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Title 47 —Telecommunication
Chapter I —Federal Communications Commission
Subchapter A —General
Part 15 —Radio Frequency Devices
Subpart E —Unlicensed National Information Infrastructure Devices

§ 15.407 General technical requirements.

(a) *Power limits:*

(1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(3)

(i) For the band 5.725-5.850 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output

power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(ii) For an indoor access point operating in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 20 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 36 dBm. Indoor access points operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 36 dBm.

(iii) For client devices operating under the control of an indoor access point in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 14 dBm e.i.r.p. in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm. Client devices operating on a channel that spans the 5.725-5.850 GHz and 5.850-5.895 GHz bands must not exceed an e.i.r.p. of 30 dBm.

(iv) For a subordinate device operating under the control of an indoor access point in the 5.850-5.895 GHz band, the maximum power spectral density must not exceed 20 dBm e.i.r.p in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 36 dBm.

(v) In the 5.850-5.895 GHz band, client devices must operate under the control of an indoor access point. In all cases, an exception exists for transmitting brief messages to an access point when attempting to join its network after detecting a signal that confirms that an access point is operating on a particular channel. Access points may connect to other access points. Client devices are prohibited from connecting directly to another client device.

Note to paragraph (a)(3): The Commission strongly recommends that parties employing U-NII devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

(4) For a standard power access point and fixed client device operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands, the maximum power spectral density must not exceed 23 dBm e.i.r.p in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 36 dBm. For outdoor devices, the maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(5) For an indoor access point operating in the 5.925-7.125 GHz band, the maximum power spectral density must not exceed 5 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm.

(6) For a subordinate device operating under the control of an indoor access point in the 5.925-7.125 GHz band, the maximum power spectral density must not exceed 5 dBm e.i.r.p in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm.

(7) For a geofenced variable power access point operating in the 5.925-6.425 GHz or 6.525-6.875 GHz band, the maximum power spectral density must not exceed 11 dBm e.i.r.p. in any 1-megahertz band. In addition, the maximum e.i.r.p. over the frequency band of operation must not exceed 24 dBm.

(8)

(i) For client devices, except for fixed client devices as defined in this subpart, operating under the control of a standard power access point in 5.925-6.425 GHz and 6.525-6.875 GHz bands, the maximum power spectral density must not exceed 17 dBm e.i.r.p. in any 1-megahertz band, the maximum e.i.r.p. over the frequency band of operation must not exceed 30 dBm, and the device must limit its power to no more than 6 dB below its associated standard power access point's authorized transmit power.

(ii) For client devices operating under the control of an indoor access point in the 5.925-7.125 GHz bands, the maximum power spectral density must not exceed −1 dBm e.i.r.p. in any 1-megahertz band, and the maximum e.i.r.p. over the frequency band of operation must not exceed 24 dBm.

(iii) For client devices operating under the control of a geofenced variable power access point in the 5.925-6.425 GHz and 6.525-6.875 GHz bands, the maximum power spectral density must not exceed 5 dBm e.i.r.p. in any 1-megahertz band, the maximum e.i.r.p. over the frequency band of operation must not exceed 18 dBm, and the

device must limit its power to no more than 6 dB below its associated geofenced variable power access point's authorized transmit power.

(9) For very low power devices operating in the 5.925-7.125 GHz band, the maximum power spectral density must not exceed −5 dBm e.i.r.p in any 1-megahertz band and the maximum e.i.r.p must not exceed 14 dBm.

(10) Access points operating under the provisions of paragraphs (a)(5), (6), (7) and (9) of this section must employ a permanently attached integrated antenna.

(11) The maximum transmitter channel bandwidth for U-NII devices in the 5.925-7.125 GHz band is 320 megahertz.

(12) The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.

(13) Power spectral density measurement: The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.895 GHz band are made over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in all other bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

(b) ***Undesirable emission limits.*** Except as shown in paragraph (b)(10) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(4) For transmitters operating solely in the 5.725-5.850 GHz band:

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

(ii) [Reserved]

(5) For transmitters operating solely in the 5.850-5.895 GHz band or operating on a channel that spans across 5.725-5.895 GHz:

(i) For an indoor access point or subordinate device, all emissions at or above 5.895 GHz shall not exceed an e.i.r.p. of 15 dBm/MHz and shall decrease linearly to an e.i.r.p. of −7 dBm/MHz at or above 5.925 GHz.

