

§ 90.219 Use of signal boosters.

This section contains technical and operational rules allowing the use of [signal boosters](#) in the Private [Land Mobile Radio Services](#) (PLMRS). Rules for [signal booster operation](#) in the [Commercial Mobile Radio Services](#) under part 90 are found in [§ 20.21](#) of this chapter.

(a) Definitions. The definitions in this paragraph apply only to the rules in this section.

Class A signal booster. A [signal booster](#) designed to retransmit signals on one or more specific channels. A [signal booster](#) is deemed to be a Class A [signal booster](#) if none of its passbands exceed 75 kHz.

Class B signal booster. A [signal booster](#) designed to retransmit any signals within a wide frequency band. A [signal booster](#) is deemed to be a Class B [signal booster](#) if it has a passband that exceeds 75 kHz.

Coverage area of a PLMRS station. All locations within the normal reliable operating range (service contour) of a PLMRS [station](#).

Deploy a signal booster. Install and/or initially adjust a [signal booster](#).

Distributed Antenna System (DAS). A network of spatially separated antenna nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure.

Operate a signal booster. Maintain operational control over, and responsibility for the proper functioning of, a [signal booster](#).

Signal booster. A device or system that automatically receives, amplifies, and retransmits signals from wireless [stations](#) into and out of building interiors, tunnels, shielded outdoor areas and other locations where these signals would otherwise be too weak for reliable communications. [Signal booster](#) systems may contain both Class A and Class B [signal boosters](#) as components.

(b) Authority to operate. PLMRS licensees for [stations](#) operating on assigned channels higher than 150 MHz may operate signal boosters, limited to the service band for which they are authorized, as needed anywhere within the PLMRS [stations'](#) service contour, but may not extend the [stations'](#) service contour.

(1) PLMRS licensees may also consent to [operation](#) of [signal boosters](#) by non-licensees (such as a building owner or a [signal booster](#) installation contractor) within their service contour and across their applicable frequencies, but must maintain a reasonable level of control over these [operations](#) in order to resolve interference problems.

(i) Non-licensees seeking to operate [signal boosters](#) must obtain the express consent of the licensee(s) of the frequencies for which the device or system is intended to amplify. The consent must be maintained in a recordable format that can be presented to an FCC representative or other relevant licensee investigating interference.

(ii) Consent is not required from third party (unintended) licensees whose signals are incidentally retransmitted. However, [signal booster operation](#) is on a non-interference basis and [operations](#) may be required to cease or alter the operating parameters due to a request from an FCC representative or a licensee's request to resolve interference.

(2) [Reserved]

(c) Licensee responsibility; interference. PLMRS licensees that operate [signal boosters](#) are responsible for their proper [operation](#), and are responsible for correcting any [harmful interference](#) that [signal booster operation](#) may cause to other licensed communications services. Normal co-channel transmissions are not considered to be [harmful interference](#). Licensees are required to resolve interference problems pursuant to [§ 90.173\(b\)](#). Licensees shall act in good faith regarding the [operation](#) of [signal boosters](#) and in the resolution of interference due to [signal booster operation](#). Licensees who are unable to determine the location or cause of [signal booster](#) interference may seek assistance from the FCC to resolve such problems.

(d) Deployment rules. Deployment of [signal boosters](#) must be carried out in accordance with the rules in this paragraph.

(1) [Signal boosters](#) may be used to improve coverage in weak signal areas only.

(2) [Signal boosters](#) must not be used to extend PLMRS stations' normal operating range.

(3)

(i) Except as set forth in [paragraph \(d\)\(3\)\(ii\)](#) of this section, [signal boosters](#) must be deployed such that the radiated power of each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts [effective radiated power \(ERP\)](#).

(ii) [Railroad licensees](#) may operate Class A [signal boosters](#) transmitting on a single channel with up to 30 Watts [ERP](#) on frequencies 452/457.9000 to 452/457.96875 MHz in areas where communication between the front and rear of trains is unsatisfactory due to distance or intervening terrain barriers.

(4) Class B [signal boosters](#) may be deployed only at fixed locations; mobile [operation](#) of Class B [signal boosters](#) is prohibited after November 1, 2014.

(5) Class B [signal booster](#) installations must be registered in the FCC [signal booster](#) database that can be accessed at the following URL: www.fcc.gov/signal-boosters/registration.

(6) Good engineering practice must be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of [harmful interference](#) caused by any given deployment, the FCC may require additional attenuation or filtering of the emissions and/or noise from [signal boosters](#) or [signal booster](#) systems, as necessary to eliminate the interference.

(i) In general, the [ERP](#) of intermodulation products should not exceed –30 dBm in 10 kHz measurement bandwidth.

(ii) In general, the [ERP](#) of noise within the passband should not exceed –43 dBm in 10 kHz measurement bandwidth.

(iii) In general, the [ERP](#) of noise on spectrum more than 1 MHz outside of the passband should not exceed –70 dBm in a 10 kHz measurement bandwidth.

(7) [Signal booster](#) passbands are limited to the service band or bands for which the operator is authorized. In general, [signal boosters](#) should utilize the minimum passband that is sufficient to accomplish the purpose. Except for distributed antenna systems (DAS) installed in buildings, the passband of a Class B booster should not encompass both commercial services (such as ESMR and Cellular Radiotelephone) and part 90 Land Mobile and Public Safety Services.

(e) Device Specifications. In addition to the general rules for equipment certification in [§ 90.203\(a\)\(2\)](#) and part 2, [subpart J](#) of this chapter, a [signal booster](#) must also meet the rules in this paragraph.

(1) The [output power](#) capability of a [signal booster](#) must be designed for deployments providing a radiated power not exceeding 5 Watts [ERP](#) for each retransmitted channel.

(2) The noise figure of a [signal booster](#) must not exceed 9 dB in either direction.

(3) Spurious emissions from a [signal booster](#) must not exceed –13 dBm within any 100 kHz measurement bandwidth.

(4) A [signal booster](#) must be designed such that all signals that it retransmits meet the following requirements:

(i) The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed, **provided that** the retransmitted signals meet the requirements of [§ 90.213](#).

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

(iii) The retransmitted signals continue to meet the unwanted emissions limits of [§ 90.210](#) applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin).

