facility operation parameters (frequency, location, etc.), and any special conditions that apply. For each of these waiver licenses the following information will be placed into a TV bands database:

(1) transmitter location (latitude and longitude) or geographic area of operations
(2) effective radiated power
(3) transmitter height above average terrain (if specified)
(4) antenna height above ground level (if specified)
(5) call sign

In cases where the operator of a PLMRS/CMRS system licensed under a waiver operates multiple transmitters (not including systems that are licensed to operate in a coverage area), information on each transmitter will be required to be maintained in a TV bands database.

217. The Offshore Radiotelephone Service uses channels 15-18 along the coast of the Gulf of Mexico.[285] The Commission's rules designate four regions to protect this service.[286] For each of the four regions a TV bands database will contain the following information:

(1) geographic boundaries of the region (latitude and longitude for each point defining the boundary of the region
(2) channel(s) used by the service in that region

218. As noted above, cable television systems often use antennas at their headends to receive broadcast television signals and then retransmit those signals to subscriber households throughout the cable system. In many cases, cable systems are able to receive broadcast TV signals at locations outside a stations' protected service contour by using high gain antennas mounted on top of buildings or tall towers. Records identifying cable systems that receive TV stations outside of their service areas are not currently maintained in the Commission's databases. As indicated above, we are extending protection to the reception of TV signals by such cable headends. We are therefore allowing cable operators to register, with a TV bands database, their headends that receive TV signals outside of a station's protected contour and requiring that a TV bands database afford protection to those facilities in accordance with the provisions indicated above. A TV bands database will collect the following information to register a cable headend:

(1) name and address of cable company
(2) location of the headend receiver (latitude and longitude)
(3) channel number of each television channel received, subject to the following condition: channels for which the cable headend is located within the protected contour of that channel's transmitting station are not eligible for registration in the database
(4) call sign of each television channel received and eligible for registration.
(5) location (latitude and longitude) of the transmitter of each television channel received

219. Television translator and low power stations, including Class A TV stations, rebroadcast the signal of a full service station or another low power station. Like many cable headends, TV translators/low power stations often receive the signal of the station they retransmit outside the

[285] *See* 47 C.F.R. § 22.1007.

[286] *See* 47 C.F.R. § 74.709(e). This rule defines four regions in which low-power television stations cannot operate. TV band devices will be excluded from these same four areas to protect the Offshore Radiotelephone Service.

retransmitted station's protected contour.[287] The TV translators and low power stations that currently receive the signal they retransmit off-the-air at locations beyond the originating station's protected service contour are not currently recorded in the Commission's databases. To protect the reception of signals at the receive sites of these stations, we will allow the licensees of such translators and low power stations to register their receive sites with a TV bands database and require the database to afford those sites protection in the same manner as similarly situated cable headends. A TV bands database will collect the following information to register a translator/low power receive site:

(1) call sign of the TV translator or low power TV station
(2) location of the TV translator or low power station receive site (latitude and longitude)
(3) 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
(4) call sign of the retransmitted television station
(5) location (latitude and longitude) of the transmitter of the retransmitted television station

220. As discussed above, low power auxiliary stations such as wireless microphones and wireless assist video devices operate in the television bands on a secondary basis under Part 74 of the Commission's rules.[288] These devices are usually licensed to operate over a broad geographic area and a wide range of television channels. The use of these devices is sometimes sporadic and nomadic and registration of the locations of such operations' locations in a TV bands database would not be practical. However, in many cases wireless microphones and wireless assist video devices are used regularly and predictably, such as at major sporting events facilities, movie studio lots, and television studios. For these situations, the low power auxiliary device users will be allowed to register in a TV bands database, the location where the devices are used to aid in avoiding interference from TV band devices. In the case of large event facilities such as race tracks and golf courses, we will allow multiple registrations with different geographic coordinates to enable protection of the entire site. We will require that requests for registration of low power auxiliary devices that operate on a seasonal basis, only on certain days within a week or only at specific times include such information; TVBDs will be restricted from operation in the channels used at registered sites only on days and at times when low power auxiliary devices at the sites are in operation. Low power auxiliary registrations will be valid for no longer than a year, after which they may be renewed. The database will collect the following information on registered sites that use low power auxiliary devices :

(1) name of the individual or business that owns the low power auxiliary device(s)
(2) the name of a contact person
(3) an address for the contact person
(4) an email address for the contact person (optional)
(5) a phone number for the contact person (optional)
(6) coordinates where the device(s) are used (latitude and longitude)

[287] Many TV translators receive the signal they retransmit without needing to receive the retransmitted station's signal over-the-air. For example, they may obtain the signal of the station they retransmit through use a fixed point-to-point microwave link or wireline connection. Other translators may receive the signal they retransmit via a receiver located within the retransmitted stations protected contour. In those cases, the translator receive sites need not be listed in a TV bands database.

[288] 47 C.F.R. § 74.801-82.

(7) channels used by the low power auxiliary devices operated at the site
(8) specific months, days and times when the device(s) are used.

221. *Database Administration.* The Commission does not maintain a database of all TV and other stations and operations in the TV bands that could be accessed regularly in real-time by a large number of TVBDs dispersed throughout the country. We will designate one or more database administrators from the private sector to create and operate a TV bands database or databases. We recognize the interests of Google and other TVBD proponents in ensuring that database services be made available on a fair and low cost (or no cost) basis and believe that providing for authorization of more than one party to operate a TV bands database will serve that purpose. The Commission will issue a Public Notice requesting proposals from entities desiring to administer a TV bands database. Any entity that ultimately administrators such a database must make its services available to all TV band device users on a non-discriminatory basis. In addition, to ensure stability for these new devices, we will require each database administrator to provide services for a five-year term, which, at the Commission's discretion, may be renewed. In the event that there is only a single a database administrator and that entity does not wish to continue at the end of its term, it will be required to transfer its database along with the IP address(es) and URL(s) used to access the database to another designated entity and would be allowed to charge a reasonable price for conveyance of that resource.

222. If the Commission chooses multiple entities to administer TV bands databases, we must ensure that each database contains consistent information so that regardless of which database a TVBD queries, it receives the same list of available channels in an area. Because a TVBD will only be required to contact a single TV bands database, there is a need for the TV bands databases to share accurate and timely registration information so that each database has a timely view of the radio environment and can make the best channel recommendations possible. Therefore, we will require that each TV bands database, at a minimum on a daily basis, provide to each other TV bands database, all registration information it receives during the previous day. This data sharing requirement extends only to registrations of fixed devices and protected facilities that are not otherwise captured in Commission databases, including wireless microphone and wireless assist video device locations, cable headends, and TV translator/low power receive sites. The databases can obtain information on other services, such as full service TV, land mobile licenses, etc. directly from Commission databases. We believe that this sharing requirement is extremely important to the success of TVBDs as it decreases the burden on any one database and also foster cooperation between the various database administrators. Although we are requiring the TV bands databases to share information daily, we will leave the actual implementation details up to the database administrators. Once the specific entities are selected, they will need to agree on a specific protocol and data format requirement so that manufacturers can build standard devices that can work with any of the databases and each database can easily transmit and receive data from each other database. In addition, the database administrators may agree whether to share on a more frequent timeframe than daily.

223. A TV bands database will obtain much of the information on licensed use of the television bands for populating the database from the existing Commission databases. The TV bands database will be required to synchronize itself with the existing Commission databases at least once a week so that the information in the TV bands database remains current. Entities operating facilities that are entitled to protection but that are not licensed by the Commission, *e.g.*, cable headends and TV translator/low power TV station receivers, will register their facilities through a process established by the database administrators. We will allow the TV bands databases to charge fees necessary to support the creation and operation of the database. These fees may be imposed on the operators of the TV band devices in order to access the database and/or on the manufacturers of TV band devices, but not on users of the television bands who are not currently in the Commission's database and desire to be included in the database. We do not believe it is appropriate to charge operators of licensed service for protection of their operations from

unlicensed devices. We believe that competition among databases will serve to keep fees low and reasonable. However, if parties believe that the fees charged by a TV bands database are excessive, they may petition the Commission for relief.

