices operating in the 602-608 MHz band (channel 36) and 614-620 MHz band (channel 38) are not permitted to operate within an area defined by the polygon described in § 15.713(j)(11) plus the distances specified in the tables below:

MODE II PERSONAL/PORTABLE WHITE SPACE DEVICES

	Required adjacent channel separation distances in meters from WMTS sites	
	16 dBm (40 mW)	20 dBm (100 mW)
Communicating with Mode II or Fixed device	8	13
Communicating with Mode I device	16	26

FIXED WHITE SPACE DEVICES

Required adjacent channel separation distances in meters 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)
8	13	20	32	50	71

*When communicating with Mode I personal/portable white space devices, the required separation distances must be increased beyond the specified distances by 8 meters if the Mode I device operates at power levels no more than 40 mW EIRP, or 13 meters if the Mode I device operates at power levels above 40 mW EIRP.

(k) *488–494 MHz band in Hawaii.* White space devices are not permitted to operate in the 488–494 MHz band in Hawaii.

§ 15.713 White space database.

(a) *Purpose.* The white space database serves the following functions:

(1) To determine and provide to a white space device, upon request, the available channels at the white space device's location in the TV bands, the 600 MHz guard bands, the 600 MHz duplex gap, the 600 MHz service band, and channel 37. Available channels are determined based on the interference protection requirements in § 15.712. A database must provide fixed and Mode II personal portable white space devices with channel availability information that includes scheduled changes in channel availability over the course of the 48 hour period beginning at the time the white space devices make a re-check contact. In making lists of available channels available to a white space device, the white space database shall ensure that all communications and interactions between the white space database and the white space device include adequate security measures such that unauthorized parties cannot access or alter the white space database or the list of available channels sent to white space devices or otherwise affect the database system or white space devices in performing their intended functions or in providing adequate interference protections to authorized services operating in the TV bands. In addition, a white space database must also verify that the FCC identifier (FCC ID) of a device seeking access to its services is valid; under this requirement the white space database must also verify that the FCC ID of a Mode I device provided by a fixed or Mode II device is valid. A list of devices with valid FCC IDs and the FCC IDs of those devices is to be obtained from the Commission's Equipment Authorization System.

(2) To determine and provide to an unlicensed wireless microphone user, upon request, the available channels at the microphone user's location in the 600 MHz guard bands, the 600 MHz

duplex gap, and the 600 MHz service band. Available channels are determined based on the interference protection requirements in § 15.236.

(3) To register the identification information and location of fixed white space devices and unlicensed wireless microphone users.

(4) To register protected locations and channels as specified in paragraph (b)(2) of this section, that are not otherwise recorded in Commission licensing databases.

(b) *Information in the white space database.* (1) Facilities already recorded in Commission databases. Identifying and location information will come from the official Commission database. These services include:

- (i) Digital television stations.
- (ii) Class A television stations.
- (iii) Low power television stations.
- (iv) Television translator and booster stations.
- (v) Broadcast Auxiliary Service stations (including receive only sites), except low power auxiliary stations.
- (vi) Private land mobile radio service stations.
- (vii) Commercial mobile radio service stations.
- (viii) Offshore radiotelephone service stations.
- (ix) Class A television station receive sites.
- (x) Low power television station receive sites.
- (xi) Television translator station receive sites.

(2) Facilities that are not recorded in Commission databases. Identifying and location information will be entered into the white space database in accordance with the procedures established by the white space database administrator(s). These include:

- (i) MVPD receive sites.
- (ii) Sites where low power auxiliary stations, including wireless microphones and wireless assist video devices, are used and their schedule for operation.
- (iii) Fixed white space device registrations.

(iv) 600 MHz service band operations in areas where the part 27 600 MHz service licensee has commenced operations.

(v) Locations of health care facilities that use WMTS equipment operating on channel 37 (608–614 MHz).

(c) *Restrictions on registration.* (1) Television translator, low power TV and Class A station receive sites within the protected contour of the station being received are not eligible for registration in the database.

(2) MVPD receive sites within the protected contour or more than 80 kilometers from the nearest edge of the protected contour of a television station being received are not eligible to register that station's channel in the database.

(d) *Determination of available channels.* The white space database will determine the available channels at a location using the interference protection requirements of § 15.712, the location information supplied by a white space device, and the data for protected stations/locations in the database.

(e) *White space device initialization.* (1) Fixed and Mode II white space devices must provide their location and required identifying information to the white space database in accordance with the provisions of this subpart.

