NFPA 1225 Standard for Emergency Services Communications 2022 Edition

NFPA 1225: Standard for Emergency Services Communications, 2022 Edition - About NFPA 1225

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Edition

This edition of NFPA 1225, *Standard for Emergency Services Communications*, was prepared by the Technical Committees on Public Safety Telecommunicator Professional Qualifications and Public Emergency Service Communication, released by the Correlating Committee on Professional Qualifications, and acted on by the NFPA membership during the 2021 NFPA Technical Meeting held June 14–July 2. It was issued by the Standards Council on August 26, 2021, with an effective date of September 15, 2021.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See "Codes & Standards" at www.nfpa.org for more information.

This edition of NFPA 1225 was approved as an American National Standard on September 15, 2021.

NFPA 1225: Standard for Emergency Services Communications, 2022 Edition - Origin and Development

Origin and Development

This is the first edition of NFPA 1225; it consolidates NFPA 1061, *Standard for Public Safety Telecommunications Personnel Professional Qualifications*, and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, into a single standard. The Standards Council approved the consolidation of NFPA 1061 and NFPA 1221 in April 2019. The two standards are separate and identifiable in NFPA 1225 for individual reference or adoption.

For this edition of NFPA 1225, the Committee on Public Safety Telecommunicator Professional Qualifications evaluated the job performance requirements for each position for validity to measure competency with the identified duties of each position. The committee identified the need for each position to maintain competency through professional development activities. To each position, the committee added the task of identifying fellow employees who exhibit signs and symptoms of emotional and behavioral distress. Updates to referenced standards were also identified by the committee.

The Committee on Public Emergency Service Communication made enhancements to all chapters addressing emergency services radio communications. Attention to maintaining the reliability of mission-critical communication was a prime focus of the committee. The committee recognized the role that Internet communication pathways play in emergency service communications. The committee created a separate chapter specific to in-building emergency responder communications enhancement systems to give stakeholders a centralized viewpoint of requirements for the systems and made refinements to definitions, permitting, system survivability, and system acceptance testing.

For more information about the ERRS consolidation project see nfpa.org/errs.

NFPA 1225: Standard for Emergency Services Communications, 2022 Edition - Chapter 1

Administration

1.1 Scope.
This standard identifies the minimum job performance requirements (JPRs) for Public Safety Telecommunications Personnel, and provides minimum requirements for the installation, maintenance, and use of emergency services communications systems.

1.2 Purpose.
The purpose of this standard is to specify the minimum job performance requirements (JPRs) for service as Public Safety Telecommunications Personnel and specify minimum requirements for systems, retransmissions, dispatching, performance levels and quality of installations for emergency services communications.

1.3 * Application.
This standard can be applied as follows:

(1) Chapters 1 through 11, and Annexes A, B, C, D, E, and G constitute the 2022 edition of NFPA 1061.

(2) Chapters 1 through 3, Chapters 12 through 23, and Annexes A, F, and G constitute the 2022 edition of NFPA 1221.

1.4 Equivalency.
Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.4.1
Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2
The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5 Units.
In this standard, equivalent values in SI units shall not be considered as the requirement, as these values can be approximate. *(See Table 1.5.)*

Table 1.5 U.S.-to-SI Conversions

Quantity	U.S. Unit/Symbol	SI Unit/Symbol	Conversion Factor
Length	inch (in.)	millimeter (mm)	1 in. = 25.4 mm
	foot (ft)	meter (m)	1 ft = 0.305 m
Area	square foot (ft^2)	square meter (m^2)	1 ft^2 = 0.0929 m^2

Chapter 18 In-Building Emergency Responder Communications Enhancement Systems

(NFPA 1221)

18.1 General.

18.1.1
All system components shall be designed, installed, tested, inspected, and maintained in accordance with the manufacturers' published instructions and the requirements of Chapter 18.

18.1.2
The requirements of other chapters shall not apply to in-building emergency responder communications enhancement systems except where specifically referenced.