224. We recognize that there is potential for inaccurate information to be entered into the database, for omissions to occur, and for records to be present for licensed facilities that are no longer operating. Such inaccuracies could be introduced in several ways. For example, any errors that might inadvertently be present in a Commission database could be transferred to a TV bands database.[289] In addition, the fact that we are permitting information on certain services in the TV bands to be voluntarily provided introduces another potential for error. Parties submitting such information could inadvertently provide inaccurate coordinates, channel or other information, and there is also the potential that a party could knowingly provide false information on channel use at a location. The database administrators will be expected to respond quickly to verify and/or correct data in the event that a party brings claims of inaccuracies in the database to its attention, including advising the Commission of any errors that may appear in the Commission's records. Further, the Commission reserves the right to request the removal of voluntarily submitted information from a TV bands database in the event that such information is determined to be inaccurate or not in compliance with the rules.

F. Technical Requirements

225. In this section, we describe the technical requirements that are applicable to unlicensed TV band devices, *i.e.*, both fixed and personal/portable. There are two general categories of requirements. The first consists of transmission system characteristics that are similar to those required for most types of transmitters, including the transmitter power, antenna characteristics and out-of-band emission limits. The second category consists of specific standards and requirements for the procedures to be used to enable unlicensed TV band devices to use the TV white space without causing interference to TV and other authorized services.

1. Transmit Antenna Height Limits

226. As the transmit antenna height of a fixed unlicensed TV band device is increased, both the device's signal coverage and the distance at which it could cause interference to other RF operations in the TV bands services also increase. In the *First R&O/Further Notice,* the Commission sought comment on whether any requirements are necessary with respect to transmitter height, such as a limit on maximum antenna height or a requirement for reduced power when a higher antenna is used.[290] We did not receive any comments specifically addressing this issue with respect to fixed devices. However, the White Space Coalition submits that height restrictions should not be imposed on personal/portable devices, arguing that such restrictions would be impossible to administer and are unnecessary given the low power of the devices.[291]

227. Our analysis indicates that the height of a TV band device's transmit antenna can significantly affect the distance at which interference could occur to licensed services in the TV bands. For example, as indicated above, a transmit antenna at 10 meters with 4 watts EIRP could cause interference to a TV receiver with a 9 meter antenna at a distance of 9 kilometers, while that same transmit antenna at 30 meters could cause interference to that TV receiver at a distance of 18 kilometers

[289] While we make every effort to ensure that our databases are complete and accurate, sometimes errors do occur; we correct any such errors as we become of aware of them and will continue to do so.

[290] *See Further Notice* at ¶ 44.

[291] *See* White Space Coalition *Further Notice* comments at 16.

and at 100 meters could cause interference at 30.5 kilometers. We therefore conclude that in order to further limit the potential interference range of fixed unlicensed TVBDs it is necessary to limit the height of antennas used with those relatively higher powered devices. We are not imposing height restrictions on the lower powered personal/portable devices.

228. In considering this issue, we observe that the distance that fixed unlicensed TVBDs must be separated from protected service areas is directly related to the maximum allowed antenna height, that is, the minimum required separation distance must increase as the maximum allowed antenna height increases. We believe that an antenna height limit of 30 meters will appropriately balance the needs of unlicensed fixed TVBDs for range to reach receivers while minimizing the range at which those operations could impact licensed services.

229. We agree with the White Space Coalition that it is not practical to administer an antenna height limit for personal/portable devices. However, those devices will not be used in the same manner as fixed devices with gain antennas mounted outdoors that maximize the propagation range of their signals. Rather, personal/portable devices will be used indoors, so that their signals will be attenuated by exterior walls, and will have a maximum of 0 dBi net antenna gain. These factors will significantly reduce the range at which signals from a personal/portable device will be of sufficient field strength to cause interference. We believe that these considerations, coupled with the fact that operation of a personal/portable device on an upper floor of a building would increase the likelihood of sensing the signals of any licensed services in the area, will adequately ensure that unlicensed personal/portable TV band devices do not cause interference when used above ground level.

2. Transmit Power Control

230. In the *First R&O/Further Notice*, the Commission proposed to require unlicensed TV band devices to incorporate transmit power control (TPC) that would automatically limit emissions to a level 6 dB below the maximum permitted transmit power if that level is sufficient to accomplish the desired communications.[292] It also proposed not to apply the TPC requirement to devices whose maximum transmit power capability is at least 3 dB below the maximum permissible transmit power. The Commission sought comment on whether it should require a greater range for transmit power control, such as the ability to operate 9 or 12 dB below the limits if that is sufficient to achieve the desired communications. The Commission has previously applied the proposed TPC provisions to Unlicensed-National Information Infrastructure (U-NII) devices that operate in spectrum at 5 GHz.[293] The Commission also sought comment on whether it should require all devices to use transmit power control and to operate with the minimum power necessary to achieve reliable communication,.

231. The Consumer Electronics Association agrees with the proposed requirements for transmit power control and believes that it is not necessary for the Commission to require a greater dynamic range because manufacturers will likely go beyond 6 dB as a matter of good design practice.[294] Other parties also support requiring TPC in TV band devices to reduce the potential for interference to services in the TV bands, but believe that the Commission should require a dynamic range greater than 6 dB. Shure supports requiring TV band devices to incorporate TPC and to operate at the minimum power needed to conduct desired communication, rather than at the proposed 6 dB reduction, to reduce interference to incumbent users and also improve co-existence among unlicensed devices.[295] The White

[292] *See Further Notice* at ¶ 45.

[293] *See* 47 C.F.R. § 15.407(h)(1).

[294] *See* Consumer Electronics Association *Further Notice* comments at 3.

[295] *See* Shure *Further Notice* comments at 16.

Space Coalition recommends a TPC range of 25 dB, with devices using the minimum power necessary for reliable communications, while IEEE 802.18 recommends a 30 dB range with one dB steps between power levels.[296] The White Space Coalition states that transmit power control can reduce the output power of a TV band device to as low as one-third of a milliwatt as appropriate.[297]

232. *Discussion.* The use of transmit power control to avoid using more power than necessary for a given communication is a sound spectrum management practice that promotes efficient use of this resource. This technique enables communications while minimizing the potential for interference and is now a practicable feature for transceivers. We will therefore require all fixed and personal/portable TV band devices to incorporate transmit power control to limit their operating power to the minimum necessary for successful communication. We are not, however, adopting our proposal to apply the U-NII transmit power control requirements to unlicensed TVBDs or to specify alternative operating parameters for transmit power control as recommended by some parties. After examining the record and the range of power control options recommended by manufacturers, we now conclude that it would be more appropriate to simply require that TVBDs limit their operating power to the minimum necessary for successful communications and let manufacturers determine the range of power control that is appropriate for their individual products. We acknowledge the Consumer Electronics Association statement that manufacturers will likely incorporate transmit power control as a matter of good design practice and note that the developing IEEE 802.22 standard has provisions for transmit power control with a wide dynamic range. We also note that the White Space Coalition states that it intends to incorporate transmit power control into its devices. While we are not specifying the technical parameters for transmit power control, we will require applicants for certification to describe a device's transmit power control feature mechanism in the application.

3. Out-Of-Band Emissions Limits

233. In the *First R&O/Further Notice*, the Commission proposed to require that emissions from an unlicensed device outside that device's channel of operation comply with the limits in Section 15.209 of the rules.[298] These are the same out-of-band limits that apply to most intentional radiators operating under Part 15 of the rules, and at frequencies above 30 MHz are also the same as the limits that apply to most unintentional radiators, including computers and radio and TV receivers. However, the Commission recognized the concerns of some parties that these emission levels may be too high for devices that operate in the TV bands and sought comment on whether other emission limits would be more appropriate.

234. The White Space Coalition initially argued that the current Section 15.209 out-of-band emission limits are adequate to protect against interference, except on adjacent channels.[299] However, in a subsequent filing, the White Space Coalition recommended that we adopt an out-of-band emissions mask that requires emissions from a device to be 55 dB below the highest average power in the band, as measured in 500 kHz segments, at the edges of the 6 MHz channel in which the device is operating. Tropos Networks believes that the Section 15.247 out-of-band emission limits for spread spectrum and

[296] *See* White Space Coalition *Further Notice* reply comments at 6 and IEEE 802.18 *Notice* comments at 17.

[297] *See* White Space Coalition *Further Notice* reply comments at 4.

[298] *See Further Notice* at ¶ 59 and 47 C.F.R. § 15.209.