(5) On or after March 1, 2014, a [signal booster](#) must be labeled to indicate whether it is a Class A or Class B device, and the label must include the following advisory

(1) In on-line point-of-sale marketing materials,

(2) In any print or on-line owner's manual and installation instructions,

(3) On the outside packaging of the device, and

(4) On a label affixed to the device:

“WARNING. This is NOT a CONSUMER device. It is designed for installation by FCC LICENSEES and QUALIFIED INSTALLERS. You MUST have an FCC LICENSE or express consent of an FCC Licensee to operate this device. You MUST register Class B [signal boosters](#) (as defined in [47 CFR 90.219](#)) online at www.fcc.gov/signal-boosters/registration. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.”

[[78 FR 21564](#), Apr. 12, 2013, as amended at [83 FR 61097](#), Nov. 27, 2018]

CHAPTER 27 ELECTRICAL

[F] 2702.2.3 Emergency responder communication coverage systems.

Standby power shall be provided for in-building 2-way emergency responder communication coverage systems required in [Section 918](#) and the [International Fire Code](#). The standby power supply shall be capable of operating the in-building 2-way emergency responder communication coverage system at 100-percent system operation capacity for a duration of not less than 12 hours.

From the Safer Buildings Coalition (January 2022):

“The SBC (Safer Buildings Coalition) does not maintain a specific list of jurisdictions that have adopted in-building emergency responder communication enhancement system (ERCES) requirements. We travel to numerous jurisdictions annually conducting seminars on the ERCES and our audiences are made up of AHJ's, industry stakeholders and building owner representatives. As such, I am aware of numerous states and jurisdictions such as Florida, South Carolina, DC, North Carolina, California, Texas, Georgia, Las Vegas, Oregon, Washington State, New Jersey, Maryland, New York, and many others that have adopted the requirements of the IFC/NFPA. **In all these locations, the requirement to provide these systems when needed is located within the fire and/or building codes and they are the responsibility of the owner typically prior to a final certificate of occupancy being issued. Virginia is the only state/jurisdiction I am aware of that has something different.**”

- Alan Perdue, Executive Director for the Safer Buildings Coalition

Honeywell – BDA/ERCES Systems Presentation (June 2021):

“At present 35 states, including Washington D.C., are requiring BDA systems. There are 34 states that have adopted the IFC; 4 more the IBC; and 9 more NFPA 1/101.”

<https://www.mycfcs.org/assets/CoffeeBreakLit/Campus%20Coffee%20Break%202021%20.pdf>

Personal Research (January 2022):

At present, 47 states have requirements for ERCES in new buildings as well as Washington, DC and Puerto Rico. Other than Virginia, the two remaining states allow optional local adoption of ERCES requirements. The vast majority of these statutes simply adopt Section 510 of the International Fire Code without amendment. **None, other than Virginia, share the responsibility of the system with the locality.**

International Code Council (August 2021):

<https://www.iccsafe.org/wp-content/uploads/Master-I-Code-Adoption-Chart-AUG-2021.pdf>



SECTION 510 EMERGENCY RESPONDER COMMUNICATION COVERAGE

510.1 Emergency responder radio communication coverage in new buildings. *Approved* in-building 2- way emergency responder communication coverage shall be provided in all new buildings. In-building 2- way emergency responder communication coverage shall be based on the existing coverage levels of the public safety communication systems utilized by the jurisdiction, measured at the exterior of the building. This section shall not require improvement of the existing public safety communication systems.

Exceptions:

1. Where *approved* by the building official and the *fire code official*, a wired communication system in accordance with Section 907.2.13.2 shall be permitted to be installed or maintained instead of an *approved communications* coverage system.
2. Where it is determined by the *fire code official* that the communications coverage system is not needed.
3. In facilities where emergency responder communication coverage is required and such systems, components or equipment required could have a negative impact on the normal operations of that facility, the *fire code official* shall have the authority to accept an automatically activated emergency responder communication coverage system.
4. New buildings 7,500 square feet or less and not more than 1 story above *grade plane*.
 - 4.1. This exception does not apply to windowless buildings, underground buildings or buildings with a *basement*.

510.2 Emergency Responder Communications Coverage in Existing Buildings. Deleted

510.3 Permit required. A construction permit for the installation of or modification to in-building 2- way emergency responder communication coverage systems and related equipment is required as specified in Section 105.7.6. Maintenance performed in accordance with this code is not considered a modification and does not require a permit.

510.4 Technical requirements. Equipment required to provide emergency responder communication coverage shall be listed in accordance with UL 2524. Systems, components and equipment required to provide the in-building 2- way emergency responder communication coverage system shall comply with Sections 510.4.1 through 510.4.2.8.

510.4.1 Emergency communication coverage system signal strength. The building shall be considered to have acceptable in-building 2- way emergency responder communication system coverage when signal strength measurements in 95 percent of all areas on each floor of the building and critical areas shall be provided with 99 percent floor area radio coverage. Critical areas are fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, sprinkler rooms, riser rooms, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the AHJ. The signal strength shall meet requirements in Sections 510.4.1.1 through 510.4.1.3.

510.4.1.1 Minimum signal strength into the building. The minimum inbound signal strength shall be sufficient to provide usable voice communications throughout the coverage area as specified by the *fire code official*. The inbound signal level shall be a minimum of -95dBm throughout the coverage area and sufficient to provide not less than a Delivered Audio Quality (DAQ) of 3.0 or an equivalent Signal-to-Interference-Plus-Noise Ratio (SINR) applicable to the technology for either analog or digital signals.

510.4.1.2 Minimum signal strength out of the building. The minimum outbound signal strength shall be sufficient to provide usable voice communications throughout the coverage area as specified by the *fire code official*. The

outbound signal level shall be sufficient to provide not less than a DAQ of 3.0 or an equivalent SINR applicable to the technology for either analog or digital signals.

510.4.1.3 System performance. Signal strength shall be sufficient to meet the requirements of the applications being utilized by public safety for emergency operations through the coverage area as specified by the fire code official in Section 510.4.2.2.

510.4.2 System design. The in-building 2- way emergency responder communication coverage system shall be designed in accordance with Sections 510.4.2.1 through 510.4.2.8 and NFPA 1221.

510.4.2.1 Amplification systems and components. Buildings and structures that cannot support the required level of in-building 2- way emergency responder communication coverage shall be equipped with systems and components to enhance the radio signals and achieve the required level of emergency communication coverage specified in Sections 510.4.1 through 510.4.1.3. Emergency communication systems utilizing radio-frequency-emitting devices and cabling shall be approved by the fire code official. Prior to installation, all RF-emitting devices shall have the certification of the radio licensing authority and be suitable for public safety use.

510.4.2.2 Technical criteria. The fire code official shall maintain a document providing the specific technical information and requirements for the in-building 2- way emergency responder communication coverage system. This document shall contain, but not be limited to, the various frequencies required, the location of radio sites, the effective radiated power of radio sites, the maximum propagation delay in microseconds, the applications being used and other supporting technical information necessary for system design.