(ii) For a client device, all emissions at or above 5.895 GHz shall not exceed an e.i.r.p. of −5 dBm/MHz and shall decrease linearly to an e.i.r.p. of −27 dBm/MHz at or above 5.925 GHz.

(iii) For a client device or indoor access point or subordinate device, all emissions below 5.725 GHz shall not exceed an e.i.r.p. of −27 dBm/MHz at 5.65 GHz increasing linearly to 10 dBm/MHz at 5.7 GHz, and from 5.7 GHz increasing linearly to a level of 15.6 dBm/MHz at 5.72 GHz, and from 5.72 GHz increasing linearly to a level of 27 dBm/MHz at 5.725 GHz.

(6) For transmitters operating within the 5.925-7.125 GHz band: Any emissions outside of the 5.925-7.125 GHz band must not exceed an e.i.r.p. of −27 dBm/MHz.

(7) For transmitters operating within the 5.925-7.125 GHz bands: Power spectral density must be suppressed by 20 dB at 1 MHz outside of channel edge, by 28 dB at one channel bandwidth from the channel center, and by 40 dB at one- and one-half times the channel bandwidth away from channel center. At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits must be linearly interpolated between 20 dB and 28 dB suppression, and at frequencies between one and one- and one-half

times an unlicensed device's channel bandwidth, the limits must be linearly interpolated between 28 dB and 40 dB suppression. Emissions removed from the channel center by more than one- and one-half times the channel bandwidth must be suppressed by at least 40 dB.

(8) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. 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 1 MHz.

(9) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.

(10) The provisions of § 15.205 apply to intentional radiators operating under this section.

(11) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

(c) ***Transmission discontinuation requirement.*** The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. The provisions in this paragraph (c) are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how the requirement in this paragraph (c) is met.

(d) ***Operational restrictions for 6 GHz U-NII devices.***

(1) Operational restrictions include:

(i) ***Oil platforms.*** Standard power access points, fixed client devices, geofenced variable power access points, very low power devices, and low-power indoor access points in the 5.925-7.125 GHz band are prohibited from operating on oil platforms.

(ii) ***Land vehicles.*** Operation of standard power access points, fixed client devices, and indoor access points in the 5.925-7.125 GHz band is prohibited on vehicles (*e.g.,* cars, trains).

(iii) ***Boats.*** Operation of standard power access points, fixed client devices, and indoor access points in the 5.925-7.125 GHz band is prohibited on boats.

(iv) ***Aircraft.*** Standard power access points, fixed client devices, geofenced variable power access points, very low power devices, and low-power indoor access points in the 5.925-7.125 GHz band are prohibited from operating on aircraft, except that very low power devices and low-power indoor access points are permitted to operate in the 5.925-6.425 GHz bands in large aircraft while flying above 10,000 feet.

(v) ***Unmanned aircraft systems.*** Operation of transmitters in the 5.925-7.125 GHz band is prohibited for control of or communications with unmanned aircraft systems.

(2) [Reserved]

(3) Transmitters operating under the provisions of paragraphs (a)(5) and (6) and (a)(8)(ii) of this section are limited to indoor locations.

(4) In the 5.925-7.125 GHz band, indoor access points and subordinate devices must bear the following statement in a conspicuous location on the device and in the user's manual: FCC regulations restrict operation of this device to indoor use only. The operation of this device is prohibited on oil platforms, cars, trains, boats, and aircraft, except that operation of this device is permitted in large aircraft while flying above 10,000 feet.

(5)

(i) In the 5.925-7.125 GHz band, client devices must operate under the control of a standard power access point, indoor access point, subordinate device, or geofenced variable power access point; Subordinate devices must operate under the control of an indoor access point.

(ii) Access points and subordinate devices may connect to other access points or subordinate devices.

(iii) Fixed client devices may only connect to a standard power access point.

(iv) In all cases, an exception exists such that a client device may transmit brief messages to an access point when attempting to join its network after detecting a signal that confirms that an access point is operating on a particular channel.