[299] *See* White Space Coalition *Further Notice* comments at 29. The White Space Coalition also suggested that adjacent channel interference protection can be accomplished using a combination of spectrum sensing and transmit power control to meet the adjacent channel D/U ratios. *See* White Space Coalition *Further Notice* comments at 15.

digitally modulated devices should apply to TV band devices, except in restricted bands.[300] However, other parties, including IEEE 802.18, Shure and NAB/MSTV claim that these limits, which resolve to the 15.209 limits at low signal levels, are too high and should be substantially reduced for devices operating in the TV bands.[301] NAB/MSTV argue that the Section 15.209 limits were not problematic previously because unlicensed devices were prohibited from operating in the TV band, so that emissions in the TV band were far separated in frequency from the channels to which TV receivers tune and therefore well below the Section 15.209 limits. They further submit that until recently most unlicensed devices operated with narrow bandwidths, so out-of-band emissions were generally narrowband spikes that presented low interference risks. MSTV/NAB state that broadband unlicensed TVBDs will have wide out-of-band emissions that may be right at the limit. They observe that the Section 15.209 limits are 5 dB higher than the 41 dBμV/m field strength of a UHF DTV station at the edge of its protected contour, and in fact need to be 23 dB lower than that level to avoid causing interference.[302] GE Healthcare believes that the Section 15.209 limits are not strict enough to protect the WMTS on channel 37 and requests that we adopt a more stringent mask for protection of WMTS devices on that channel.[303] In an *ex parte* letter of May 8, 2008, Dell, Inc. and Google support GE Healthcare's proposal for an emissions mask in channels 36 and 38 to protect WMTS devices. CTIA asks the Commission to ensure that operation of unlicensed TV band devices do not cause interference to 700 MHz band commercial wireless operations.[304]

235. We find that the emissions mask suggested by the Coalition will adequately protect against interference from out-of-band emissions from signals at the maximum 40 mW (16 dBm) power level that adjacent channels will be allowed to use. At the 10 meter distance we are using for the range at which a user can be expected to exercise control of interference, a 40 mW signal propagating over a free-space path would produce a signal level of -32 dBm at an indoor receiver using an antenna with 0 dBi gain or, in the worst case, -24 dBm radiating directly into an outdoor antenna with 10 dBd (dB reference to a dipole) gain and 4 dB cable loss.[305] However, we also believe that in the great majority of instances a personal/portable device will not transmit directly into a TV gain antenna but rather will be off to the side and/or below the rooftop level of the TV antenna so that the received TVBD signal will be picked up at less than maximum gain and could in fact be negative. Thus, we will ignore the gain factor of outdoor antennas in this analysis and use only the -32 dBm signal level at the edge of a TVBD users premises. We also believe that it is appropriate to consider that a TV set or a receiver in some other TV band service that might receive interference from a personal/portable TVBD would be located in the premises of someone else would be on the other side of some structural elemental such as a wall and therefore, as detailed above, assume 10 dB of wall attenuation, 3 dB of polarization mismatch, and an additional 5 dB to account for indoor propagation which is generally greater than free space resulting in 18 dB of

[300] *See* Tropos Networks comments at 13-14. Section 15.247 of the rules which addresses spread spectrum transmitters requires out-of-band emissions to be attenuated at least 20 dB below the level of the fundamental signal, but in no case less than the Section 15.209 limits. Emissions in restricted bands may not exceed the Section 15.209 limits. *See* 47 C.F.R. § 15.247. The requirement to attenuate out-of-band emissions 20 dB below the level of the fundamental emission may be significantly less stringent than the Section 15.209 limit, depending on the transmitter power used.

[301] *See* IEEE 802.18 *Notice* comments at 27, Shure *Notice* comments at 20-21, and NAB/MSTV *Notice* comments at 21-24.

[302] *See* NAB/MSTV *Notice* reply comments at 22-23.

[303] *See* GE Healthcare *Further Notice* comments at 7-8.

[304] *See* CTIA *Further Notice* comments at 3.

[305] Free space attenuation of a 600 MHz signal 10 meters from a non-directional antenna is approximately 48 dB. The attenuation varies slightly over the TV band depending on the specific frequency of operation.

attenuation of the TVBD signal, so that the signal would be no higher than -50 dBm in the adjoining premise.

236. The mask suggested by the Coalition would reduce emissions at the edges of the channel to -55 dB below the average power level in 500 kHz. Using that mask would reduce the out-of-band emissions appearing at a TV receiver to -110 dBm or to 23 dBμV/m at the receiver's antenna, which is well below the service threshold for DTV reception and the Section 15.209 limit and in fact below the noise floor for 6 MHz. This mask is also more restrictive than the DTV emissions mask in the first adjacent channel for signals of the same power level. We also see no reason to extend the -23 db "weak signal" signal to noise ratio provision of Section 73.622(c)(3) to protection against adjacent channel interference but instead will use the standard 15 db signal-to-noise ratio in that rule section. Given that -110 dBm is more than the standard 15 dB signal-to-noise ratio below the -84 dBm DTV reception threshold (and is in fact below the -107 dBm thermal noise floor in a 6 MHz channel), we conclude that TVBD signals complying with the -55 dB mask will adequately avoid the interference concerns expressed by MSTV/NAB. We also observe that the performance of the Adaptrum transmitter demonstrates that meeting this mask is feasible. While we believe that the emissions mask is less critical for fixed devices that will not operate on adjacent channels, we will require those devices to comply with the same mask as personal/portable devices. This will ensure that out-of-band emissions from all TVBDs pose the minimum potential for interference. Accordingly, we will require that emissions from unlicensed TVBDs be at least 55 dB below the highest average power in the 6 MHz channels adjacent to the 6 MHz channel in which the device is operating.[306] Beyond 6 MHz from the edge of the operating channel, radiated emissions from TVBD devices shall meet the requirements of Section 15.209. In addition, we are adopting GE Healthcare's proposal for a mask in channels 36 and 38 to protect WMTS devices in channel 37. All TVBDs will be required to comply with this more stringent requirement for suppression of out-of-band emissions into channel 37.

4. Spectrum Sensing

237. As discussed above, we are requiring TVBDs to be capable of detecting DTV stations, analog (NTSC) TV stations (because low power analog stations may continue to operate after the DTV transition), and wireless microphones at a minimum signal level of -114 dBm. In this section, we discuss and specify the technical requirements for spectrum sensing by unlicensed TV band devices.

238. Detection *Bandwidth and Sensing Antenna.* In the *First R&O/Further Notice*, the Commission sought comment on the appropriate detection threshold for TV band devices that incorporate spectrum sensing. The Commission noted that IEEE 802.22 was considering detection threshold values as low as -114 dBm, referenced to an omnidirectional receive antenna with a gain of 0 dBi, and sought comment on this value or alternative values for the detection threshold.[307] The Commission noted that there is a relationship between the sensing receiver bandwidth and ability of a device to detect weak signals. A receiver with a wide bandwidth is not able to detect as weak a signal as a receiver using a narrow bandwidth because the thermal noise in a receiver is proportional to the bandwidth. The Commission sought comment on whether there is a need to specify a sensing bandwidth in addition to a

[306] To determine compliance with the OOBE, the average power, in 500 kHz segments, in the first adjacent 6 MHz channel is compared to the highest average power in the 6 MHz channel in which the device is operating. Since the resolution bandwidth generally used for making measurements in the 30 MHz to 1000 MHz band is 100 kHz, this measurement may be performed using a minimum resolution bandwidth of 100 kHz as long as the same RBW is used in both channels. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over the RBW used to make the in-band measurement.

[307] *See Further Notice* at ¶¶ 37-39.

detection threshold, or whether it is necessary to specify only the characteristics of the signals to be detected as discussed below and leave the sensing bandwidth to the manufacturer's discretion.[308] Shure recommends a detection bandwidth of 200 kHz for wireless microphones.[309]

239. IEEE 802.18 believes that the sensing antenna should have a minimum gain of 0 dBi, assuming the antenna is omnidirectional, but believes that the Commission's rules should allow alternative approaches, such as an electronically rotated high gain antenna that scans 360 degrees.[310] IEEE 802.18 recommends a requirement that the sensing antenna be located outdoors at a minimum height of 10 meters above the ground to ensure that it is not shadowed by either terrain or man made structures.[311] The White Space Coalition is not opposed to a requirement that the receive antenna have a gain of 0 dBi, but argues that a minimum sensing height requirement is not practical for personal/portable devices.[312]

240. We are specifying detection bandwidths for TVBDs to ensure uniformity of detection capabilities between devices. We find that a detection bandwidth of 6 MHz is appropriate for digital TV because that is the nominal occupied bandwidth of an ATSC signal, a detection bandwidth for analog TV is 100 kHz, which is representative of the visual carrier bandwidth of an NTSC signal, and a detection bandwidth for wireless microphones is 200 kHz, recommended by Shure and IEEE as being representative of the bandwidth in which they typically operate.