510.4.2.3 Standby power. In-building 2- way emergency responder communication coverage systems shall be provided with dedicated standby power or provided with 2-hour standby batteries and connected to the facility generator power system in accordance with Section 604. The standby power supply shall be capable of operating the in-building 2- way emergency responder communication coverage system at 100-percent system capacity for a duration of not less than 12 hours.

510.4.2.4 Signal booster requirements. If used, signal boosters shall meet the following requirements:

1. All signal booster components shall be contained in a National Electrical Manufacturer's Association (NEMA) 4-type waterproof cabinet.
2. Battery systems used for the emergency power source shall be contained in a NEMA 3R or higher-rated cabinet.
3. Equipment shall have FCC or other radio licensing authority certification and be suitable for public safety use prior to installation.
4. Where a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas to not less than 20dB greater than the system gain under all operating conditions.
5. Active RF emitting devices used in in-building 2- way emergency responder communication coverage systems shall have built-in oscillation detection and control circuitry.
6. The installation of amplification systems or systems that operate on or provide the means to cause interference on any in-building 2- way emergency responder communication coverage network shall be coordinated and approved by the fire code official.

510.4.2.5 System monitoring. The in-building 2-way emergency responder communication coverage system shall be monitored by a listed fire alarm control unit, or where approved by the fire code official, shall sound an audible signal at a constantly attended on-site location. Automatic supervisory signal shall include the following:

1. Loss of normal AC power supply.
2. System battery charger(s) failure.

3. Malfunction of the donor antenna(s).
4. Failure of active RF-emitting device(s).
5. Low-battery capacity at 70-percent reduction of operating capacity.
6. Failure of critical system components.
7. The communications link between the *fire alarm system* and the in-building 2- way emergency responder communication coverage system.
8. Oscillation of active RF-emitting device(s)

510.4.2.6 Additional frequencies and change of frequencies. The in-building 2- way emergency responder communication coverage system shall be capable of modification or expansion in the event frequency changes are required by the FCC or other radio licensing authority, or additional frequencies are made available by the FCC or other radio licensing authority.

510.4.2.7 Design documents. The *fire code official* shall have the authority to require “as-built” design documents and specifications for in-building 2- way emergency responder communication coverage systems. The documents shall be in a format acceptable to the *fire code official*.

510.4.2.8 Radio communication antenna density. Systems shall be engineered to minimize the near-far effect. In-building 2- way emergency responder communication coverage system designs shall include sufficient antenna density to address reduced gain conditions.

Exception:

1. Systems where all portable devices within the same band use active power control features.

510.5 Installation requirements. The installation of the in-building 2- way emergency responder communication coverage system shall be in accordance with NFPA 1221 and Sections 510.5.1 through 510.5.5.

510.5.1 Mounting of the donor antenna(s). To maintain proper alignment with the system designed donor site, donor antennas shall be permanently affixed on the building or where approved, mounted on a movable sled with a clearly visible sign stating "Movement or repositioning of this antenna is prohibited without approval from the fire code official". The antenna installation shall be in accordance with the applicable requirements in the *International Building Code* for weather protection of the building envelope.

510.5.2 Approval prior to installation.

Amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC or other radio licensing authority shall not be installed without prior coordination and approval of the *fire code official* and the frequency license holder(s).

510.5.3 Minimum qualifications of personnel. The minimum qualifications of the system designer and lead installation personnel shall include both of the following:

1. A valid FCC-issued general radio operator’s license.
2. Certification of in-building system training issued by an approved organization or approved school, or a certificate issued by the manufacturer of the equipment being installed.

These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the *fire code official* is provided.

510.5.4 Acceptance test procedure. Where an in-building 2- way emergency responder communication coverage system is required, and upon completion of installation, the building owner shall have the radio system tested to verify that two-way coverage on each floor of the building is not less than 95 percent. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of 20 approximately equal test areas. Where a floor exceeds 128,000 ft² (11,900 m²), which is the floor area that can be covered by the maximum grid dimension of 80 ft. (24.4m), the floor shall be subdivided into sectors each having an area less than or equal to 128,000 ft² (11,900 m²), and each sector be tested individually with 20 grid cells in each sector. Signal strength measurements should be taken at the center of each grid and should be performed using standardized parameters as specified by NFPA 1221.

2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system or equipment approved by the fire code official.

3. Failure of more than one test area shall result in failure of the test.

4. In the event that two of the test areas fail the test, in order to be more statistically accurate, the floor shall be permitted to be divided into 40 equal test areas. Failure of not more than two nonadjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 95-percent coverage requirement.

5. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered to be a failure of that test area. Additional test locations shall not be permitted.

6. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building owner so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building owner shall be required to rerun the acceptance test to reestablish the gain values.

7. As part of the installation, a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at the time of installation and at subsequent annual inspections.

8. Systems shall be tested using two portable radios simultaneously conducting subjective voice quality checks. One portable radio shall be positioned not greater than 10 feet (3048 mm) from the indoor antenna. The second portable radio shall be positioned at a distance that represents the farthest distance from any indoor antenna. With both portable radios simultaneously keyed up on different frequencies within the same band, subjective audio testing shall be conducted and comply with DAQ levels as specified in Sections 510.4.1.1 and 510.4.1.2.

510.5.5 FCC compliance. The in-building 2- way emergency responder communication coverage system installation and components shall comply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219.

510.6 Maintenance. The in-building 2- way emergency responder communication coverage system shall be maintained operational at all times in accordance with Sections 510.6.1 through 510.6.4.

510.6.1 Testing and proof of compliance. The owner of the building or owner's authorized agent shall have the in-building 2- way emergency responder communication coverage system inspected and tested annually or where structural changes occur including additions or remodels that could materially change the original field performance tests. Testing shall consist of the following:

1. In-building coverage test as described in Section 510.5.3.

2. Signal boosters shall be tested to verify that the gain is the same as it was upon initial installation and acceptance-
or set to optimize the performance of the system.
3. Backup batteries and power supplies shall be tested under load of a period of 1 hour to verify that they will properly operate during an actual power outage. If within the 1-hour test period the battery exhibits symptoms of failure, the test shall be extended for additional 1-hour periods until the integrity of the battery can be determined.
4. All active components shall be checked to verify operation within the manufacturer's specifications.
5. At the conclusion of the testing, a report, which shall verify compliance with Section 510.5.3, shall be submitted to the *fire code official*.