(v) Client devices are prohibited from connecting directly to another client device, except that client devices under the control of the same geofenced variable power access point may communicate directly with each other using the same frequency they are using to communicate with the geofenced variable power access point.

(6) All U-NII transmitters, except for standard power access points and fixed client devices, operating in the 5.925-7.125 GHz band must employ a contention-based protocol.

(7) [Reserved]

(8) Very low power devices, geofenced variable power access points, and clients operating under the control of a geofenced variable power access point may not be installed on fixed outdoor infrastructure. Such devices may not be mounted on outdoor structures, such as buildings or poles.

(9) Geofenced variable power access points and very low power devices must prioritize operations on frequencies above 6.105 GHz prior to operating on frequencies between 5.925 GHz and 6.105 GHz.

(10) Geofenced variable power access points and very low power devices operating in the 5.925-7.125 GHz band shall employ a transmit power control (TPC) mechanism with the capability to operate at least 6 dB below the device's maximum e.i.r.p. PSD value.

(e) Within the 5.725-5.850 GHz and 5.850-5.895 GHz bands, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

(f) Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§ 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a “general population/uncontrolled” environment. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

(h) Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS).

(1) Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

(2) Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is −64 dBm. For devices that operate with less than 200 mW e.i.r.p. and a power spectral density of less than 10 dBm in a 1 MHz band, the minimum detection threshold is −62 dBm. The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna. For the initial channel setting, the manufacturers shall be permitted to provide for either random channel selection or manual channel selection.

(i) Operational Modes. The DFS requirement applies to the following operational modes:

(A) The requirement for channel availability check time applies in the master operational mode.

(B) The requirement for channel move time applies in both the master and slave operational modes.

(ii) Channel Availability Check Time. A U-NII device shall check if there is a radar system already operating on the channel before it can initiate a transmission on a channel and when it has to move to a new channel. The U-NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of this section, is detected within 60 seconds.

(iii) Channel Move Time. After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

(iv) Non-occupancy Period. A channel that has been flagged as containing a radar system, either by a channel availability check or in-service monitoring, is subject to a non-occupancy period of at least 30 minutes. The non-occupancy period starts at the time when the radar system is detected.

(i) ***Device Security.*** All U-NII devices must contain security features to protect against modification of software by unauthorized parties.

(1) Manufacturers must implement security features in any digitally modulated devices capable of operating in any of the U-NII bands, so that third parties are not able to reprogram the device to operate outside the parameters for which the device was certified. The software must prevent the user from operating the transmitter with operating frequencies, output power, modulation types or other radio frequency parameters outside those that were approved for the device. Manufacturers may use means including, but not limited to the use of a private network that allows only authenticated users to download software, electronic signatures in software or coding in hardware that is decoded by software to verify that new software can be legally loaded into a device to meet these requirements and must describe the methods in their application for equipment authorization.

(2) Manufacturers must take steps to ensure that DFS functionality cannot be disabled by the operator of the U-NII device.

(j) ***Operator Filing Requirement:*** Before deploying an aggregate total of more than one thousand outdoor access points within the 5.15-5.25 GHz band, parties must submit a letter to the Commission acknowledging that, should harmful interference to licensed services in this band occur, they will be required to take corrective action. Corrective actions may include reducing power, turning off devices, changing frequency bands, and/or further reducing power radiated in the vertical direction. This material shall be submitted to Laboratory Division, Office of Engineering and Technology, Federal Communications Commission, 7435 Oakland Mills Road, Columbia, MD 21046. Attn: U-NII Coordination, or via Web site at *https://www.fcc.gov/labhelp* with the SUBJECT LINE: “U-NII-1 Filing”.

(k) ***Automated frequency coordination (AFC) system.***

(1) Standard power access points and fixed client devices operating under paragraph (a)(4) of this section must access an AFC system to determine the available frequencies and the maximum permissible power in each frequency range at their geographic coordinates prior to transmitting. Standard power access points and fixed client devices may transmit only on frequencies and at power levels that an AFC system indicates as available.

(2) An AFC system must be capable of determining the available frequencies in steps of no greater than 3 dB below the maximum permissible e.i.r.p of 36 dBm, and down to at least a minimum level of 21 dBm.