241. As proposed, we will require that the -114 dBm detection threshold be referenced to a 0 dBi gain receive antenna for both fixed and personal/portable devices. That antenna design will maximize the likelihood of sensing signal on an omnidirectional basis. We will also require that the receive antenna used with fixed devices be located at least 10 meters above the ground to maximize the likelihood that it's reception is not blocked from receiving signals originating from any direction. We will allow alternative approaches for the sensing antenna, *e.g.*, electronically rotate-able 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.[313] We agree with the White Space Coalition that sensing antenna receive height requirements are impractical for personal/portable devices and decline to impose such requirements.

242. *Channel Availability Check Time, Move Time, and Non-Occupancy Period.* In the *First R&O/Further Notice*, the Commission proposed to require that unlicensed TV band devices that use sensing to determine the availability of unused TV band frequencies perform sensing for a certain period of time before accessing a channel and periodically thereafter to ensure that the channel is still available, *i.e.*, unoccupied.[314] The Commission sought comment on whether sensing for 30 seconds would be a necessary or sufficient period of time for the initial channel availability check when a device is placed in operation, *i.e.*, turned-on. It also proposed to require that devices re-check the channel at least every 10 seconds to ensure that they are not on the air for extended periods of time causing harmful interference to

[308] *See Further Notice* at ¶ 43.

[309] *See* Shure *Notice* comments at 14.

[310] *See* IEEE 802.18 *Further Notice* comments at 16.

[311] *See* IEEE 802.18 *Further Notice* comments at 12.

[312] *See* White Space Coalition *Further Notice* comments at 16.

[313] Minimum directional gain is defined as the antenna gain in the direction and at the frequency that exhibits the least gain.

[314] *See Further Notice* at ¶¶ 40-41.

authorized services in the TV bands that are not present during an initial sensing check. The Commission did not propose to require unlicensed devices to remain off-the-air for any prescribed period of time after a channel is first determined to be occupied because it believed that the requirement to perform sensing before operating would ensure that devices will not cause harmful interference to authorized services that are already on the air.

243. The White Space Coalition argues that it is not necessary for the Commission to specify a channel availability minimum sensing period because the optimum check time will be dictated by the algorithms implemented by each manufacturer to meet the minimum detection threshold. It also submits that because of the "always on" nature of services in the TV bands, a re-check interval of one minute is more appropriate than 10 seconds, because the shorter 10 second interval would reduce the throughput of TV band devices.[315] The White Space Coalition states that a period of 10 seconds after detecting a station is sufficient and appropriate for a device to vacate a channel, and that it is unnecessary to specify a non-occupancy period because devices would be required to confirm that a channel is unoccupied before commencing operation.[316] IEEE 802.18 recommends that we require that TV band devices check for the presence of wireless microphones every two seconds, but states that a recheck interval of 10 seconds or longer is adequate for DTV signals.[317]

244. Shure advocates that a TV band device be required to monitor a channel for 30 seconds before transmitting to detect wireless microphones that operate intermittently. It believes that an unlicensed device should vacate a channel within two seconds after detecting that it is occupied. Shure further submits that if the Commission does not adopt a requirement that unlicensed devices to avoid for a period of time channels detected as occupied (non-occupancy period), then it should require TV band devices to engage in periodic re-sensing every 10 seconds.[318] Tropos Networks agrees that the proposed 30 second channel check and 10 second re-check intervals are reasonable.[319]

245. We will require that an unlicensed TV band device perform a channel availability check for at least 30 seconds before first accessing a channel each time the device is activated, *i.e.*, powered-up after being off. This will allow sufficient time for the TVBDs to ensure that the channel is unoccupied, and in particular, to verify that there are no wireless microphones operating intermittently on that channel. We will also require that an unlicensed TVBD perform periodic monitoring of channels being used at intervals not to exceed one minute. This will ensure that the TVBD can detect the signal of an authorized TV band service, particularly wireless microphones, which may commence operation after the device begins using a channel. While we did not propose to set a specific time limit within which a TVBD must vacate a channel after detecting an authorized user, we conclude that such a requirement is needed to ensure that a TVBD device vacates a channel quickly to prevent interference to other users. We therefore are requiring that TVBDs vacate a channel found to be occupied subsequent to a devices' initial sensing operation within a two second interval, as suggested by Shure. This will provide a reasonable time

[315] We note that while wireless microphones tend to operate on an intermittent basis over periods of time, *i.e.*, an evening, an afternoon, a one or two hour program, etc., the predominant method of modulation used by those devices is frequency modulation (FM) in which the carrier is always on. However, we are also aware that some digital wireless microphones are now available that use digital modulation schemes that may or may not be on for the full period of an event.

[316] *See* White Space Coalition *Further Notice* comments at 14.

[317] *See* IEEE 802.18 *Further Notice* comments at 12-14.

[318] *See* Shure *Further Notice* comments at 15.

[319] *See* Tropos Networks *Further Notice* comments at 10.

interval for the TVBDs to terminate its use of the channel while minimizing interference to the service that has commenced operation on that channel.

246. We decline to adopt a non-occupancy period during which a TVBD must remain off a channel after determining that it is occupied. The requirements to monitor a channel for 30 seconds before commencing operation, combined with the requirement to periodically monitor a channel being used and quickly vacate when an authorized user begins operation, will adequately protect against operation on occupied channels. We recognize the White Space Coalition's concerns that a channel re-check interval of ten seconds could affect throughput capacity, and agree that under most circumstances the users of the spectrum will not change rapidly and a channel re-check time of one minute should be sufficient.

247. *Distributive Sensing and Display of Available Channels.* In the *First R&O/Further Notice*, the Commission recognized that distributive sensing, whereby multiple receivers/antennas at different locations share sensing information, offers an approach for mitigating the hidden node problem. It requested comment on how a distributed sensing approach could be employed on an unlicensed basis. The Commission also indicated that it intended to consider other measures that would promote sharing and further protection of licensed services by devices using spectrum sensing.[320]

248. Shure, the White Space Coalition, and WISPA support requiring unlicensed TV band devices to use distributed sensing, although the White Space Coalition believes that a sensing threshold of -114 dBm is sufficient to detect TV band signals in any case.[321] Shure recommends that we require distributed sensing by at least two TV band devices, stating this approach would immensely improve the ability of devices to detect wireless microphones and overcome the hidden node problem. WISPA states that a distributed sensing approach would improve the ability to detect the signals, and that the performance of such capability would improve over time as the number of sensors in an area increases.

249. We agree with these parties that distributive sensing will improve the ability of unlicensed TVBDs to detect the signals of licensed services. Use of this approach will better enable these devices to avoid using occupied channels when they are located in hidden nodes or areas where there are signal nulls. We are therefore requiring that unlicensed TVBDs communicating in a local area group or network, either directly with one another or linked through a common base station, share information on channel occupancy determined by sensing. If any device in a local area group or network determines that a channel is occupied, all other linked devices will also be required to treat a sensed signal as if they detected it themselves. However, we also recognize that the service range of wireless microphones is limited to very short distances and that the coverage of a network of TVBDs could extend to areas beyond which some TVBDs on the network would not pose a threat to the operation of a detected microphone system. We therefore will limit the application of the distributive sensing provision with respect to wireless microphones to only require that all TVBDs that are in direct communication with one another treat a wireless microphone signal detected by one as if they detected it themselves.

250. In order to aid users in responding to any complaints of interference that may arise, we are also requiring that an unlicensed TVBD be able to provide its user with a list of available channels as determined by the TV bands database and sensing. This information could be provided through the devices set-up menu or other feature that is readily accessible by the user. While the commenting parties did not specifically address this measure, we find that including this capability in unlicensed TVBDs will greatly simplify answering questions about the channels they are using and provide a means to readily

[320] *See Further Notice* at ¶¶ 42 and 47.

[321] *See* Shure *Further Notice* comments at 14 and *Notice* reply comments at 7, White Space Coalition *Further Notice* comments at 17, and WISPA *Further Notice* reply comments at 3.

examine whether a device is sensing a licensed TV band service. We also do not believe that inclusion of this feature in devices will have a significant cost impact as the current channel availability information must be resident in a device at all times in order for it to function in compliance with the rules adopted herein. In addition, we are requiring that the user manual for the TVBD include information advising consumers of the potential for harmful interference and steps that they can take to identify and remediate the interference, such as increasing the separation of the device from other communications equipment and contacting the manufacturer for technical assistance.