510.6.2 Additional frequencies. The building *owner* shall modify or expand the in-building 2- way emergency responder communication coverage system at his or her expense in the event frequency changes are required by the FCC or other radio licensing authority, or additional frequencies are made available by the FCC-or other radio licensing authority. Prior approval of an in-building 2- way emergency responder communication coverage system on previous frequencies does not exempt this section.

510.6.3 Nonpublic safety system. Where other nonpublic safety amplification systems installed in buildings reduce the performance or cause interference with the in-building 2- way emergency responder communication coverage system, the nonpublic safety amplification system shall be corrected or removed.

510.6.4 Field testing. Agency personnel shall have the right to enter onto the property at any reasonable time to conduct field testing to verify the required level of radio coverage.

Chapter 80 Referenced Standards

NFPA

NFPA 1221-19 Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems.....510.4.2, 510.5, 510.5.4.

UL

UL2524 -19 Standard for In-building 2- Way Emergency Radio Communication Enhancement Systems510.4.

FCC

47 CFR Part 90.219-2007510.5.4, 510.5.5

NFPA 1225 (2022 Edition) vs. NFPA 1221 (2019 Edition)

The most significant changes:

NFPA 1225 (2022 Edition) expands the definition of emergency communications, a movement from Emergency Responder Radio Communications Systems (ERRCS) to Emergency Responder Communication Enhancement Systems (ERCES)

- The Government Affairs Work Group is recommending the adoption of the 2022 edition of NFPA 1225 because there are new requirements that will improve the performance as well as reducing interference issues caused from improperly deployed signal boosters.

NFPA 1225 (2022 Edition) requires the “system” and “components” be listed and labeled in accordance with the UL2524 Standard

- 18.12.1.3: All repeaters, transmitters, receivers, signal-booster components, remote annunciators and operational consoles, power supplies, and battery charging system components shall be listed and labeled in accordance with UL2524, Standard for In-Building 2-Way Emergency Radio Communication Enhancement Systems.
- 1221 (2019): All repeater, transmitter, receiver, signal booster components, optical-to-RF and RF-to-optical converters, external filters, batteries, and battery system components shall be contained in a NEMA4 or NEMA4X type enclosure(s).

NFPA 1225 (2022 Edition) has consolidated the standards for easier access.

NFPA 1225 (2022 Edition) requires under 18.8.4 that “General building areas shall be provided with 95% floor area radio coverage. This differs from NFPA 1221 9.6.7.4 which only requires 90% coverage.

NFPA 1225 (2022 Edition) adds LTE into the code:

- 18.9.1 Downlink
 - A minimum downlink signal shall be sufficient to provide a minimum of DAQ 3.0 for voice communications using either narrowband analog or digital P25 signals or wideband LTE digital signals throughout the coverage area.
- 18.9.2 Uplink
 - The uplink signal shall be sufficient to provide a minimum of DAQ for voice communications using either narrowband, analog or digital P25 signals or widespread LTE digital signals.

NFPA 1225 (2022) 18.11.2.1 requires “Systems shall be upgradeable to allow for instances where the jurisdiction changes or adds system frequencies to maintain communication system coverage as it was originally designed.”.

NFPA 1225 (2022) has added a 3rd prong to “Secondary Power Source” 18.13.2

- (3) A 2-hour standby battery and connection to the facility generator power system, providing the facility generator power system can support the complete system load for 12 hours.

Other Changes

- Lightning protection to comply with NFPA 780
- Plan submittal requirements have changed to include a link budget.
- Renewable permit or written authorization by licensee shall be issued for the system
- Coverage in critical areas shall be at 99% including elevators.
- Building and structures that cannot support the required level of radio coverage shall be equipped with an RF-Emitting device certified by the licensee.
- Systems shall be designed to support two different talk paths or channels –
- Minimum inbound signal to support usable voice communications of DAQ 3
- Minimum outbound signal to support usable voice communications of DAQ 3
- AHJ shall maintain a list of all inbound/outbound frequency pairs for distribution to designers
- RF emitting devices shall be compatible with both analog and digital communications
- All cables shall be installed in accordance with chapters 7 and 8 of NFPA 70
- AHJ may approve a single supervisory signal to the fire panel
- Back cables and components installed in buildings that are fully protected by an automatic sprinkler system shall be installed in metal raceways
- Backbone cables and components installed in non-sprinklered buildings or buildings that are only partially protected by a sprinkler system shall meet the following: 1) Listed with a fire rating, and 2) protected by an assembly having a fire resistance rating in accordance with the following: Where primary structural frame of a building is required to have a fire rating of 2 hours or more, the minimum fire resistance rating shall be 2 hours; where the primary structure frame of a building is less than 2 hours, minimum shall be 1 hour; where primary structural frame has no rating, no fire resistance is required.

SAFECOM Guidance Frequently Asked Questions: Understanding P25 Standards and Compliance

This document summarizes the compliance requirements for Project 25 (P25) compliance standards outlined in the *SAFECOM Guidance on Emergency Communications Grants (SAFECOM Guidance)*. Grantees and applicants funding emergency communications projects using federal funds should reference this frequently asked questions document to understand P25 compliance and find resources when needed. For the purpose of this document, the terms “I” and “my” refer to the grantee or applicant of an agency seeking federal funds for emergency communications projects.

Project 25

Q1. What are P25 standards?

P25 is a suite of standards and specifications which enable interoperability among digital two-way land mobile radio (LMR) communications products provided by multiple manufacturers to support the mission critical public safety requirements. These standards provide a number of technical specifications for emergency communications equipment designed to ensure that equipment is interoperable, regardless of manufacturer. The P25 suite of standards, referenced as TIA-102 standards, is published by the Telecommunications Industry Association (TIA),¹ a recognized American National Standards Institute standards development organization. The P25 Steering Committee periodically publishes a list of “Approved Project 25 Suite of Standards” that includes the most recent documents, including revisions.

Q2. What is the P25 Compliance Assessment Program (CAP)?

The P25 CAP is a formal, independent process administered by the Department of Homeland Security (DHS) Office for Interoperability and Compatibility (OIC), to ensure communications equipment offered by the supplier is compliant with the applicable published standards and the test results are reflected in publicly published documents. Through this third party testing process by independent labs, the P25 CAP provides public safety agencies with evidence that the communications equipment they purchase is tested against and complies with the P25 standards for performance, conformance, and interoperability. Compliance test results are provided with official summary test reports and suppliers’ declaration of compliance, which are available at <https://www.dhs.gov/science-and-technology/p25-cap>.

Q3. What does P25 compliance mean?