(2) Fixed and Mode II white space devices shall not transmit unless they receive, from the white space database, a list of available channels and may only transmit on the available channels on the list provided by the database.

(3) Fixed white space devices register and receive a list of available channels from the database by connecting to the Internet, either directly or through another fixed white space device that has a direct connection to the Internet.

(4) Mode II white space devices receive a list of available channels from the database by connecting to the Internet, either directly or through a fixed or Mode II white space device that has a direct connection to the Internet.

(5) A fixed or Mode II white space device that provides a list of available channels to a Mode I device shall notify the database of the FCC identifier of such Mode I device and receive verification that that FCC identifier is valid before providing the list of available channels to the Mode I device.

(6) A fixed device with an antenna height above ground that exceeds 30 meters or an antenna height above average terrain (HAAT) that exceeds 250 meters shall not be provided a list of available channels. The HAAT is to be calculated using computational software employing the methodology in § 73.684(d) of this chapter.

(f) *Unlicensed wireless microphone database access.* Unlicensed wireless microphone users in the 600 MHz band may register with and access the database manually via a separate Internet connection. Wireless microphone users must register with and check a white space database to determine available channels prior to beginning operation at a given location. A user must re-check the database for available channels if it moves to another location.

(g) *Fixed white space device registration.* (1) Prior to operating for the first time or after changing location, a fixed white space device must register with the white space database by providing the information listed in paragraph (g)(3) of this section.

(2) The party responsible for a fixed white space device must ensure that the white space device registration database has the most current, up-to-date information for that device.

(3) The white space device registration database shall contain the following information for fixed white space devices:

- (i) FCC identifier (FCC ID) of the device;
- (ii) Manufacturer's serial number of the device;
- (iii) Device's geographic coordinates (latitude and longitude (NAD 83));
- (iv) Device's antenna height above ground level (meters);
- (v) Name of the individual or business that owns the device;
- (vi) Name of a contact person responsible for the device's operation;
- (vii) Address for the contact person;
- (viii) Email address for the contact person;
- (ix) Phone number for the contact person.

(h) *Mode II personal/portable device information to database.* A personal/portable device operating in Mode II shall provide the database its FCC Identifier (as required by § 2.926 of this chapter), serial number as assigned by the manufacturer, and the device's geographic coordinates (latitude and longitude (NAD 83)).

(i) *Unlicensed wireless microphone registration.* Unlicensed wireless microphone users in the 600 MHz band shall register with the database prior to

operation and include the following information:

- (1) Name of the individual or business that owns the unlicensed wireless microphone
- (2) Address for the contact person
- (3) Email address for the contact person
- (4) Phone number for the contact person; and
- (5) Coordinates where the device will be used (latitude and longitude in NAD 83).

(j) *White space database information.* The white space database shall contain the listed information for each of the following:

- (1) Digital television stations, digital and analog Class A, low power, translator and booster stations, including stations in Canada and Mexico that are within the border coordination areas as specified in § 73.1650 of this chapter (a white space database is to include only TV station information from station license or license application records. In cases where a station has records for both a license application and a license, a white space database should include the information from the license application rather than the license. In cases where there are multiple license application records or license records for the same station, the database is to include the most recent records, and again with license applications taking precedence over licenses.):

- (i) Transmitter coordinates (latitude and longitude in NAD 83);
- (ii) Effective radiated power (ERP);
- (iii) Height above average terrain of the transmitting antenna (HAAT);
- (iv) Horizontal transmit antenna pattern (if the antenna is directional);
- (v) Amount of electrical and mechanical beam tilt (degrees depression below horizontal) and orientation of mechanical beam tilt (degrees azimuth clockwise from true north);
- (vi) Channel number; and
- (vii) Station call sign.
- (2) Broadcast Auxiliary Service.
 - (i) Transmitter coordinates (latitude and longitude in NAD 83).
 - (ii) Receiver coordinates (latitude and longitude in NAD 83).
 - (iii) Channel number.
 - (iv) Call sign.
- (3) Metropolitan areas listed in § 90.303(a) of this chapter.
 - (i) Region name.
 - (ii) Channel(s) reserved for use in the region.
 - (iii) Geographic center of the region (latitude and longitude in NAD 83).
 - (iv) Call sign.
- (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.

(5) Offshore Radiotelephone Service: For each of the four regions where the Offshore Radiotelephone Service operates.