5. Measurement Procedures

251. In the *First R&O/Further Notice*, the Commission stated that it intended to develop interim measurement procedures that will be provided when final rules are adopted. It indicated that these procedures would draw on the measurement procedures for 5 GHz U-NII devices, to the extent those procedures are relevant to unlicensed devices in the TV bands and the rules it adopts for their operation, and its general measurement procedures for unlicensed devices as specified in Section 15.31 of the rules.[322] The Commission also presented proposals on certain specific measurement issues. With regard to testing the sensing detection threshold, it proposed to subject the sensing capabilities of unlicensed devices to an ATSC DTV signal, an NTSC signal and a 200 kHz FM signal with peak levels adjusted to the threshold level. It also observed that the test procedure for 5 GHz U-NII devices calls for performing the detection tests a number of times and specifies pass/fail ratios. The Commission stated that it does not believe such an approach is appropriate for detection of TV band signals because it should be simpler to detect signals from the types of transmitters operating in the TV spectrum than for radars, but invited comment in this regard.

252. A new measurement procedure is needed for evaluating compliance by unlicensed TVBDs with the spectrum sensing and other technical requirements that we are adopting herein. While the spectrum sensing requirements for TVBDs are somewhat similar to the U-NII dynamic frequency selection (DFS) requirements, as we observed in the *First R&O/Further Notice*, there are important differences between TV band and U-NII devices. For example, TV band devices must be capable of detecting signals at a significantly lower threshold than U-NII devices. Also, the types of signals that must be detected (TV, wireless microphone, PLMRS/CMRS, and certain other signals) have different spectral characteristics than radar signals. Further, there are other new requirements for TVBDs, including geo-location accuracy, that are not addressed in any current measurement procedures. Due to the complexity of the requirements necessary to protect authorized services in the TV bands, we expect that it will take some time to develop the appropriate procedures. We plan to develop these measurement procedures as expeditiously as possible. Consistent with the Commission's actions in the U-NII proceeding, our Office of Engineering and Technology will release the procedure for unlicensed TV band devices when it is completed and the Commission will accept data that has been measured in accordance with that procedure pursuant to Section 2.947(a) of the rules.[323]

6. Spectrum Sharing

253. In the *First R&O/Further Notice,* the Commission stated that it anticipates that industry will develop protocol standards that facilitate shared use of the TV white space spectrum.[324] It expressed concern, however, that in the absence of some minimal mandatory requirements, a single device or network of devices could conceivably monopolize use of a channel at a given location or area. The

[322] As indicated above, the U-NII compliance measurement procedure is set forth in the appendix to the *Memorandum Opinion and Order* in ET Docket No. 03-122. *See also* 47 C.F.R. § 15.31.

[323] *See* 47 C.F.R. § 2.947(a)(1).

[324] *See Further Notice* at ¶ 47.

Commission therefore invited comment as to whether it may be necessary or appropriate for the Commission to establish minimal technical requirements to facilitate sharing by TV band devices. It cited examples of such requirements that might include limitations on the duration of transmissions and a requirement to repeat spectrum sensing at intervals more frequently than ten seconds.

254. The White Space Coalition states that it is not opposed to a minimal regulatory requirement to ensure spectrum sharing among devices. It proposes a maximum channel occupancy time of 400 milliseconds, followed by a minimum 100 millisecond interval during which a device may not transmit.[325] However, IEEE 802.18 opposes restrictions on the duration or duty cycle of unlicensed transmissions, arguing that the sharing protocols it is developing will render regulatory restrictions unnecessary.[326] Tropos believes that Commission requirements to facilitate spectrum sharing would ill serve innovation and may undermine the Commission's objective to promote competition.[327] CEA believes that the Commission should leave any spectrum sharing initiatives in the hands of industry, which it claims has proven more facile in adopting self-regulatory standards that improve spectrum efficiency than government regulation.[328]

255. We see no demonstrated need at this time for mandatory spectrum sharing provisions for TVBDs and therefore are not adopting such rules. We also note that the IEEE industry group is already developing standards for spectrum sharing between TVBDs. In addition, we are concerned that any spectrum sharing requirements we might adopt now could conflict with the developing industry standards or otherwise limit manufacturers' flexibility in designing TVBDs. We further observe that the requirements we are adopting for TVBDs to periodically re-check a channel for availability will prevent a device from transmitting continuously. We also advise the involved industries and other interested parties that we may revisit this decision in the future if it appears that regulatory requirements for spectrum sharing between TVBDs are needed.

G. Equipment Certification Required

256. We are requiring TVBDs to be certificated under our equipment authorization program. The applicant for an equipment authorization of a device based on geo-location and database access and sensing must meet all of the usual requirements for an application for equipment certification as specified in Parts 2 and 15 of the FCC rules.[329] In addition, we will require an applicant to submit a sample of the device for testing at the FCC Laboratory to determine compliance with all of the pertinent requirements for a TVBD. The device will only be certified once it has been found through testing to meet all of the FCC requirements. This is the process that the Commission has generally followed for new technologies that must meet complex standards and raise significant interference concerns. For example, we have taken a similar approach relative to certification of ultrawideband devices and to new 5 GHz unlicensed devices that include spectrum sensing to avoid causing interference to Department of Defense radars. As noted below, we are not allowing certification of TVBDs by Telecommunications Certification Bodies at this time. The FCC laboratory will act on such applications under delegated authority pursuant to section 0.241(b) of the Commission's rules.

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[325] *See* White Space Coalition *Further Notice* comments at 17.

[326] *See* IEEE 802.18 *Further Notice* comments at 18.

[327] *See* Tropos Networks *Further Notice* comments at 11.

[328] *See* CEA *Further Notice* comments at 5.

[329] *See* 47 C.F.R. Parts 2 and 15.

H. Equipment Certification Under A "Proof Of Performance" Standard

257. As indicated above, we are providing a special equipment certification procedure for approval of sensing only devices that demonstrate the ability to detect protected services with a high level of accuracy. In providing this procedure, we recognize that cognitive radio technology, including sensing, is in its nascent stage of development for commercial applications. Cognitive radio technology holds great promise for increasing access spectrum access to the benefit of consumers and businesses and we find it in the public interest to continue to encourage the development of this technology. We also recognize that the TV band prototype devices that were submitted to the Commission for evaluation were designed primarily to demonstrate the capability of using spectrum sensing for interference avoidance. While the devices were able to detect the signals of incumbent services under certain conditions, they were not able to do so under others. For example, it does not appear that the devices were designed to cope with certain real-world conditions such as strong adjacent channel signals or the challenges of operating in noisy environments. This made it particularly difficult to fully validate the performance of the technology and develop standards that would ensure a high degree of confidence that devices relying on sensing alone would not interfere. Nevertheless, we believe that these problems can be solved. As an incentive to continue to develop this technology, we will provide for certification of devices under the conditions and process described below.

258. We therefore are adopting rules that will allow for certification of personal/portable devices that rely solely on a spectrum sensing capability and do not include geo-location and database access capabilities. These sensing only devices will be required to meet a "proof of performance" standard where they must demonstrate with an extremely high degree of confidence that they will not cause harmful interference to incumbent radio services. Devices authorized under this procedure will be subject to all rules for personal/portable devices, except that out-of-an abundance of caution with regard to their interference potential, such devices will be limited to 50 mW EIRP rather than the 100 mW permitted for personal/portable devices that use the geolocation and database method.

259. Manufacturers must submit an application for certification in accordance with Part 2, Subpart J of the Commission's rules. The application must include a full explanation of how the device will protect the incumbent radio services against harmful interference. In addition to the procedures of Part 2, Subpart J of the Commission's rules, the applicant must submit a pre-production sample for laboratory and field testing. The pre-production sample device must be identical to the device expected to be marketed.

260. The Commission will process this application in the following manner. 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 section 0.459 of this chapter. This Public Notice will include proposed test procedures and methodologies. After the comment period, the Commission will test the devices to evaluate proof of performance, including characterization of its sensing capability and its interference potential. The testing will be open to the public. 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. The ultimate decision on whether to certify a device that relies solely on sensing will be made by the full Commission.