18.2 Approval.

18.2.1 *
Where an in-building emergency responder communications enhancement system is used, the design of the system shall be approved by the AHJ and the frequency license holder(s).

A.18.2.1
In many countries, the frequency license holder(s) is legally responsible for retransmission on the frequencies to which the licensee is licensed by the licensing authority of the country of jurisdiction. Therefore, the frequency license holder(s) must be able to review and approve every ERCES design prior to the commencement of any ERCES installation. The purpose of the initial review is to determine if the design, equipment selection, and overall solution will properly operate and not cause interference on the public safety land mobile radio system. For example, in the United States, this is covered in 47 CFR, *Federal Communications Commission*.

The design submitted for approval should consist of the following, as appropriate for the design:

(1) DAQ signal source level measurements in a format acceptable to the AHJ [e.g., DAQ, bit error rate (BER), signal to interference noise ratio (SINR)]

(2) Local code requirements and statement of compliance

(3) Building site plan, building floor plans, and elevation plans

(4) Donor RF link path profiles, link budgets, azimuths, and distances

(5) Donor antenna mounting details and donor antenna cable installation details

(6) Grounding and surge suppression details

(7) Backbone and distribution antenna cable diagrams

(8) Device locations on floor plans

(9) Pathway survivability design as applicable

(10) Primary and backup power distribution design and wiring

(11) Backup power calculations

(12) Monitoring system design including fire alarm control unit (FACU) interfaces and annunciators

(13) Donor/DAS antenna isolation calculations

(14) Pre-installation predictive DAQ or signal coverage maps on floor plans

(15) Designer qualifications

(16) Installer qualifications

(17) Test grids on floor plans, or walk plan if approved by AHJ

(18) Manufacturers' specification sheets (i.e., cut sheets) for all equipment and cable

18.2.2
The design of the system shall be performed by a RF system designer.

18.3 * System Design.

A.18.3
There are multiple system solutions that might solve the problem of in-building RF coverage for ERUs. The choice depends on many factors, including the proximity and number of buildings with such systems, the RF noise floor in the area, the costs to agencies and building owners, and the accessibility to various agencies, such as fire, emergency medical services (EMS), and law enforcement. Ideally, the RF design professional should provide frequency license holder(s) and AHJs with an analysis of the pros and cons of the options that are most useful in the particular building, so that the AHJ and frequency license holder(s) can choose a solution. This review should be made each time a new solution is proposed for another building in the vicinity, because multiple devices can have an increasing impact on noise floor and other system parameters.

18.3.1 Enclosures.

18.3.1.1
Battery systems used for the emergency power source shall be contained in a NEMA 3R or higher-rated cabinet.

18.3.1.2
All repeater, transmitter, receiver, signal booster components, optical-to-RF and RF-to-optical converters, and external filters shall be contained in a NEMA 4– or NEMA 4X–type enclosure(s).

18.3.1.3
Batteries that require venting shall be stored in NEMA 3R–type enclosures.

18.3.2 * Oscillation Detection and Control.
Signal boosters used in emergency responder communications enhancement systems shall have built-in oscillation detection and control circuitry to reduce gain and maintain operation.

A.18.3.2
Mandating oscillation detection and control does not ensure the equipment will maintain operation to the best extent possible during an emergency. If a signal booster shuts down during oscillation that could leave emergency personnel stranded without communications coverage during an emergency. Oscillation is caused by the reduction in isolation between the inside and outdoor donor antennas. An event such as fire or earth movement can cause damage to the building, thereby reducing the isolation between the

inside antennas and the outside donor antenna. If the signal booster were to reduce gain until oscillation is no longer present, there would be some level of communications coverage.