(3) An AFC system must obtain information on protected services within the 5.925-6.425 GHz and 6.525-6.875 GHz bands from Commission databases and use that information to determine frequency availability for standard power access points and fixed client devices. Based on the criteria specified in paragraph (n) of this section, an AFC system must establish location and frequency-based exclusion zones (both co-channel and adjacent channel) around fixed microwave receivers operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands. Individual standard power access points and fixed client devices must not operate co-channel to fixed microwave system frequencies within co-channel exclusion zones, or on adjacent channel frequencies within adjacent channel exclusion zones.

(4) An AFC system must use the information supplied by standard power access points and fixed client devices during registration, as set forth in this section, to determine available frequencies and the maximum permissible power in each frequency range for a standard power access point at any given location. All such determinations and assignments must be made in a non-discriminatory manner, consistent with this part.

(5) An AFC system must store registered information in a secure database until a standard power access point or fixed client device ceases operation at a location. For the purpose of this paragraph, a standard power access point or fixed client device is considered to have ceased operation when that device has not contacted the AFC system for more than three months to verify frequency availability information.

(6) An AFC system must verify the validity of the FCC identifier (FCC ID) of any standard power access point and fixed client device seeking access to its services prior to authorizing the access point to begin operation. A list of standard power access points with valid FCC IDs and the FCC IDs of those devices must be obtained from the Commission's Equipment Authorization System.

(7) The general purposes of AFC system include:

(i) Enacting all policies and procedures developed by the AFC system operators pursuant to this section.

(ii) Registering, authenticating, and authorizing standard power access point and fixed client device operations, individually or through a network element device representing multiple standard power access points from the same operating network.

(iii) Providing standard power access points and fixed client devices with the permissible frequencies and the maximum permissible power in each frequency range at their locations using propagation models and interference protection criteria defined in paragraph (n) of this section.

(iv) Obtaining updated protected sites information from Commission databases.

(8) Standard power access points and fixed client devices:

(i) Must register with and be authorized by an AFC system prior to the standard power access point and fixed client device's initial service transmission, or after a standard power access point or fixed client device changes location, and must obtain a list of available frequencies and the maximum permissible power in each frequency range at the standard power access point and fixed client device's location.

(ii) Must register with the AFC system by providing the following parameters: Geographic coordinates (latitude and longitude referenced to North American Datum 1983 (NAD 83)), antenna height above ground level, FCC identification number, and unique manufacturer's serial number. If any of these parameters change, the standard power access point or fixed client device must provide updated parameters to the AFC system. All information provided by the standard power access point and the fixed client device to the AFC system must be true, complete, correct, and made in good faith.

(iii) Must provide the registration information to the AFC system either directly and individually or by a network element representing multiple standard power access points or fixed client devices from the same operating network. The standard power access point, fixed client device or its network element must register with the AFC system via any communication link, wired or wireless, outside 5.925-6.425 GHz and 6.525-6.875 GHz bands.

(iv) Must contact an AFC system at least once per day to obtain the latest list of available frequencies and the maximum permissible power the standard power access point or fixed client device may operate with on each frequency at the standard power access point and fixed client device's location. If the standard power access point or fixed client device fails to successfully contact the AFC system during any given day, the standard power access point or fixed client device 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 AFC system and re-verifies its list of available frequencies and associated power levels.

(v) Must incorporate adequate security measures to prevent it from accessing AFC systems not approved by the FCC and to ensure that unauthorized parties cannot modify the device to operate in a manner inconsistent with the rules and protection criteria set forth in this section and to ensure that communications between standard power access points, fixed client devices and AFC systems are secure to prevent corruption or unauthorized interception of data. Additionally, the AFC system must incorporate security measures to protect against unauthorized data input or alteration of stored data, including establishing communications authentication procedures between client devices and standard power access points.

(9) Standard power access point and fixed client device geo-location capability:

(i) A standard power access point and a fixed client device must include either an internal geo-location capability or an integrated capability to securely connect to an external geolocation devices or service, to automatically determine the standard power access point's geographic coordinates and location uncertainty (in meters), with a confidence level of 95%. The standard power access point and fixed client device must report such coordinates and location uncertainty to an AFC system at the time of activation from a power-off condition.

(ii) An external geo-location source may be connected to a standard power access point or fixed client device through either a wired or a wireless connection. A single geo-location source may provide location information to multiple standard power access points or fixed client devices.