Compliance with the P25 suite of standards may differ by each federal agency. To maximize opportunities to improve interoperability across investments, grantees are highly encouraged to ensure that digital voice systems and equipment purchased with federal grant funds comply with the P25 suite of standards, unless otherwise noted in a program’s grant guidance.² P25 compliance

¹ The published standards approved by the P25 Steering Committee are available to employees of government agencies at no cost by completing the TIA online request form for government agencies at: <http://www.tiaonline.org/all-standards/p25-downloads-application>.

² Grantees should read a program’s grant guidance carefully to ensure compliance with standards, allowable cost, documentation, reporting, and audit requirements.

helps to ensure federal grant funds are used to purchase interoperable solutions for state, local, tribal, and territorial first responders.

Q4. Why is purchasing P25 compliant equipment and systems so important to the public safety community?

Following the tragic events from 9/11, legislation was passed to improve the interoperability of public safety communications systems and equipment. Congress mandated that new or upgraded equipment must be interoperable and meet certain interoperability standards. As a result, the Federal Government supported the purchase of P25 compliant LMR equipment through grants and policy, to ensure public safety systems can interoperate, regardless of manufacturer.

Purchasing P25 equipment ensures that digital LMR systems will be compatible with other, most importantly contiguous, P25 systems. Additionally, standards-based systems enable interoperable communications between emergency responders from various agencies, jurisdictions, and levels of government in the event they need to communicate during day-to-day incidents, large-scale emergencies, and disaster responses. Additionally, P25 standards provide a broader resource of competitive vendors providing more flexibility in purchasing equipment.

P25 Compliance for DHS Grantees

Q5. DHS/FEMA requires its grantees to comply with the SAFECOM Guidance. As a DHS grantee, am I also required to comply with P25 standards?

Yes, DHS/FEMA grantees are required to comply with P25 standards when purchasing LMR equipment. This requirement and other conditions specific to DHS/FEMA grantees are outlined in Appendix D of the *SAFECOM Guidance*. For additional information, reference the [DHS Authorized Equipment List](#) to determine allowable equipment types for individual grant programs. If the proposal includes any non-compliant P25 LMR equipment, DHS/FEMA grantees must apply for prior approval.

P25 Purchases Using Federally-Funded Grants

Q6. When applying for a federally-funded emergency communications project, how do I demonstrate that purchases are P25 compliant?

To ensure equipment and systems are compliant with the P25 suite of standards, grantees are strongly encouraged to:

- Review the technical specifications detailed in the P25 Technology Interest Group's (PTIG) *Capabilities Guide*³ to determine which standards are applicable to the proposed purchase and project.
- Include all applicable P25 standards and expectations for interoperability in any Statement of Work or bid for communications procurements funded through federal grants.
- Ensure all P25 eligible equipment, features, and capabilities selected are P25 compliant, to include new equipment and upgrades. When federal grant funds are used to purchase P25 LMR equipment and systems that contain non-standard features or capabilities⁴, when a comparable

³ The PTIG *Capabilities Guide* can be found on the PTIG website. To register, visit: <http://www.project25.org/>.

⁴ Within the P25 standards, services and features are categorized as mandatory or standard option (see Appendix A for list of mandatory and standard option features). To be P25 compliant, a product *must* support mandatory features, in accordance with

P25 feature or capability is available, grantees must ensure the standards-based feature or capability is included as well.

- Obtain documented evidence of P25 compliance from the manufacturer that the equipment has been tested and passed all the applicable, published, normative P25 compliance assessment test procedures for performance, conformance, and interoperability as defined in the latest P25 CAP Compliance Assessment Bulletins for testing requirements. If documentation for applicable equipment is not available through the P25 CAP, grantees are encouraged to obtain documented evidence from the manufacturer, as part of the proposal, stating that the applicable tests (identified in the procurement package) were conducted in accordance with the published test procedures in the P25 suite of standards.

Q7. What will the federal agency issuing grant funding use to confirm if purchases in my grant application are P25 compliant?

When reviewing grant applications, the federal agency will verify that proposed equipment purchases are P25 compliant by:

- Reviewing the [P25 Compliant Approved \(Grant-Eligible\) Equipment List](#) to confirm if the equipment to be purchased has been tested and is reflected on the list. If the item is included, it is P25 compliant.
- Referring to the [DHS Authorized Equipment List](#) (applicable to DHS/Federal Emergency Management Agency [FEMA] grants only).
 - Note: Some items on this list may not be applicable to the P25 standards.
- Reviewing the application package to confirm if the applicant provided a letter from the manufacturer verifying the purchase is P25 compliant.

If the purchase cannot be verified as P25 compliant using these methods, then the federal agency has the authority to request additional information, grant a waiver, or deny the purchase. As a reminder, the federal agency awarding the grant has the right to deny a waiver and one should only be considered for unique circumstances that will not impact interoperability.

Q8. What will happen if I try to purchase non-compliant P25 equipment?

While not encouraged, in the event a grantee is using federal funds to purchase equipment that does not align with P25 standards, the grantee must consult with the federal agency to determine if non-compliant P25 equipment is allowable. In some cases, written justification must be provided to the grantor.

Many agencies will not approve non-standards-based equipment unless there are compelling reasons for using other solutions. Authorizing language for most emergency communications grants strongly encourages investment in standards-based equipment. Funding requests by agencies to replace or add radio equipment to an existing non-compliant P25 system will be

the P25 definition in the standards. Standard option features are not essential but must conform to the P25 definitions if offered by the manufacturer. All other features offered by a manufacturer are considered proprietary options. A manufacturer's proprietary option is a feature that is not a requirement but may provide an added value to the customer (e.g., status messaging). However, this feature may not be interoperable with other manufacturers' equipment.

considered if there is a clear rationale why such equipment should be purchased and written justification of how the equipment will advance interoperability and support eventual migration to interoperable systems. The written justification should also explain how that purchase will serve the needs of the applicant better than equipment or systems that meet or exceed such standards. Absent compelling reasons for using other solutions, agencies are strongly encouraged to invest in standards-based equipment.

P25 Compliance Resources

Q9. What resources should be considered when applying for emergency communications grant funding?

Grant applicants applying for emergency communications funding are strongly encouraged to work with their Statewide Interoperability Coordinator (SWIC). The SWIC should review the application prior to submission to ensure projects support the state or territory's strategy to improve interoperable emergency communications. The SWIC can also confirm the funding request aligns to the latest versions of their *Statewide Communication Interoperability Plan* and the [National Emergency Communications Plan](#), as these are vital plans to improving interoperability.

Q10. Where can I find more information about P25 standards and/or compliance?