18.3.2.1
When a signal booster detects oscillation, a supervisory signal shall be transmitted.

18.3.2.2
In the event of uncorrectable oscillation, the system shall be permitted to shut down.

18.3.3 Mounting of the Donor Antenna(s).

18.3.3.1
To maintain proper alignment with the system designed donor site, donor antennas shall meet one of the following:
(1) Antennas shall be permanently affixed on the building.
(2) Where approved, antennas shall be mounted on a movable sled with a visible sign stating “Movement or repositioning of this antenna is prohibited without approval from the AHJ.”

18.3.3.2
If a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas to a minimum of 20 dB above system gain.

18.3.3.3
The antenna installation shall also be in accordance with the applicable requirements of the building code for weather protection of the building envelope.

18.3.4 Communication Antenna Density.

18.3.4.1 *
In-building emergency responder communication enhancement systems shall be designed to minimize the near-far effect.

A.18.3.4.1
Near-far problems arise when a distributed antenna system (DAS) is not designed correctly. These problems are caused by a transmission from a portable that is near a DAS antenna, overpowering the uplink amplifier. When this occurs, the strong signal forces the amplifier into a reduced gain situation. Other portables transmitting simultaneously on a different channel(s), far away from the antenna system, will not be provided the gain necessary to achieve adequate uplink communications.

18.3.4.2
In-building emergency responder communication enhancement system designs shall include a sufficient number of distribution antennas(density) to address reduced gain conditions.

18.3.4.3
Where an in-building emergency responder communication enhancement system is required and such system, components, or equipment has a negative impact on the normal operations of the facility at which it is installed, the AHJ shall have the authority to accept an automatically activated responder system.

18.4 * Lightning Protection.
Systems shall have lightning protection that complies with 18.4.1 through 18.4.4.

A.18.4
US Army Technical Manual TM 5-811-3, *Electrical Design: Lightning and Static Electricity Protection*, provides additional guidance.

18.4.1
The donor antenna coaxial cable(s) shall be protected by antenna discharge units in accordance with Article 820 of *NFPA 70*.

18.4.2
The antenna discharge units shall be listed to UL 497C, *Standard for Protectors for Coaxial Communications Circuits*.

18.4.3
Each donor antenna coaxial cable(s) shall be provided with a listed antenna discharge unit in accordance with Article 820 of *NFPA 70*.

18.4.4
The antenna, antenna mast, and antenna discharge unit(s) shall be grounded in accordance with Article 820 of *NFPA 70*.

18.5 Testing Requirements.
Systems that are used to comply with the requirements of Chapter 18 shall be tested in accordance with 20.3.10 and 20.3.10.1.

18.6 Non-Interference and Non-Public Safety System Degradation.

18.6.1 *
No in-building emergency responder communications enhancement system capable of operating on frequencies or causing interference to frequencies assigned to the jurisdiction by the licensing authority of the country of jurisdiction shall be installed without prior coordination and approval of the AHJ and the frequency license holder(s).

A.18.6.1
Frequencies and modulation technologies utilized by emergency services are assigned by the licensing authority of the country of jurisdiction. In the US, for example, the FCC assigns frequencies that may be utilized by emergency services. Typically, these are thought of in the VHF, UHF, and 700/800 MHz bands. More recently, the US government created a nationwide public safety broadband network for use by emergency services. As more jurisdictions utilize non-traditional broadband networks for emergency service operations the need to have those capabilities as a part of the in-building emergency responder communications enhancement system will be important for incident operations. It is important to understand that to enhance coverage of any commercial carrier broadband signal, prior coordination and approval must be obtained from the frequency license holder of those frequencies.

18.6.2
The building owner or authorized agent shall suspend and correct equipment installations that degrade the performance of the public safety communications system or emergency responder communications enhancement system.

18.6.3 *
Systems that share infrastructure with non-public safety services shall ensure that the coverage and performance of the public safety communications channels are not degraded below the level of performance identified in Sections 18.8 and 18.9, regardless of the amount of traffic carried by the non-public safety services.

A.18.6.3
Use of shared commercial and public safety systems on the same in-building communications enhancement system infrastructure should be evaluated to ensure that systems and technology provide

optimized operational capabilities. Multiple DAS systems, whether combined or not, need to be designed and configured to avoid interference with each other and with other building RF systems.