(iii) An external geo-location source must be connected to a standard power access point or fixed client device using a secure connection that ensures that only an external geo-location source approved for use with a standard power access point or fixed client device provides geographic coordinates to that standard power access point or fixed client device. Alternatively, an extender cable may be used to connect a remote receive antenna to a geo-location receiver within a standard power access point or fixed client device.

(iv) The applicant for certification of a standard power access point or fixed client device must demonstrate the accuracy of the geo-location method used and the location uncertainty. For standard power access points and fixed client devices that may not use an internal geo-location capability, this uncertainty must account for the accuracy of the geo-location source and the separation distance between such source and the standard power access point or fixed client device.

(10) An AFC system operator will be designated for a five-year term which can be renewed by the Commission based on the operator's performance during the term. If an AFC system ceases operation, it must provide at least 30-days' notice to the Commission and transfer any registration data to another AFC system operator.

(11) The Commission will designate one or more AFC system operators to provide service in the 5.925-6.425 GHz and 6.525-6.875 GHz bands.

(12) The Commission may permit the functions of an AFC system, such as a data repository, registration, and query services, to be divided among multiple entities; however, entities designated as AFC system operators will be held accountable for the overall functioning and system administration of the AFC system.

(13) The AFC system must ensure that all communications and interactions between the AFC system and standard power access points and fixed client devices are accurate and secure and that unauthorized parties cannot access or alter the database, or the list of available frequencies and associated powers sent to a standard power access point.

(14) An AFC system must implement the terms of international agreements with Mexico and Canada.

(15) Each AFC system operator designated by the Commission must:

(i) Maintain a regularly updated AFC system database that contains the information described in this section, including incumbent's information and standard power access points and fixed client devices registration parameters.

(ii) Establish and follow protocols and procedures to ensure compliance with the rules set forth in this part.

(iii) Establish and follow protocols and procedures sufficient to ensure that all communications and interactions between the AFC system and standard power access points and fixed client devices are accurate and secure and that unauthorized parties cannot access or alter the AFC system, or the information transmitted from the AFC system to standard power access points or fixed client devices.

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

(v) Respond in a timely manner to verify, correct, or remove, as appropriate, data in the event that the Commission or a party presents to the AFC system Operator a claim of inaccuracies in the AFC system. This requirement applies only to information that the Commission requires to be stored in the AFC system.

(vi) Establish and follow protocols to comply with enforcement instructions from the Commission, including discontinuance of standard power access point operations in designated geographic areas.

(16) An AFC system operator may charge fees for providing service in registration and channel availability functions. The Commission may, upon request, review the fees and can require changes to those fees if the Commission finds them unreasonable.

(l) ***Geofencing system.***

(1) A geofencing system must obtain information on protected services within the 5.925-6.425 GHz and 6.525-6.875 GHz bands from Commission databases and use that information to determine frequency specific zones for geofenced variable power access points and provide that information to those devices. These zones must be determined for specified frequencies based on the propagation models and protection criteria specified in paragraph (n) of this section.

(i) The zones can be determined as exclusion zones specifying frequencies on which and locations where geofenced variable power devices are not permitted to operate or inclusion zones specifying frequencies on which and locations where geofenced variable power devices are permitted to operate.

(ii) The geofencing system must assume that geofenced variable power devices are at a height of 10 meters when determining exclusion zones.

(iii) The geofencing system must access the Commission's licensing databases and update the frequency-specific zones at least once per day to ensure that they are based on the most recent information in the Commission's databases.

(2) Geofencing systems must establish exclusion or inclusion zones to prevent geofenced variable power access point operations between 6.525-6.875 GHz on the oceans beyond the United States territorial sea as defined in 33 CFR 2.22(a)(1).

(3) The geofencing system must ensure that all communications and interactions between the geofencing system and the geofenced variable power access point and/or all communications between the geofencing system and Commission databases are accurate and secure and that unauthorized parties cannot access or alter the database or any information it provides to geofenced variable power access points. Additionally, the geofencing system must incorporate security measures to protect against unauthorized data input or alteration of stored data.