Grantees should be aware that a wide range of information is available from government and industry resources, including:

- SAFECOM and the National Council of Statewide Interoperability Coordinators' Land Mobile Radio Trio - LMR 101, LMR for Decision Makers, and LMR for Project Managers: <https://www.dhs.gov/safecom/funding>
- PTIG: <http://www.project25.org/> (Free registration required)
- P25 Suite of Standards: http://www.project25.org/images/stories/ptig/20160128_Approved_P25_TIA_Standards_Q1-2016.pdf
- P25 CAP Information: <https://www.dhs.gov/science-and-technology/p25-cap>; <http://www.firstresponder.gov/Pages/P25CAP.aspx?s=Saver>
- P25 CAP Approved (Grant-Eligible) Equipment List: <https://www.dhs.gov/science-and-technology/approved-grant-eligible-equipment>
- P25 CAP Compliance Assessment Bulletins: <https://www.dhs.gov/science-and-technology/p25-cap>
- Best Practices for Encryption in P25 Public Safety Land Mobile Radio Systems: https://www.dhs.gov/sites/default/files/publications/20160830%20Best%20Practices%20for%20Encryption_Final%20Draft508.pdf

Update on UL 2524, Standard for In-Building 2-Way Emergency Radio Communications Enhancement Systems

September 17, 2019 SUPDET

Larry Shudak, P.E.
Principal Engineer - Life Safety Systems

UL and the UL logo are trademarks of UL LLC © 2018.



Empowering Trust™

Background on ERECS

- Portable Land Mobile Radios (LMRs) are an essential life-safety tool for firefighters
- Many buildings prevent the receipt or transmission of LMR messages based on construction elements and/or building configuration
- ERCES provide assurance that emergency messages can be transmitted and received into and out of every building
- ERCES do not rely on alternate communication equipment or fixed locations from which to transmit



Background on ERECS

Code Requirements – ICC and NFPA

NFPA 72 and NFPA 1221

The 2016 edition of NFPA 1221 includes Section 9.6 (Two-Way Radio Communication Enhancement Systems) with technical requirements for design, installation and performance generally consistent with the 2018 IFC Section 510.



Background on ERECS

Code Requirements – ICC and NFPA

NFPA 1 Fire Code

- First introduced in 2012 edition
- All buildings to have *approved* radio coverage for emergency responders available throughout the interior of building at a level determined by the AHJ.
- References NFPA 72 and NFPA 1221



Background on ERECS

Code Requirements – ICC and NFPA

International Fire Code (IFC) Section 510

- First introduced in 2009 edition
- All new buildings to have *approved* radio coverage for emergency responders available throughout the interior of building at the same coverage levels that existed outside the building
- References NFPA 72 and NFPA 1221



UL 2524

December 2017: UL 2524 published as an Outline of Investigation

Spring 2018: Standards Technical Panel (STP) formed for US/CAN

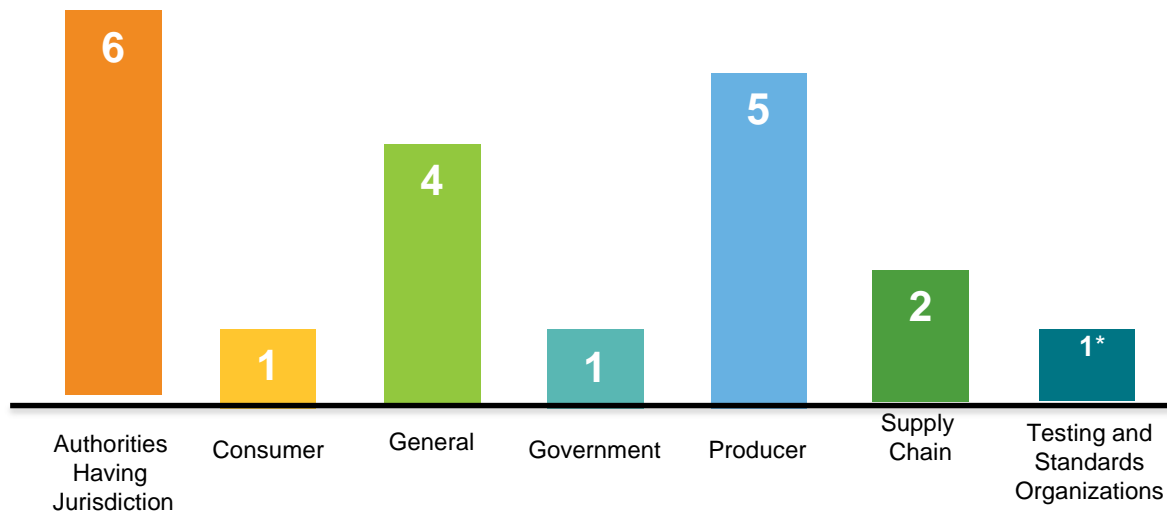
October 2018: ANSI accredited First Edition standard published

January 2019: ANSI and SCC accredited Second Edition standard published



UL 2524 Standards Technical Panel (STP)

NUMBER OF VOTING SEATS HELD – 20 TOTAL



GROUPS REPRESENTED

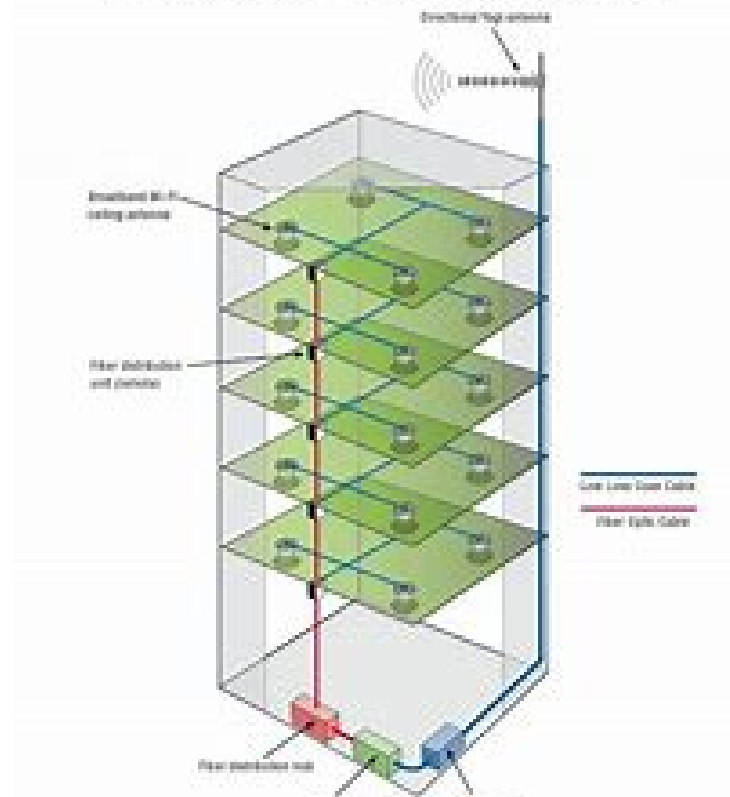
* UL holds the one voting seat in this category