(i) Geographic boundaries of the region (latitude and longitude in NAD 83 for each point defining the boundary of the region).

(ii) Channel(s) used by the service in that region.

(6) MVPD receive sites: Registration for receive sites is limited to channels that are received over-the-air and are used as part of the MVPD service.

(i) Name and address of MVPD company;

(ii) Location of the MVPD receive site (latitude and longitude in NAD 83, accurate to ± 50 m);

(iii) Channel number of each television channel received, subject to the following condition: channels for which the MVPD receive site is located within the protected contour of that channel's transmitting station are not eligible for registration in the database;

(iv) Call sign of each television channel received and eligible for registration;

(v) Location (latitude and longitude) of the transmitter of each television channel received;

(7) Television translator, low power TV and Class A TV station receive sites: Registration for television translator, low power TV and Class A receive sites is limited to channels that are received over-the-air and are used as part of the station's service.

(i) Call sign of the TV translator station;

(ii) Location of the TV translator receive site (latitude and longitude in NAD 83, accurate to ± 50 m);

(iii) Channel number of the retransmitted television station, subject to the following condition: a channel for which the television translator receive site is located within the protected contour of that channel's transmitting station is not eligible for registration in the database;

(iv) Call sign of the retransmitted television station; and

(v) Location (latitude and longitude) of the transmitter of the retransmitted television station.

(8) Licensed low power auxiliary stations, including wireless microphones and wireless assist video

devices: Use of licensed low power auxiliary stations at well-defined times and locations may be registered in the database. Multiple registrations that specify more than one point in the facility may be entered for very large sites. Registrations will be valid for no more than one year, after which they may be renewed. Registrations must include the following information:

- (i) Name of the individual or business responsible for the low power auxiliary device(s);
- (ii) An address for the contact person;
- (iii) An email address for the contact person (optional);
- (iv) A phone number for the contact person;
- (v) Coordinates where the device(s) are used (latitude and longitude in NAD 83, accurate to ± 50 m);
- (vi) Channels used by the low power auxiliary devices operated at the site;
- (vii) Specific months, weeks, days of the week and times when the device(s) are used (on dates when microphones are not used the site will not be protected); and
- (viii) The stations call sign.

(9) Unlicensed wireless microphones at venues of events and productions/shows that use large numbers of wireless microphones that cannot be accommodated in the two reserved channels and other channels that are not available for use by white space devices at that location. Prior to June 23, 2017, but no later than release of the Channel Reassignment Public Notice upon completion of the broadcast television spectrum incentive auction, as defined in § 73.3700(a) of this chapter, sites of large events and productions/shows with significant unlicensed wireless microphone use at well-defined times and locations may be registered in the database. Entities responsible for eligible event venues registering their site with a TV bands data base are required to first make use of the two reserved channels and other channels that are not available for use by white space devices at that location. As a benchmark, at least 6–8 wireless microphones should be operating in each channel used at such venues (both licensed and unlicensed wireless microphones used at the event may be counted to comply with this benchmark). Multiple registrations that specify more than one point in the facility may be entered for very large sites. Sites of eligible event venues using unlicensed wireless microphones must be registered with the Commission at least 30 days in advance and the Commission will provide this information to the data base managers. Parties responsible for eligible event

venues 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, including channels 7–51 (except channel 37). The Commission will make requests for registration of sites that use unlicensed wireless microphones public and will provide an opportunity for public comment or objections. Registrations will be valid for one year, after which they may be renewed. The Commission will take actions against parties that file inaccurate or incomplete information, such as denial of registration in the database, removal of information from the database pursuant to paragraph (i) of this section, or other sanctions as appropriate to ensure compliance with the rules. Registrations must include the following information:

- (i) Name of the individual or business that owns the unlicensed wireless microphones;
- (ii) An address for the contact person;
- (iii) An email address for the contact person (optional);
- (iv) A phone number for the contact person;
- (v) Coordinates where the device(s) are used (latitude and longitude in NAD 83, accurate to ± 50 m);
- (vi) Channels used by the wireless microphones operated at the site and the number of wireless microphones used in each channel. As a benchmark, least 6–8 wireless microphones must be used in each channel. Registration requests that do not meet this criteria will not be registered in the TV bands data bases;
- (vii) Specific months, weeks, days of the week and times when the device(s) are used (on dates when microphones are not used the site will not be protected); and
- (viii) The name of the venue.