18.7 Approval and Permit.

18.7.1
Plans, including, but not limited to, specifications, link budget, and other information required by the AHJ and frequency license holder(s), shall be submitted for approval prior to installation.

18.7.2 *<u>*</u>
Written authorization by the frequency license holder shall be required upon initial installation and prior to activation of the emergency responder communications enhancement system.

A.18.7.2
Written consent from the radio frequency licensing authority could be required in some areas. An example of where the radio frequency licensing authority could require express written consent is through the FCC in the United States. The FCC rule Title 47, CFR, Part 90.219(b) states, in part, the following:

Authority to operate. Private land mobile radio service (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.

(a) 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.

(b) 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.

18.7.3
Where required by the AHJ, a renewable permit shall be issued for the operation of an emergency responder communications enhancement system.

18.8 * Radio Coverage.

18.8.1
Radio coverage shall be provided throughout the building as a percentage of floor area as specified in 18.8.3 and 18.8.4.

A.18.8
The use of radio communication enhancement systems has become prevalent throughout the United States. Safety features and flexibilities of radio systems include the following:

(1) Full building coverage is allowed to facilitate communications from any point within the building, in case access to the wired two-way communications system is compromised.

(2) Communications can be conducted between emergency responders in the field to allow quicker dissemination of safety and emergency information.

(3) Emergency responders typically carry individual radios, allowing the responders to provide information or request assistance individually, which can be important if crew members become separated during an incident.

(4) Radio systems permit “firefighter or public safety officer down” emergency calls in case of injury — by the push of a single button, a call is placed to a central location to initiate a roll call to determine which emergency responder has been injured and requires assistance. Radio systems can employ an emergency call where, by the push of a single button, an emergency responder call can be given prioritized system access to allow wide-range communication.

(5) The AHJ can determine whether the in-building coverage is for tactical on-site communications, for communications to an off-site dispatch center, or both.

18.8.2
The system shall adhere to the maximum acceptable propagation delay standard provided by the AHJ.

18.8.3
Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevators, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the AHJ, shall be provided with 99 percent floor area radio coverage.

18.8.4
General building areas shall be provided with 95 percent floor area radio coverage.

18.8.5
Buildings and structures that cannot support the required level of radio coverage shall be equipped with a system that includes RF-emitting devices that are certified by the radio licensing authority to achieve the required adequate radio coverage.

18.8.6
Radio enhancement systems shall be designed to support two portable radios simultaneously transmitting on different talk paths or channels, where the AHJ has required the radio enhancement system to support more than one channel or talk path.

18.9 * Signal Strength and Quality.

A.18.9
Many radio systems are in use by public safety agencies in the United States. A number of them have different operational characteristics. A prescribed signal strength measurement might not produce usable voice communications for all systems [e.g., VHF, UHF, 700/800 MHz, analog, P-25, 4 slot time division multiple access (TDMA), 2 slot TDMA, etc.]. Requiring the AHJ to provide operational parameters required for usable voice communications for the systems in use eliminates possible confusion regarding the specified value, as determined by the AHJ. A better indicator of proper system performance and coverage is to use the DAQ audio quality measurement system whether the signals are either analog or digital.

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. *(See A.20.3.10.)*

A.18.9.1
Downlink refers to the signal from the base station to the portable. Although DAQ 3.0 is required as a minimum, it is recommended that systems be designed for DAQ 3.4 to provide a safety factor.

18.9.2 * Uplink.
The uplink signal shall be sufficient to provide a minimum of DAQ 3.0 for voice communications using either narrowband, analog, or digital P25 signals or widespread LTE digital signals. *(See A.20.3.10.)*

A.18.9.2
Uplink refers to the signal from the portable to the base station.