UL 2524

Distributed Antenna System (DAS)

In-Building Distributed Antenna System



UL 2524

This standard addresses the following areas:

- Safety (risk of fire and risk of shock) requirements – construction and testing
- Compliance with specific performance requirements in accordance with the IFC-2018 & NFPA 1221-2019
- Reliability performance requirements applicable for life safety systems – construction and testing
- Product marking and installation documentation



UL 2524

Construction:

- Type 4 or 4X for all repeater, transmitter, receiver, signal booster components, external filters, and battery system components
 - ❖ *Rechargeable standby batteries are permitted to be contained in enclosures that comply with the requirements for a Type 3R*
- The system shall be sufficiently modular to have the capability to support revised and/or additional system frequencies within the same frequency band of the bi-directional amplifier supplied to maintain radio system coverage as it was originally intended without the need to replace the system.



UL 2524

Performance - Operation:

- a) Loss of normal AC power *
- b) Battery charger failure *
- c) Loss of battery capacity (to 70 percent depletion) *
- d) Donor antenna disconnection *
- e) Active RF emitting device malfunction *
- f) System component malfunction, other than passive RF components, which affects system performance *
- g) Donor antenna malfunction **

* = Visual and Audible annunciation within 200 sec of fault

** = Visual and Audible annunciation within 24 hrs. of fault



UL 2524

Reliability:

- a) Variable Voltage Operation Test
- b) Variable Ambient Temperature and Humidity Tests
- c) Component Temperatures Test
- d) Charging Current Test – 12 hours full transmitting load
- e) Supply line and input/output ckt Transient Testing



UL 2524

Equipment Survivability

- Type 4 and 4X enclosures
- Backbone pathway survivability
- Standby power – 12 hours at 100% capacity

- Does the equipment need to maintain performance to a minimum ambient temperature to extend system operation?
 - Note that equipment includes: repeater, transmitter, receiver, signal booster components, power supply, and battery charging system components



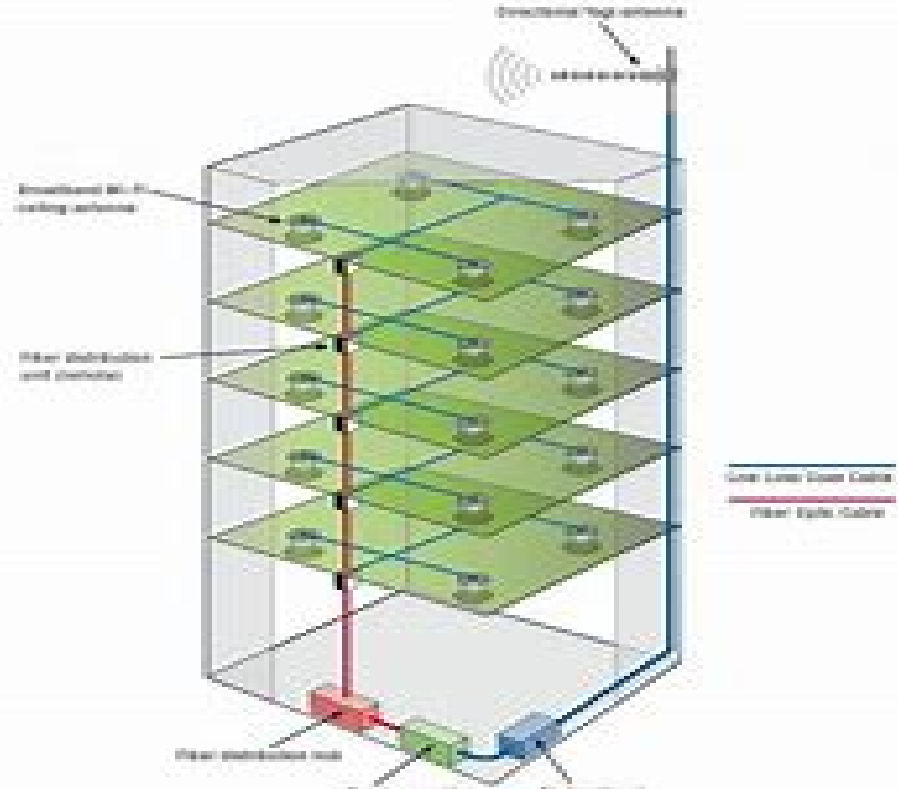
UL 2524

PASSIVE RF COMPONENT – Any device that RF passes through that does not have an active electronic component that requires external power. This includes antennas, splitters, couplers, coaxial cable and connectors. Passive components cannot amplify RF signals.

ACTIVE RADIO FREQUENCY EMITTING DEVICE – A powered device that emits a radio frequency signal as part of an in-building 2-way emergency radio communication enhancement system

Should passive RF components be monitored for integrity?

In-Building Distributed Antenna System



UL 2524A Outline of Investigation Outline for In-Building Auxiliary Radio Communication Systems

- ARCS for FDNY
- Equipment such as base station, repeaters, transmitters, receivers, signal boosters, power supplies, battery charging system components, and dedicated radio console
- New York City Fire Department Rule 1–RCNY and Rule 3-RCNY 511-01, In-Building Auxiliary Radio Communication Systems.



UL 2524A Outline of Investigation Outline for In-Building Auxiliary Radio Communication Systems

- Unique requirements for FDNY
 - No donor antenna
 - Only manual activation
 - For use with specific channels and radios
 - Passive RF antenna malfunction monitored for integrity



Thank You

Larry Shudak
UL LLC
847-664-2791
lawrence.j.shduak@ul.com

Empowering Trust™

UL and the UL logo are trademarks of UL LLC © 2018.



ERCES standard (933)

VCC: CHAPTER 9, SECTION 918, 918.1, 918.1.1, 918.1.2, 918.1.3, 918.2, (New)

Proponents: Scott Lang (scott.lang@honeywell.com); Richard Roberts (richard.roberts@systemsensor.com)

2018 Virginia Construction Code

CHAPTER 9 FIRE PROTECTION AND LIFE SAFETY SYSTEMS SECTION 918 IN-BUILDING EMERGENCY COMMUNICATIONS COVERAGE

918.1 General. For localities utilizing public safety wireless communications, dedicated infrastructure to accommodate and perpetuate continuous in-building emergency communication *equipment* to allow *emergency public safety personnel* to send and receive emergency communications shall be provided in new *buildings* and *structures* in accordance with this section.