(10) 600 MHz service in areas where the part 27 600 MHz band licensee has commenced operations:

- (i) Name of 600 MHz band licensee;
- (ii) Name and address of the contact person;
- (iii) An email address for the contact person (optional);
- (iv) A phone number for the contact person;
- (v) Area within a part 27 600 MHz band licensee's Partial Economic Areas (PEA), as defined in § 27.6 of this chapter, where it has commenced operation. This area must be delineated by at minimum of eight and a maximum of 120 geographic coordinates (latitude and longitude in NAD 83, accurate to ± 50 m);
- (vi) Date of commencement of operations;

(vii) Identification of the frequencies on which the part 27 600 MHz band licensee has commenced operations;

- (viii) Call sign.
- (11) Location of health care facilities operating WMTS networks on channel 37 (608–614 MHz):
 - (i) Name and address of the health care facility;
 - (ii) Name and address of a contact person;
 - (iii) Phone number of a contact person;
 - (iv) Email address of a contact person;
 - (v) Latitude and longitude coordinates referenced to North American Datum 1983 (NAD 83) that define the perimeter of each facility. If several health care facilities using 608–614 MHz wireless medical telemetry equipment are located in close proximity, it is permissible to register a perimeter to protect all facilities in that cluster.
 - (k) *Commission requests for data.* (1) A white space database administrator must provide to the Commission, upon request, any information contained in the database.
 - (2) A white space database administrator must remove information from the database, upon direction, in writing, by the Commission.
 - (l) *Security.* The white space database shall employ protocols and procedures to ensure that all communications and interactions between the white space database and white space devices are accurate and secure and that unauthorized parties cannot access or alter the database or the list of available channels sent to a white space device.
 - (1) Communications between white space devices and white space databases, and between different white space databases, shall be secure to prevent corruption or unauthorized interception of data. A white space database shall be protected from unauthorized data input or alteration of stored data.
 - (2) A white space database shall verify that the FCC identification number supplied by a fixed or personal/portable white space device is for a certified device and may not provide service to an uncertified device.
 - (3) A white space database must not provide lists of available channels to uncertified white space devices for purposes of operation (it is acceptable for a white space database to distribute lists of available channels by means other than contact with white space devices to provide list of channels for operation). To implement this provision, a white space database administrator shall obtain a list of certified white space devices from the FCC Equipment Authorization System.

§ 15.714 White space database administration fees.

(a) A white space 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, 600 MHz service band, and the 600 MHz guard bands and duplex gap.

(b) A white space database administrator may charge a fee for provision of lists of available channels to wireless microphone users.

(c) The Commission, upon request, will review the fees and can require changes in those fees if they are found to be excessive.

§ 15.715 White space database administrator.

The Commission will designate one or more entities to administer the white space database(s). The Commission may, at its discretion, permit the functions of a white space database, such as a data repository, registration, and query services, to be divided among multiple entities; however, it will designate specific entities to be a database administrator responsible for coordination of the overall functioning of a database and providing services to white space devices. Each database administrator designated by the Commission shall:

(a) Maintain a database that contains the information described in § 15.713.

(b) Establish a process for acquiring and storing in the database necessary and appropriate information from the Commission's databases and synchronizing the database with the current Commission databases at least once a week to include newly licensed facilities or any changes to licensed facilities.

(c) Establish a process for registering fixed white space devices and registering and including in the database facilities entitled to protection but not contained in a Commission database, including MVPD receive sites.

(d) Establish a process for registering facilities where part 74 low power auxiliary stations are used on a regular basis.

(e) Provide accurate lists of available channels and the corresponding maximum permitted power for each available channel to fixed and personal/portable white space devices that submit to it the information required under § 15.713(e), (g), and (h) based on their geographic location and provide accurate lists of available channels and the corresponding maximum permitted power for each available channel to

fixed and Mode II devices requesting lists of available channels for Mode I devices. Database administrators may allow prospective operators of white space devices to query the database and determine whether there are vacant channels at a particular location.

(f) Establish protocols and procedures to ensure that all communications and interactions between the white space database and white space devices are accurate and secure and that unauthorized parties cannot access or alter the database or the list of available channels sent to a white space device consistent with the provisions of § 15.713(l).

(g) Make its services available to all unlicensed white space device users on a non-discriminatory basis.

(h) Provide service for a five-year term. This term can be renewed at the Commission's discretion.