261. The determination of whether to certify the device will be based on a demonstrated ability to avoid causing harmful interference with an extremely high degree of reliability. As noted above, there has been much discussion in this proceeding as to the effectiveness of sensing at particular levels. We note that we are adopting a detection threshold of -114 dBm for devices that rely on geolocation and database access. However, this particular level may or may not be the appropriate sensing threshold for these sensing only devices. The decision by the Commission whether to certify the equipment will rest on its performance in avoiding interference, not any particular sensing level. If the

device is certificated, we will permit routine certification of other devices that have identical characteristics (*i.e.*, have the identical electrical characteristics and antenna system). We will endeavor to complete the certification process within 180 days of submittal of the device for testing, barring any unforeseen circumstances.

I. Other Matters

1. Certification By Telecommunications Certification Bodies

262. In the *First R&O/Further Notice*, the Commission proposed that Telecommunications Certification Bodies (TCBs) initially not be permitted to certify TV band devices because these devices would contain new technologies and many questions about the application of the rules may arise.[330] Specifically, the Commission proposed to place TV band devices on the list of types of devices that TCBs are excluded from certifying until it has more experience with them and can advise TCBs on the application of the rules.[331] Both the Consumer Electronics Association and Shure support this proposal and no parties opposed it.[332] We continue to believe that we should exclude TCBs from granting applications for certification of unlicensed TV band devices at this time for the reasons indicated above. We will therefore limit the processing of those applications to our Laboratory Division until such time as we gain experience with unlicensed TVBDs and the technology used in those products becomes mature such that the application review process becomes routine. Accordingly, we will not allow TCBs to certify TV band devices until further notice.

2. Operation In Border Areas

263. The allotment and assignment of TV channels in the border areas with Canada and Mexico are subject to agreements with each of those countries. Low power TV assignments within 32 kilometers (20 miles) of the Canadian border must be referred to the Canadian authorities for approval.[333] In addition, low power UHF TV stations that are located less than 40 kilometers (25 miles) from the Mexican border, and low power VHF TV stations that are less than 60 kilometers (37 miles) from the Mexican border, must be referred to the Mexican government for approval.[334] In the *Notice*, the

[330] *See Further Notice* at ¶ 64. All unlicensed transmitters and most licensed transmitters are required to be certified by the Commission or a designated Telecommunication Certification Body (TCB) before they may be legally marketed within the United States. In establishing the requirements for TCBs, the Commission stated that while it intended to allow TCBs to certify a broad range of equipment, certain functions should continue to be performed by the Commission. These functions include certifying new or unique equipment for which the rules or requirements do not exist or for which the application of the rules is not clear.

[331] The Commission's Laboratory maintains a list of types of devices that TCBs are excluded from certifying. Once it determines that TCBs have the necessary expertise to certify an excluded device, the Laboratory will remove it from the list.

[332] *See* Consumer Electronics Association comments at 7 and Shure comments at 21.

[333] *See Working Arrangement for Allotment and Assignment of VHF and UHF Television Broadcasting Channels under the Agreement between the Government of the United States of America and the Government of Canada Relating to the TV Broadcasting Service*, dated March 1, 1989. This agreement is available on the Commission's web site at http://www.fcc.gov/ib/sand/agree/files/can-bc/can-tv.pdf.

[334] *See Agreement Amending the Agreement Relating to Assignments and Usage of Television Broadcasting Channels in the Frequency Range 470-806 MHz (Channels 14-69) along the United States-Mexico Border*, dated November 21, 1988. This agreement is available on the Commission's web site at http://www.fcc.gov/ib/sand/agree/files/mex-bc/lpuhfbc.pdf. *See also*, the untitled amendment to the United States-Mexican agreement on VHF stations dated September 14-26, 1988, available on the Commission's web site at http://www.fcc.gov/ib/sand/agree/files/mex-bc/lpvhfbc.pdf. The agreements may require coordination at greater distances from the border depending on the ERP and HAAT of the LPTV station.

Commission proposed to prohibit unlicensed TV band devices from operating at less than these distances from the Canadian and Mexican borders until agreements are reached with those countries.[335] The Commission also sought comment on how to ensure that unlicensed devices using vacant TV channels do not operate within the border areas and whether the methods used to ensure that these devices operate only on vacant TV channels could be adapted to preclude operation in the border areas. In the *First R&O/Further Notice,* the Commission sought comment on whether the agreements with Canada and Mexico would need to be modified before unlicensed TV band devices could operate in the border areas.[336]

264. The White Space Coalition argues that the agreements with Canada and Mexico do not need to be modified because they relate to restrictions on TV station operations and not on devices that operate in the TV bands using significantly less power than TV stations. It further argues that the use of unlicensed TV band devices is not inconsistent with those agreements, assuming the devices use spectrum sensing to avoid Canadian and Mexican TV signals.[337] NAF, et al., believe that given the low power and sensing capabilities proposed in this proceeding, there is no risk to either Canadian or Mexican television operations. They also believe that geo-location is another reliable option. The NAF, et al., also submit that the Commission should interpret the legal requirement for coordination as existing only where a device can potentially interfere.[338] IEEE 802.18 states that operation of fixed devices can easily be controlled using geo-location to ensure that they do not violate the necessary separation from the border.[339]

265. We find that fixed TV band devices should not be permitted to operate within the border areas specified in our Canadian and Mexican agreements until we have an opportunity to negotiate any necessary changes to those agreements with Canada and Mexico. The fixed TV band devices that operate with outdoor antennas at an EIRP of up to 4 watts will be somewhat similar in operation to low power TV stations. Therefore, in keeping with the low power broadcasting agreements with Canada and Mexico, we will not permit fixed TV band devices to operate on any channels within 32 kilometers of the Canadian border, within 40 kilometers of the Mexican border on UHF channels, or within 60 kilometers of the Mexican border on VHF channels.[340] These distance restrictions will be enforced through the use of a device's geo-location and database access capabilities, which all fixed devices must incorporate.

266. We will apply these same restrictions on the use of unlicensed personal/portable TV band devices within the border areas. While personal/portable devices will operate with significantly lower power, in order to avoid any uncertainty in administering our agreements with our neighboring administrations, we believe it is also necessary to restrict operation of those devices in the border areas. Personal/portable devices that operate in Mode II using a geo-location/database access capability will be required to use that capability to determine whether they are located in a border area. Devices operating in Mode I on a client basis without a geo-location/database access capability will be prevented from operating in the border areas in that they will operate relatively close to an associated base station (fixed or personal/portable) that uses a geo-location/database access capability that will keep it from operating in

[335] *See Notice* at ¶ 46.

[336] *See First R&O/Further Notice* at ¶ 65.

[337] *See* White Space Coalition *Further Notice* comments at 30-31.

[338] *See* NAF, et al. *Further Notice* comments at 87-88.

[339] *See* IEEE 802.18 *Further Notice* comments at 24.

[340] The distances we specify are the minimums specified in the agreements because those distances would apply to a station with the proposed maximum unlicensed device power of 1 watt into a 6 dBi gain antenna (2.43 watts ERP).

the border areas. The requirement that all personal/portable devices incorporate sensing to a level of -114 dBm will further minimize the risk of interference to TV stations in Canada and Mexico.

3. Reconsideration Of Marketing Date For Unlicensed TV Band Devices

267. In their Petition for Reconsideration, NAF/CUWN request that we reverse our decision to prohibit the marketing of TV white space devices until the DTV transition ends on February 17, 2009, and instead authorize marketing of such devices as soon as we develop rules and certify that devices comply with them. NAF/CUWN argue that there is no technical reason why devices using any of the mechanisms the Commission will approve cannot operate prior to the analog switch off date. They also contend that if the transition is to go smoothly, the vast majority of stations must be converted to digital operation and the public must be ready to receive digital signals well before February 17, 2009. They further argue that delays will impose considerable and needless costs on the public. NAF/CUWN state that because TVBDs will represent new devices operating under new rules, developers will need to start from scratch when innovating with the new equipment rather than simply building on past experience and existing software. They contend that the sooner the Commission allows properly certified devices on the market, the sooner the learning and experimentation can begin.