(4) A geofencing system must verify the validity of the FCC identifier (FCC ID) of any geofenced variable power access point seeking access to its services prior to authorizing the access point to begin operation. A list of geofenced variable power access points with valid FCC IDs and the FCC IDs of those devices must be obtained from the Commission's Equipment Authorization System.

(5) A geofencing system must implement the terms of international agreements with Mexico and Canada.

(6) With regard to enforcement instruction *and* data accuracy, each geofencing system must:

(i) Ensure that a regularly updated geofencing system database that contains the information described in this section, including frequency-specific exclusion or inclusion zones and geofenced variable power access points authorization parameters, is maintained.

(ii) Respond in a timely manner to verify, correct, or remove, as appropriate, data in the event that the Commission or a party presents a claim of inaccuracies in the geofencing system.

(iii) Establish and follow protocols to comply with enforcement instructions from the Commission, including discontinuing geofenced variable power access point operations on specified frequencies in designated geographic areas and predetermined exclusion zones.

(iv) Comply with instructions from the Commission to adjust frequency-specific exclusion or inclusion zones to more accurately reflect the potential for harmful interference.

(7) A geofencing system operator must provide continuous service to all geofenced variable power access points for which it has agreed to provide service. If a geofencing system ceases operation, the operator must provide at least 30 days' notice to the Commission and a description of any arrangements made for those devices to continue to receive location and frequency-specific update information.

(8) A geofencing system operator may charge fees for providing service. The Commission may, upon request, review the fees and can require changes to those fees if the Commission finds them to be unreasonable.

(m) ***Geofenced variable power access point requirements.***

(1) A geofenced variable power access point must register with and be authorized by a geofencing system prior to the geofenced variable power access point's initial service transmission. At registration the geofenced variable power access point must provide its FCC identifier (FCC ID) and either its unique manufacturer's serial number or its model name/number or other information sufficient to uniquely identify the device manufacturer and model.

(2) Geofenced variable power access point device geo-location capability:

(i) A geofenced variable power access point must include an internal geo-location capability to automatically determine the geofenced variable power access point's geographic coordinates and location uncertainty (in meters), with a 95% confidence level. The geofenced variable power access point must use such coordinates and location uncertainty when comparing the device's specific location to frequency-specific information for its location obtained from the geofencing system.

(ii) Geofenced variable power access point equipment authorization applicants must provide an attestation describing the geo-location method used, that method's accuracy, and the location uncertainty accuracy.

(3) A geofenced variable power access point must access a geofencing system to obtain frequency-specific information (*i.e.,* exclusion zones or inclusion zones) for the area in which it is operating or intends to operate (*e.g.,* within a specific point radius or within specific boundaries) prior to transmitting. If the geofenced variable power access point moves beyond those boundaries, it must obtain additional frequency-specific information for the new area and adjust its operating frequency, if necessary, prior to operating in this new area. If the geofenced variable power access point does not obtain frequency specific information for the area in which it is currently located, it may not transmit. The geofenced variable power access point must obtain updated frequency-specific information from the geofencing system at least once per day. If the geofenced variable power access point fails to obtain the updated frequency specific information on any given day, the geofenced variable power access point may continue to operate until 11:59 p.m. of the following day at which time it must cease operations until it can obtain updated frequency-specific information for its location.

(4) A geofenced variable power access point must determine its location and avoid transmitting on frequencies that are not available in accordance with the frequency-specific information for its location obtained from the geofencing system. The geofenced variable power access point may not permit a client device operating under its control to transmit on frequencies that are not available to the geofenced variable power access point. The geofenced variable power access point must determine its location frequently enough to ensure that it can adjust its operating frequency, including ceasing operation, within one second after any portion of the access point's location uncertainty region crosses into an area in which its current operating frequency is prohibited.

(5) A geofenced variable power access point must incorporate adequate security measures to prevent it from accessing geofencing systems not approved by the FCC, to ensure that unauthorized parties cannot modify the device to operate in a manner inconsistent with the rules and protection criteria set forth in this section, and to ensure that communications between the geofenced variable power access point and geofencing systems and between the geofenced variable power access point and a client device operating under its control are secure to prevent corruption or unauthorized interception of data.

(n) ***Incumbent protection by AFC and geofencing systems: Fixed microwave services*** —

(1) ***Propagation models.*** Propagation models to determine the appropriate separation distance between a standard power access point, a fixed client device, or geofenced variable power access point and an incumbent fixed microwave service receiver. For a separation distance:

(i) Up to 30 meters, the AFC system and geofencing system must use the free space path-loss model.