(i) Respond in a timely manner to verify, correct and/or remove, as appropriate, data in the event that the Commission or a party brings claim of inaccuracies in the database to its attention. This requirement applies only to information that the Commission requires to be stored in the database.

(j) Transfer its database along with the IP addresses and URLs used to access the database and list of registered fixed white space devices, to another designated entity in the event it does not continue as the database administrator at the end of its term. It may charge a reasonable price for such conveyance.

(k) The database must have functionality such that upon request from the Commission it can indicate that no channels are available when queried by a specific white space device or model of white space devices.

(l) If more than one database is developed, the database administrators shall cooperate to develop a standardized process for providing on a daily basis or more often, as appropriate, the data collected for the facilities listed in § 15.713(b)(2) to all other white space databases to ensure consistency in the records of protected facilities.

(m) Provide a means to make publicly available all information the rules require the database to contain, including fixed white space device registrations and voluntarily submitted protected entity information, except the information provided by 600 MHz band licensees pursuant to § 15.713(j)(10)(v) and (vi) of this part shall not be made publicly available.

(n) Establish procedures to allow part 27 600 MHz service licensees to upload the registration information listed in

§ 15.713(j)(10) for areas where they have commenced operations and to allow the removal and replacement of registration information in the database when corrections or updates are necessary.

(o) Remove from the database the registrations of fixed white space devices that have not checked the database for at least three months to update their channel lists. A database administrator may charge a new registration fee for a fixed white space device that is removed from the database under this provision but is later re-registered.

(p) Establish procedures to allow health care facilities to register the locations of facilities where they operate WMTS networks on channel 37.

(q) Establish procedures to allow unlicensed wireless microphone users in the 600 MHz band to register with the database and to provide lists of channels available for wireless microphones at a given location.

§ 15.717 White space devices that rely on spectrum sensing.

(a) *Applications for certification.* Parties may submit applications for certification of white space devices that rely solely on spectrum sensing to identify available channels. Devices authorized under this section must demonstrate with an extremely high degree of confidence that they will not cause harmful interference to incumbent radio services.

(1) In addition to the procedures in subpart J of part 2 of this chapter, applicants shall comply with the following.

(i) The application must include a full explanation of how the device will protect incumbent authorized services against interference.

(ii) Applicants must submit a pre-production device, identical to the device expected to be marketed.

(2) The Commission will follow the procedures below for processing applications pursuant to this section.

(i) Applications will be placed on public notice for a minimum of 30 days for comments and 15 days for reply comments. Applicants may request that portions of their application remain confidential in accordance with § 0.459 of this chapter. This public notice will include proposed test procedures and methodologies.

(ii) The Commission will conduct laboratory and field tests of the pre-production device. This testing will be conducted to evaluate proof of performance of the device, including characterization of its sensing capability and its interference potential. The testing will be open to the public.

(iii) Subsequent to the completion of testing, the Commission will issue by public notice, a test report including recommendations. The public notice will specify a minimum of 30 days for comments and, if any objections are received, an additional 15 days for reply comments.

(b) *Power limit for devices that rely on sensing.* The white space device shall meet the requirements for personal/portable devices in this subpart except that it will be limited to a maximum EIRP of 50 mW per 6 megahertz of bandwidth on which the device operates and it does not have to comply with the requirements for geo-location and database access in § 15.711(b), (d), and (e). Compliance with the detection threshold for spectrum sensing in § 15.717(c), although required, is not necessarily sufficient for demonstrating reliable interference avoidance. Once a device is certified, additional devices that are identical in electrical characteristics and antenna systems may be certified under the procedures of part 2, Subpart J of this chapter.

(c) *Sensing requirements—(1) Detection threshold.* (i) The required detection thresholds are:

(A) ATSC digital TV signals: - 114 dBm, averaged over a 6 MHz bandwidth;

(B) NTSC analog TV signals: - 114 dBm, averaged over a 100 kHz bandwidth;

(C) Low power auxiliary, including wireless microphone, signals: - 107 dBm, averaged over a 200 kHz bandwidth.

(ii) The detection thresholds are referenced to an omnidirectional receive antenna with a gain of 0 dBi. If a receive antenna with a minimum directional gain of less than 0 dBi is used, the detection threshold shall be reduced by the amount in dB that the minimum directional gain of the antenna is less than 0 dBi. Minimum directional gain shall be defined as the antenna gain in the direction and at the frequency that exhibits the least gain. Alternative approaches for the sensing antenna are permitted, e.g., electronically rotatable antennas, provided the applicant for equipment authorization can demonstrate that its sensing antenna provides at least the same performance as an omnidirectional antenna with 0 dBi gain.