268. We are maintaining our decision to prohibit the marketing of unlicensed TV band devices until the DTV transition ends on February 18, 2009. In this regard, we remain concerned that allowing operation of unlicensed devices during the transition period could cause uncertainty for the broadcast television about possible interference. For example, in the transition period stations will be changing channels and otherwise operating in manners that are temporary. This changing pattern of TV channel usage will affect the availability of channels that could be used by unlicensed devices. We believe that it is quite reasonable for broadcasters to be uncertain about whether their services are adequately protected from interference from unlicensed devices in such an environment. We further note that, as reflected in the issues raised in the third DTV period review, all stations will not be fully converted well before the end of the transition.[341] We also are not persuaded by NAF/CUWN's argument that the proscription on marketing of unlicensed TVBDs until the transition ends will impede the development of unlicensed TVBDs. That development process, including completion of the certification requirement, can take place prior to the actual marketing of devices. Given that there are only a few months remaining before the end of the transition, the period of time between when devices are certified and otherwise ready for marketing and the end of the transition will be long in any case.

4. Emergency Request For Additional Comment Period

269. On October 17, 2008, several broadcast interests filed an "Emergency Request" asking the Commission to issue a public notice seeking comment on the Phase II Test Report.[342] The requesters contend that the report expresses conclusions that are not supported by the data in the report and that the public has not had opportunity to review and comment meaningfully on the results of the report. This request is denied. The testing process has been open and members of the public, including persons representing the requesters and their interests, have observed the testing and have been privy to the data as it was collected. All have had opportunity on a continuing basis to comment and they have done so, as has been demonstrated in numerous *ex parte* submissions related to, referring to, or based on the testing.

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[341] *See Notice of Proposed Rulemaking* in MB Docket No. 07-91, *supra*.

[342] *See* Emergency Request filed by The Association For Maximum Service Television, Inc., The National Association of Broadcasters, The ABC, NBC, CBS, and FOX Television Networks, and The Open Mobile Video Coalition, filed Oct. 17, 2008.

V. PROCEDURAL MATTERS

A. Final Regulatory Flexibility Analysis

270. The Final Regulatory Flexibility Analysis, required by the Regulatory Flexibility Act, *see* 5 U.S.C. § 604, is contained in Appendix B.

B. Final Paperwork Reduction Act of 1995 Analysis

271. This Second Report and Order contains new or modified information collections subject to the Paperwork Reduction Act of 1995 (PRA) and will be submitted to the Office of Management and Budget (OMB) for review under Section 3507(d) of the PRA, Public Law 104-13. A modification is required to the Form 731 (OMB 3060-0057).

C. Contact Persons

272. For additional information concerning this Second Report and Order and Memorandum Opinion and Order, please contact Mr. Hugh L. Van Tuyl at (202) 418-7506, Mr. Nicholas Oros at (202) 418-0636, or Mr. Alan Stillwell at (202) 418-2925, or via the Internet at Hugh.VanTuyl@fcc.gov, Nicholas.Oros@fcc.gov, and Alan.Stillwell@fcc.gov, respectively.

VI. ORDERING CLAUSES

273. Accordingly, **IT IS ORDERED** that, pursuant to the authority contained in Sections 4(i), 302, 303(e), 303(f), and 307 of the Communications Act of 1934, as amended, 47 USC Sections 154(i), 302, 303(c), 303(f), and 307 this Second Report and Order **IS HEREBY ADOPTED**.

274. **IT IS FURTHER ORDERED** that Part 15 of the Commission's rules **IS AMENDED** as specified in Appendix B, and such rule amendments shall be effective 30 days after publication of the text thereof in the Federal Register. This Second Report and Order contains information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13, that are not effective until approved by the Office of Management and Budget. The Federal Communications Commission will publish a document in the Federal Register following approval of the information collection by the Office of Management and Budget ("OMB") announcing the effective date of those rules.

275. **IT IS FURTHER ORDERED** that, pursuant to Sections 4(i), 302, 303(e) 303(f), 303(g), 303(r) and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), 303(f), 303(g), 303(r) and 405, the petition for reconsideration filed by the New America Foundation and the Champaign Urbana Wireless Network **IS DENIED**.

276. **IT IS FURTHER ORDERED** that, pursuant to Sections 4(i), 302, 303(e) 303(f), 303(g), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), 303(f), 303(g) and 303(r), the Emergency Request filed by The Association For Maximum Service Television, Inc., The National Association of Broadcasters, The ABC, NBC, CBS, and FOX Television Networks, and The Open Mobile Video Coalition **IS DENIED**.

277. **IT IS FURTHER ORDERED** that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, **SHALL SEND** a copy of the Second Report and Order, including the Final Regulatory Flexibility Analysis, to the Government accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. 801(a)(1)(A).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

Parties Filing Comments

Comments on NPRM

1. Adaptrum, Inc.
2. Alan Greagor
3. Association of Public Safety Communications Officials
4. Association of Public Television Stations
5. ATK Audiotek
6. Attron Networks, LLC
7. Audio-Technica U.S., Inc.
8. Chip Brown
9. Chuck Profito
10. Cohen, Dippell and Everist, P.C.
11. Commercial Broadcasting Corporation
12. Community Broadcasters Association
13. Consumer Electronics Association
14. County of Los Angeles
15. Cox Broadcasting, Inc.
16. CWLab
17. Dan Lubar
18. Dustin Goodwin
19. Entravision Holdings, LLC
20. Harris Corporation
21. IEEE 802
22. Industrial Telecommunications Association, Inc.
23. Intel Corporation
24. International Communications Industries Association, Inc.
25. Itron, Inc.
26. James M. McKinion
27. James Stoffo
28. John Laprise
29. John Notor
30. John Terrill
31. Jon M. Peha
32. Josephson Engineering, Inc.
33. Karl Winkler
34. Kenneth DiPietro
35. Kenneth Youngquist
36. KHEM Television
37. Lee Good, RTS
38. Mark Koskenmaki
39. Marlon K. Schafer
40. Metropolitan Area Networks, Inc.
41. Michael Falaschi
42. Michael J. Marcus
43. Michael Mason
44. Michiana Wireless
45. Microsoft Corporation
46. Motorola, Inc.
47. NAB and MSTV
48. NAMM, the International Music Products Association
49. National Academy of Sciences
50. National Cable & Telecommunications Association
51. National Radio Astronomy Observatory
52. National Systems Contractors Association
53. National Translator Association
54. New America Foundation, et al.
55. Noah Miller
56. NPG of Oregon, Inc.
57. NYCwireless.net
58. Old Colorado City Communications
59. OnlyInternet Broadband & Wireless, Inc.
60. Pappas Telecasting Companies
61. Paul Burkholder
62. Pikes Peak Broadcasting Company
63. Professional Audio Manufacturers' Alliance
64. PVT Networks, Inc.
65. QUALCOMM Incorporated
66. R. Kent Parsons
67. Raymond D. Meredith, Jr.
68. Rebekah Morris
69. Red River Broadcasting Co., LLC
70. Region 1 Translator Association
71. Ron Wallace
72. Ronald E. Wallace
73. Sascha D. Meinrath
74. Sennheiser Electronic Corporation
75. Shared Spectrum Company
76. Shure Incorporated
77. Society of Broadcast Engineers, Inc.
78. Southwest Colorado TV Translator Association
79. Stelios Valavanis
80. Symmetrical Networks, Inc.
81. Syncom Media Group, Inc.
82. Telecommunications Industry Association
83. Telex Communications, Inc.
84. Tim Foster
85. Tony Ray
86. Total RF Marketing, Inc.

87. Tropos Networks
88. Vaxeo.com
89. WDLP Broadcasting Co., LLC
90. White Pine Television District No. 1
91. Wi-Fi Alliance
92. Wireless Broadband Operators Coalition
93. Wireless Internet Service Providers Association
94. Wireless Unleashed
95. Yochai Benkler
96. Zachary C. Miller

Reply Comments on NPRM

1. 700 MHz Advancement Coalition
2. Alan B. Greager
3. Allcom Communications, Inc.
4. BPS Networks
5. Brendan Geaney
6. Cameron Communications Corporation
7. Cohen, Dippell and Everist, P.C.
8. Community Broadcasters Association
9. Consumer Electronics Association
10. EarthLink, Inc.
11. Information Technology Industry Council
12. Intel Corporation
13. KBDI, Channel 12
14. Kennebec Telephone Company
15. Land Mobile Communications Council
16. Lanham Rattan
17. Motorola, Inc.
18. NAB and MSTV
19. NARTE
20. National Translator Association
21. New America Foundation, et al.
22. North Dakota Network Company
23. OnTarget Technologies, LLC
24. Pitkin County FM-TV Department
25. Ponderosa Telephone Company
26. PVT Networks, Inc.
27. QUALCOMM Incorporated
28. Red River Rural Telephone Association
29. Shared Spectrum Company
30. Shure Incorporated
31. Society of Broadcast Engineers, Inc.
32. Timothy X Brown
33. Webster Calhoun Cooperative Telephone Association