18.9.3 * Noise Floor.
If the design of the in-building emergency responder communications enhancement system (ERCES) requires the use of a signal booster, then the maximum uplink RF noise (noise crown) created by any signal booster or signal booster booster-based ERCES shall not raise the noise floor at the public safety communications site closest to the ERCES or any receiving site within the public safety communications network that the ERCES is intended to operate with.

A.18.9.3
Receiver noise floor testing can be accomplished by first noting the idle noise on all channels involved within the public safety communications system at the public safety communications site closest to the ERCES with the signal booster system off. This can be done by using a spectrum analyzer with the resolution bandwidth set to be equal or less than the noise bandwidth of the receiver used at the site. Note: Use 10 kHz for 12.5 kHz narrowband systems, and use 10 kHz for 25 kHz systems at 800 MHz in the US.

The spectrum analyzer's input should be connected to the public safety communications site receiver multi-coupler so that it is exposed to the same noise environment as the site receivers. Note that this setup would be the same regardless if the public safety communications system is a trunked or conventional system.

The signal booster systems should then be powered on and idle noise levels at the closest public safety communications site to the ERCES should be noted. If the noise level(s) is raised by 1 dB or more at the nearest public safety communications site when the signal booster is active, then an attenuator or gain change should be executed at the signal booster site until the noise power drops back to the idle level noted when the signal booster was inoperative.

An additional 3 dB of attenuation or gain reduction should be added to the signal booster installation once the noise level has been reduced to the idle level measurement made. This should be done to provide a safety factor. This step should be performed prior to the signal booster activation authorized by the AHJ and the frequency license holder(s).

The setting(s) of the ERCES gain should be documented on the as-built documents.

If an LTE network is the source of the signal, the LTE service provider should deliver the noise requirements and measuring process to the integrator or installation company. Measuring should be conducted during quieter times for the public safety communications system as determined by the AHJ and the frequency license holder(s). The test should be conducted for a period of 5 minutes, and the average noise over that period should be used for the noise level at the site.

18.10 Donor Antenna.
If a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas to a minimum of 20 dB above system gain.

18.11 * Frequencies.
The in-building emergency responder communications enhancement system shall be capable of transmitting on all radio frequencies, as required by the AHJ, and be capable of using any modulation technology in current use by the public safety agencies in the jurisdiction.

A.18.11
Newer transmission technologies, such as LTE and 5G, will dramatically change the capability of public safety communications systems.

18.11.1 List of Assigned Frequencies.
The AHJ and the frequency license holder(s) shall each maintain a list of all downlink/uplink frequency pairs for distribution to system designers.

18.11.2 * Frequency Changes.

A.18.11.2
There is an ongoing national effort to eliminate current interference issues between cellular carriers and public safety bands in the 800 MHz band. This effort could revise the actual frequencies for public agencies within this band. The public safety radio enhancement system design should be capable of being changed to accommodate updated frequencies to allow maintenance of the minimum system-design criteria. In-building emergency responder communication enhancement systems that are used to comply with the requirements of Chapter 18 should be tested in accordance with 20.3.10. Also note that this is not easily done at VHF because of filters and nonstandard Tx and Rx spacings.

18.11.2.1
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.

18.11.2.2
Where frequency changes occur and systems are upgraded, they shall comply with 18.6.1.

18.12 System Components.

18.12.1 * Component Approval, Certification, and Listing.

A.18.12.1
Radio licensing authorities in some countries have distinctions between consumer-grade and industrial-grade in-building emergency responder communications enhancement system. The intent of these distinctions is to ensure that industrial grade devices are used in public facilities, instead of consumer devices, which are usually held to a lower technical standard, and cannot be required to be certified by or registered with the radio licensing authority. The AHJ should become cognizant of these differences operating in his or her country and jurisdiction, and be certain that the devices used in his or her system are suitable to the purpose of a system used and depended upon by public safety users. For example, in the United States, the FCC published *Use and Design of Signal Boosters Report and Order 13-21*, which took effect in March 2014, and established requirements for consumer-grade and industrial-grade signal boosters. Additionally, under FCC regulations, some industrial signal boosters are Part 90 signal boosters used for public safety land mobile radio systems — as opposed to those used for public cellular wireless carriers — which include type A signal boosters (i.e., channelized) and type B signal boosters (i.e., broadband). Type B devices must be registered with the FCC before being used because of the potential for broadband devices to cause interference if improperly installed.