Exceptions:

1. *Buildings* of Use Groups A-5, I-4, within *dwelling units* of R-2, R-3, R-4, R-5, and U.
2. Buildings of Types IV and V *construction* without basements, that are not considered unlimited area *buildings* in accordance with Section 507.
3. Above grade single story buildings of less than 20,000 square feet (1858 m²).
4. *Buildings* or leased spaces occupied by federal, state, or local governments, or the contractors thereof, with security requirements where the *building official* has *approved* an alternative method to provide emergency communication equipment for *emergency public safety personnel*.
5. Where the *owner* provides technological documentation from a qualified individual that the *structure* or portion thereof does not impede emergency communication signals.
6. *Buildings* in *localities* that do not provide the additional communication *equipment* required for the operation of the system.

918.1.1 Installation. The *building owner* shall install radiating cable, such as coaxial cable or equivalent. The radiating cable shall be installed in dedicated conduits, raceways, plenums, attics, or roofs, compatible for these specific installations as well as other applicable provisions of this code. The *locality* shall be responsible for the installation of any additional communication *equipment* required for the operation of the system.

918.1.2 Operations. The *locality* will assume all responsibilities for the operation and maintenance of the emergency communication *equipment*. The *building owner* shall provide sufficient operational space within the *building* to allow the *locality* access to and the ability to operate in-building emergency communication *equipment*.

918.1.3 Inspection. In accordance with Section 113.3, all installations shall be inspected prior to concealment.

918.2 Acceptance test. Upon completion of installation, after providing reasonable notice to the *owner* or their representative, *emergency public safety personnel* shall have the right during normal business hours, or other mutually agreed upon time, to enter onto the property to conduct field tests to verify that the required level of radio coverage is present at no cost to the *owner*. Any noted deficiencies in the installation of the radiating cable or operational space shall be provided in an inspection report to the *owner* or the *owner's* representative.

Add new text as follows:

New Code Section. 918.3 System design. The in-building communications coverage system shall be designed in accordance with NFPA 1225

918.4 Listing. Equipment required to provide communication enhancement system coverage shall be listed in accordance with UL 2524

Reason Statement: This proposal seeks to accomplish the three critical objectives that will enhance the safety of emergency responders and the public from requiring ERCES to be designed/installed in accordance with NFPA 1225.

1. Improve the performance, reliability of ERCES
2. Minimize noise to the public safety macro systems from improperly deployed in-building signal boosters
3. Reduce the total installation cost by removing unsubstantiated fire-resistant rating requirements

Requiring ERCES to be installed in accordance with the recently published 2022 edition of NFPA 1225, Standard for Emergency Services Communications, is critically important for the following reasons.

- Improve Performance and Reliability: Add prescription requirements for the annual operational test of the ERCES and allow newer

transmission technologies, such as LTE and 5G,

- **Minimizing Noise:** In accordance with Federal Communications Commission (FCC) rule 47 CFR 90.219, the frequency license holder(s) is legally responsible for retransmission on the frequencies to which the licensee is licensed by the FCC. Therefore, the frequency license holder is legally required to review and approve every in-building emergency responder communications enhancement system (ERCES) design prior to the commencement of any ERCES installation.
- **Reduce Total Installation Cost:** Remove unsubstantiated fire-resistance rating requirements of the backbone cables and backbone components

Requiring ERCES equipment to comply with UL 2524 will provide assurance to all stakeholders that the equipment provides safe and effective performance as required by the Code and the claims by the manufacturer. Product standards are the foundation of modern society because they specify the construction, performance, reliability and marking requirements for each type of product. This is especially critical for Life Safety Systems like fire alarm, and ERCES systems. UL 2524 covers the repeaters, transmitters, receivers, signal booster components, remote annunciators, power supplies and battery charging system components.

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency

Cost Impact: The code change proposal will decrease the cost of construction

The code change proposal may decrease the cost of construction. The code change proposal may decrease the cost of construction without sacrificing performance or reliability.

HOW TO BEST DETERMINE WHETHER A BUILDING NEEDS AN ERCES OR NOT

An In-Building Radio Signal Strength Survey/Signal Survey is a process of measuring the signal strength by taking the signal readings within a specific area and documenting the readings in the form of a signal survey report. This process measures and quantifies the strength of an RF signal of a specific frequency within a specific area of the building. If the project is in a pre-construction phase (Greenfield), an accurate survey may be accomplished by using a radio receiver, i.e. a hand-held portable radio that has a calibrated RSSI (Radio Signal Strength Indication) readout in dBm (Decibel Milliwatts). Lower signal levels will go into negative numbers, therefore, a higher negative number is really a lower signal level. A signal survey will tell us if a building has acceptable signal coverage or not, both before and after an ERCES system is installed.

An empty lot survey can be extremely useful to pre-construction engineering. iBwave is a design software that uses the design of the building, as well as the materials of the building, e.g. concrete, steel, low E-glass etc. to help anticipate the final signal prior to construction. It helps define the walls in the building and calculates the radio signal strength and DAQ (Delivered Audio Quality) before the building is built. (Most jurisdiction require a minimum of 3.0 DAQ.) By taking your signal measurements and, through the software, incorporating the material (type of wall and exterior build e.g.), you can calculate how much of the signal will be degraded or attenuated by the Low-E glass, cinder block walls, concrete, and sheetrock.

In a nutshell, to perform an accurate site testing, pre-construction, have an FCC-GROL licensed technician take RSSI readings and measure DAQ N, S, E, and W, of the property. The Project Managers and Engineers that are iBwave experts can predict the signal strength after the building is “dried in” (windows & walls are installed). If the predicted signal strength / Delivered Audio Quality for the critical areas of the building do not meet minimum code-required thresholds, then an ERCES will most likely be required. This is oftentimes too late in the construction process—and sometimes results in costly retrofits pulling cable & hanging antennas in areas that were previously finished. That is why a preliminary RSSI / DAQ test, accompanied with an iBwave design of the building, can accurately predict whether an ERCES will be needed before construction has begun—for a nominal fee.

The final “official” test to determine whether an ERCES is required would be after the building is dried-in, testing RSSI / DAQ in 20 equal size grids / floor. If any of the critical areas fail, then this will be reported to the building owner & the AHJ.