Comments on Further NPRM

1. Advanced Broadband Solutions, Inc.
2. American Society for Healthcare Engineering – ASHE
3. American Federation of Television and Radio Artists
4. Comm Enterprises, LLC
5. Communications Research Centre Canada
6. Community Broadcasters Association
7. CompTIA
8. Consumer Electronics Association
9. County of Los Angeles
10. Cox Broadcasting, Inc.
11. CTIA – The Wireless Association
12. Dell, Google, HP, Intel, Microsoft and Philips ("The Coalition")
13. Entravision Holdings, LLC
14. GE Healthcare
15. Guitar Center, Inc.
16. IEEE 802.18 Radio Regulatory Technical Advisory Group
17. ION Media Networks
18. Itron, Inc.
19. James R. McDonald
20. Joint Comments of Broadcasters
21. Kenneth E. Lewetag
22. KJLA, LLC
23. Land Mobile Communications Council
24. Martin J. Jackson
25. McGraw-Hill Broadcasting Company, Inc.
26. Media General, Inc.
27. Motorola, Inc.
28. MSTV & NAB
29. National Cable and Telecommunications Association
30. National Translator Association
31. National Radio Astronomy Observatory
32. Qualcomm Incorporated
33. R. Kent Parsons
34. Radio-Television News Directors Association
35. Recording Artists' Coalition
36. Region 1 Translator Association
37. Shure, Inc.
38. The Brattle Group
39. The Professional Audio Manufacturers Alliance
40. The National Academy of Recording Arts and Sciences
41. Tropos Networks
42. TV Transmission Antenna Group, Inc.

43. Wi-Fi Alliance
44. Microphone Interests Coalition
45. NAF, et al.
46. Thomas C. Smith

Reply comments on Further NPRM

1. Audio-Technica U.S., Inc.
2. Capitol Broadcasting Company, Inc.
3. DC Access, LLC
4. Dell, Google, HP, Intel, Microsoft and Philips ("The Coalition")
5. EchoStar Satellite LLC
6. Grand Ole Opry and Microphone Interests Coalition
7. Hubbard Broadcasting Company, Inc.
8. Motorola, Inc.
9. MSTV and NAB
10. NAMM, The International Music Products Association
11. National Translator Association
12. National Cable and Telecommunications Association
13. NAF, et al
14. NextWave Broadband, Inc.
15. Professional Audio Manufacturers Alliance
16. Roadstar Internet
17. Shure, Inc.
18. The Brattle Group
19. Tropos Networks
20. Wireless Internet Service Providers' Association

Comments on Technical Reports

1. Cohen, Dippell and Everist, P.C.
2. Community Broadcasters Association
3. DTV Manufacturers
4. LG Electronics, Panasonic and TTE
5. Microphone Interests Coalition
6. Microtune, Inc.
7. Motorola, Inc.
8. MSTV and NAB
9. NAF, et al.
10. National Cable & Telecommunications Association
11. Philips Electronics North America Corporation
12. Samsung Electronics
13. Shure, Inc.
14. Sony Electronics, Inc.
15. Sprint Nextel Corporation
16. White Space Coalition

In addition to the above-listed comments, over 30,000 parties submitted filings outside of the Commission's designated comment and reply comment periods.

APPENDIX B

Final Rules

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

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

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

2. Section 15.37 is amended by adding a new paragraph (n) to read as follows:

Section 15.37 Transition provisions for compliance with the rules.

* * * * *

(n) Marketing of TV band devices operating under Subpart H of this section is not permitted prior to February 18, 2009.

3. A new Subpart H is added to read as follows:

Subpart H – Television Band Devices

Section 15.701 Scope.

This subpart sets out the regulations for Television Band Devices (TVBDs) which are unlicensed intentional radiators operating on available channels in the broadcast television frequency bands at 54-60 MHz, 76 - 88 MHz, 174 - 216 MHz, 470 - 608 MHz and 614 - 698 MHz bands.

Section 15.703 Definitions.

(a) Available Channel. A television channel which is not being used by an authorized user at or near the same geographic location as the TVBD and is acceptable for use by an unlicensed device under the provisions of Section 15.709 of this chapter. A TVBD determines television channel availability either from the *TV bands database* or *Spectrum Sensing*.

(b) Client Device. A TVBD operating in *Client Mode*.

(c) Client Mode. An operating mode in which the transmissions of the TVBD, including frequencies of operation, are under control of the *Master Device*. A device in client mode is not able to initiate a network.

(d) Fixed Device. A TVBD that transmits and/or receives radiocommunication signals at a specified fixed location. Fixed TVBDs may operate as part of a system, transmitting to one or more fixed TVBDs or to personal/portable TVBDs.

(e) Geo-location. The capability of a TVBD to determine its geographic coordinates within a specified level of accuracy.

(f) Master Device. A TVBD operating in *Master Mode*.

(g) Master Mode. An operating mode in which the TVBD has the capability to transmit without receiving an enabling signal. The TVBD is able to select a channel itself and initiate a network by sending enabling signals to other devices. A network always has at least one device operating in master mode.

(h) Mode I Operation. Operation of a personal/portable TVBD operating only on the *Available Channel* identified by either the fixed TVBD or Mode II TVBD that enables its operation. Mode I operation does not require use of a *Geo-location* capability or access to the *TV bands database* and requires operation in *Client Mode*.

(i) Mode II Operation. Operation of a personal/portable TVBD whereby the device determines the *Available Channels* at its location using its own *Geo-location* and *TV bands database* access capabilities. Devices operating in Mode II may function as *Master Devices*.

(j) Network Initiation. The process by which a fixed or Mode II TVBD sends control signals to another similar device or to a *Client Devices(s)* and allows them to begin transmissions.

(k) Operating Channel. An *Available Channel* used by a TVBD for transmission and/or reception.

(l) Personal/portable Device. A TVBD that transmits and/or receives radiocommunication signals while in motion or at unspecified locations.

(m) Receive site. The location where the signal of a full service station is received for rebroadcast by a television translator or low power TV, including Class A TV, station.

(n) Spectrum Sensing. A process whereby a TVBD listens to a television channel to detect whether the channel is occupied by a radio signal.

(o) Television band device (TVBD). Intentional radiators operating on *Available Channels* in the broadcast television frequency bands at 54-60 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz.

(p) TV bands database. A database of authorized services in the TV frequency bands that is used to determine the *Available Channels* at a given location for use by TVBDs.

Section 15.705 Cross reference.

(a) The provisions of Subparts A, B, and C of this part apply to TVBDs, except where specific provisions are contained in subpart H.

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

Section 15.706 Information to the user.

(a) For TV band device, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

> NOTE: This equipment has been tested and found to comply with the rules for TV band 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 communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does 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:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- 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.

Section 15.707 Permissible Channels of operation.

(a) All TVBDs are permitted to operate in the frequency bands 512-608 MHz and 614-698 MHz, except that in the 13 metropolitan areas listed Section 90.303(a) of this chapter and nearby areas where private land mobile services and commercial land mobile services are authorized by waiver, operation of TVBDs is prohibited on the first available channel on each side of TV channel 37 (608-614 MHz). These channels will be listed in the TV bands database.

(b) Operation in the bands 54-60 MHz, 76-88 MHz, 174-216 MHz, 470-512 MHz is permitted only for fixed TVBDs that communicate only with other fixed TVBDs.

(c) Fixed and Mode II TVBDs shall only operate on available channels as determined by the TV bands database and in accordance with the interference avoidance mechanisms of section 15.711 of this part.

(d) Mode I TVBDs shall only operate on available channels provided to it from a Fixed or Mode II TVBD.

Section 15.709 General technical requirements.

(a) Power limits for TVBDs are as follows:

(1) For fixed TVBDs, the maximum conducted output power over the TV channel of operation shall not exceed one watt. Transmitter power will be measured at the antenna input to account for any cable losses between the transmitter and the antenna. 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) For personal/portable TVBDs, the maximum conducted output power over the TV channel of operation shall not exceed 100 milliwatts; except that for personal/portable TVBDs that do not meet the adjacent channel separation requirements in Section 15.712(a), the maximum conducted output power shall not exceed 40 milliwatts. If transmitting antennas of directional gain greater than 0 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 0 dBi.