18.12.1.1
RF-emitting devices and cabling used in the installation of in-building emergency responder communications enhancement systems shall be approved by the AHJ and the frequency license holder.

18.12.1.2
All RF-emitting devices shall have the certification of the radio licensing authority of that country and be suitable for public safety use prior to installation.

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 UL 2524, *Standard for In-Building 2-Way Emergency Radio Communication Enhancement Systems*.

18.12.2 Active RF-Emitting Devices.
Active RF-emitting devices shall meet the following requirements in addition to any other requirements determined by the AHJ or the frequency license holder(s):

(1) Active RF-emitting devices that have a transmitted power output sufficient to require certification of the frequency licensing authority shall have the certification of the frequency licensing authority prior to installation.
(2) All active RF-emitting devices shall be compatible for their intended use, as required by the frequency licensing authority, the frequency license holder(s), and the AHJ, simultaneously at the time of installation.

(3) Written authorization shall be obtained from the frequency license holder(s) prior to the initial activation of any RF-emitting devices required to be certified by the frequency licensing authority.

18.12.3 Component Requirements.

18.12.3.1
All cables shall be installed in accordance with Chapters 7 and 8 of *NFPA 70*.

18.12.3.2
Mechanical protection of work and raceways for coaxial cables shall comply with Article 820 of <u>*NFPA 70*</u>.

18.12.3.3
Backbone cables and backbone cable components installed in buildings that are fully protected by an automatic sprinkler system in accordance with <u>NFPA 13</u> shall not be required to have a fire resistance rating.

18.12.3.4 <u>*</u>
Backbone cables and backbone cable components installed in nonsprinklered buildings, in buildings that are partially protected by a sprinkler system, or in high-rise buildings shall be protected from attack by fire in accordance with one of the following:

(1) Use a cable with a listed fire-resistance rating in accordance with the following:

> (1) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 hours or more or is classified as heavy timber construction, the minimum fire-resistance rating shall be 2 hours.
>
> (2) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 hours, the minimum fire resistance rating shall be 1 hour.
>
> (3) Where the primary structural frame of a building does not require a fire-resistance rating, a fire resistance rating shall not be required.

(2) A protected enclosure or area shall have a fire-resistance rating in accordance with the following:

(a) Where the primary structural frame of a building is required to have a fire-resistance rating of 2 hours or more or is classified as heavy timber construction, the minimum fire-resistance rating shall be 2 hours.

(b) Where the primary structural frame of a building is required to have a fire-resistance rating of less than 2 hours, the minimum fire resistance rating shall be 1 hour.

(c) Where the primary structural frame of a building does not require a fire-resistance rating, a fire resistance rating shall not be required.

A.18.12.3.4
The intent of the fire-resistance rating requirements in 18.12.3.4 is to provide for survival of the radio system backbone components correlating to the design basis for structural integrity of the building in which the system is installed. The fire-resistance rating for the primary structural frame under *NFPA 5000* is established by the required rating for structural columns. Other building codes established the fire resistance requirements for the primary structural frame using the term *primary structural frame*.

18.12.3.5
Where backbone cables and distribution antenna cables are run in a fire-resistant enclosure or protected area, both of the following shall apply, except as permitted in 18.12.3.6:

(1) The connection between the backbone cable and the distribution antenna cables shall be made within an enclosure or protected area identified in 18.12.3.4.

(2) Passage of the distribution antenna cable in and out of the enclosure or protected area shall be fire-stopped to an equivalent rating of the enclosure or protected area.