(2) *Channel availability check time.* A white space device may start operating on a TV channel if no TV, wireless microphone or other low power auxiliary device signals above the detection threshold are detected within a minimum time interval of 30 seconds.

(3) *In-service monitoring.* A white space device must perform in-service monitoring of an operating channel at least once every 60 seconds. There is no minimum channel availability check time for in-service monitoring.

(4) *Channel move time.* After a TV, wireless microphone or other low power auxiliary device signal is detected on a white space device operating channel, all transmissions by the white space device must cease within two seconds.

PART 27—MISCELLANEOUS WIRELESS COMMUNICATIONS SERVICES

■ 9. The authority citation for part 27 continues to read as follows:

Authority: 47 U.S.C. 154, 301, 302a, 303, 307, 309, 332, 336, 337, 1403, 1404, 1451, and 1452, unless otherwise noted.

■ 10. Add § 27.1320 to read as follows:

§ 27.1320 Notification to white space database administrators.

To receive interference protection, 600 MHz licensees shall notify one of the white space database administrators of the areas where they have commenced operation pursuant to §§ 15.713(j)(10) and 15.715(n) of this chapter.

PART 74—EXPERIMENTAL RADIO, AUXILIARY, SPECIAL BROADCAST AND OTHER PROGRAM DISTRIBUTIONAL SERVICES

■ 11. The authority citation for part 74 continues to read as follows:

Authority: 47 U.S.C. 154, 302a, 303, 307, 309, 336 and 554.

■ 12. Section 74.802 is amended by adding paragraph (a)(2) and by revising paragraphs (c) introductory text and (f) to read as follows:

§ 74.802 Frequency assignment.

(a)(1) * * *

(2) The four megahertz segment from one to five megahertz above the lower edge of the 600 MHz duplex gap may be assigned for use by low power auxiliary stations.

Note to paragraph (a)(2): The specific frequencies for the 600 MHz duplex gap will be determined in light of further proceedings pursuant to GN Docket No. 12-268 and the rule will be updated accordingly pursuant to a future public notice.

* * * * *

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

* * * * *

Note to paragraph (c): The specific frequencies for the 600 MHz duplex gap will be determined in light of further proceedings pursuant to GN Docket No. 12-268 and the rule will be updated accordingly pursuant to a future public notice.

* * * * *

(f) *Operations in 600 MHz band assigned to wireless licensees under part 27 of this chapter.* A low power auxiliary station that operates on frequencies in the 600 MHz band assigned to wireless licensees under part 27 of this chapter must cease operations on those frequencies no later than the end of the post-auction transition period as defined in § 27.4 of this chapter. During the post-auction transition period, low power auxiliary stations will operate on a secondary basis to licensees of part 27 of this chapter, i.e., they must not cause to and must accept harmful interference from these licensees, and must comply with the distance separations in § 15.236(e)(2) of this chapter outside the areas where a licensee has commenced operations as specified pursuant to § 15.713(j)(10).

■ 13. Section 74.861 is amended by revising paragraphs (a), (e) introductory text, (e)(1) introductory text, and (e)(1)(iii) to read as follows:

§ 74.861 Technical requirements.

(a) Except as specified in paragraph (e) of this section, transmitter power is the power at the transmitter output terminals and delivered to the antenna, antenna transmission line, or any other impedance-matched, radio frequency load. For the purpose of this subpart, the transmitter power is the carrier power.

* * * * *

(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) The power may not exceed the following values.

* * * * *

(iii) 600 MHz duplex gap: 20 mW EIRP

* * * * *

PART 95—PERSONAL RADIO SERVICES

■ 14. The authority citation for part 95 continues to read as follows:

Authority: 47 U.S.C. 154, 301, 302(a), 303, and 307(e).

■ 15. Section 95.1111 is amended by adding paragraph (d) to read as follows:

§ 95.1111 Frequency coordination.

* * * * *

(d) To receive interference protection, parties operating WMTS networks on

channel 37 shall notify one of the white space database administrators of their operating location pursuant to

§§ 15.713(j)(11) and 15.715(p) of this chapter.

[FR Doc. 2015-29496 Filed 11-20-15; 8:45 am]

BILLING CODE 6712-01-P