(ii) More than 30 meters and up to and including one kilometer, the AFC system and geofencing system must use the Wireless World Initiative New Radio phase II (WINNER II) model. The AFC system or geofencing system must use site-specific information, including buildings and terrain data, for determining the line-of-sight/non-line-of-sight path component in the WINNER II model, where such data is available. For evaluating paths where such data is not available, the AFC system and geofencing system must use a probabilistic model combining the line-of-sight path and non-line-of-sight path into a single path-loss as follows:

Equation 1 to Paragraph (n)(1)(ii)

$$\text{Path-loss } (L) = \Sigma_i P(i) * L_i = P_{LOS} * L_{LOS} + P_{NLOS} * L_{NLOS}$$

Where:
P_{LOS} is the probability of line-of-sight.
L_{LOS} is the line-of-sight path loss.
P_{NLOS} is the probability of non-line-of sight.
L_{NLOS} is the non-line-of-sight path loss.
L is the combined path loss.

The WINNER II path loss models include a formula to determine P_{LOS} as a function of antenna heights and distance.

P_{NLOS} is equal to $(1-P_{LOS})$.

In all cases, the AFC system and geofencing system will use the correct WINNER II parameters to match the morphology of the path between a standard power access point or geofenced variable power access point and a fixed microwave receiver (*i.e.,* Urban, Suburban, or Rural).

(iii) More than one kilometer, the AFC system and geofencing system must use Irregular Terrain Model (ITM) combined with the appropriate clutter model. To account for the effects of clutter, such as buildings and foliage, the AFC system and geofencing system must combine the ITM with the ITU-R P.2108-0 (06/2017) clutter model for urban and suburban environments and the ITU-R P.452-16 (07/2015) clutter model for rural environments. The AFC system and geofencing system should use the most appropriate clutter category for the local morphology when using ITU-R P.452-16. However, if detailed local information is not available, the “Village Centre” clutter category should be used. The AFC system and geofencing system must use 1 arc-second digital elevation terrain data and, for locations where such data is not available, the most granular available digital elevation terrain data.

(2) ***Interference protection criteria.***

(i) The AFC system and geofencing system must use −6 dB I/N as the interference protection criteria in determining the size of the co-channel zone where I (interference) is the co-channel signal from the standard power access point, geofenced variable power access point, or fixed client device at the fixed microwave service receiver, and N (noise) is background noise level at the fixed microwave service receiver.

(ii) The AFC system must use −6 dB I/N as the interference protection criteria in determining the size of the adjacent channel zone, where I (interference) is the signal from the standard power access point or fixed client device's out of channel emissions at the fixed microwave service receiver and N (noise) is background noise level at the fixed microwave service receiver. The adjacent channel zone must be calculated based on the emissions requirements of paragraph (b)(7) of this section.

(3) ***Body loss.*** Geofencing systems may include up to 4 dB additional loss to account for losses due to scattering and absorption from a nearby body or object.

(o) ***Incumbent protection by AFC and geofencing systems: Radio astronomy services.*** The AFC system and geofencing system must enforce a zone to the following radio observatories that observe between 6650-6675.2 MHz: Arecibo Observatory, the Green Bank Observatory, the Very Large Array (VLA), the 10 Stations of the Very Long Baseline Array (VLBA), the Owens Valley Radio Observatory, and the Allen Telescope Array. The zone sizes are based on the radio line-of-sight and determined using 4/3 earth curvature and the following formula:

Equation 2 to Paragraph (o)

dkm_los = 4.12 * (sqrt(Htx) + sqrt(Hrx))

Where:
Htx is the height of the unlicensed standard power access point or fixed client device.
Hrx is the height of the radio astronomy antenna in meters above ground level.
Htx is 10 meters for an unlicensed geofenced variable power access point.

Coordinate locations of the radio observatories are listed in § 2.106(c)(131) and (385) of this chapter.

(p) ***Incumbent protection of fixed satellite services.*** Standard power access points and fixed client devices located outdoors must limit their maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon to 21 dBm (125 mW) to protect fixed satellite services.

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