18.12.3.6
If both the backbone cables and the backbone cable components are fire rated in accordance with 18.12.3.4, the connection of the distribution antenna cable shall not be required to be made within an enclosure or protected area.

18.13 Power Sources.
At least two independent and reliable power sources shall be provided for all RF-emitting devices and any other active electronic components of the system: one primary and one secondary.

18.13.1 Primary Power Source.
The primary power source shall be all of the following.

(1) Supplied from a dedicated branch circuit

(2) Permanently connected

(3) Compliant with *NFPA 72*

(4) Protected from overvoltage

18.13.2 Secondary Power Source.
The secondary power source shall consist of one of the following:

(1) A storage battery dedicated to the system with 12 hours of 100 percent system operation capacity

(2) An alternative power source of 12 hours at 100 percent system operation capacity as approved by the AHJ

(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

18.13.3 Monitoring Integrity of Power Sources.
Monitoring the integrity of power sources shall be in accordance with 17.1.2.2.

18.14 System Monitoring.

18.14.1 Fire Alarm System.

18.14.1.1
The system shall include automatic supervisory signals for malfunctions of the in-building emergency responder communications enhancement system that are annunciated by the fire alarm system in accordance with *NFPA 72*.

18.14.1.2
The system shall comply with all of the following:

(1) Monitoring for integrity of the system shall comply with Chapter 10 of *NFPA 72*.

(2) System supervisory signals shall include the following:

> (a)* Signal source malfunction
>
> (b) Active RF-emitting device failure
>
> (c) Low-battery capacity indication when 70 percent of the 12-hour operating capacity has been depleted
>
> (d) Active system component failure

(3) Power supply supervisory signals shall include the following for each RF-emitting device and active system components:

> (a) Loss of normal ac power
> (b) Failure of battery charger

(4) The communications link between the fire alarm system and the in-building emergency responder communications enhancement system shall be monitored for integrity.(5) Where approved by the AHJ, a single supervisory input to the fire alarm system to monitor all system supervisory signals shall be permitted.

18.14.2 Dedicated Annunciation.

18.14.2.1
A dedicated annunciator shall be provided within the fire command center to annunciate the status of all RF-emitting devices and active system component locations.

18.14.2.2
The annunciator shall provide visual and labeled indications of the following for each system component and RF-emitting device:

(1) Normal ac power

(2) Loss of normal ac power

(3) Battery charger failure

(4) Low-battery capacity (i.e., to 70 percent depletion)

(5) Signal source malfunction *[See A.18.14.1.2(2)(a).]*

(6) Active RF-emitting device malfunction

(7) Active system component malfunction

18.14.2.3
The communications link between this device and the in-building emergency responder communications enhancement system shall be monitored for integrity.

18.15 Technical Criteria.

18.15.1
The AHJ and the frequency license holder(s) shall maintain a document containing technical information specific to its requirements for the installation of emergency responder communications enhancement systems.

18.15.2
The document shall include relevant information from the frequency license holder(s).

18.15.3
The AHJ technical information documents shall be accessible to emergency responder communications enhancement system design personnel.

18.15.4
The AHJ technical information documents shall contain, but not be limited to, the following:

(1) Frequencies and other modulation technologies required for the in-building emergency responder communications enhancement system and the point of contact for the frequency license holder(s)

(2) Location and effective radiated power (ERP) of public safety radio sites used by the emergency responder communications enhancement system

(3) Maximum propagation delay — in microseconds

(4) Other supporting technical information necessary to direct system design

18.15.5
Where required, system design and installation documents, specifications, test results, and other records necessary to document the operation of the emergency responder communications enhancement system shall be provided.

18.15.6
The documents shall be in a format and location approved by the AHJ.

20.3.10 * Test and Inspection of In-Building Emergency Responder Communications Enhancement Systems.
Where in-building emergency responder communications enhancement system are installed, a system test shall be conducted, documented, and signed by a person approved by the AHJ upon system acceptance and once every 12 months.

A.20.3.10
Test Procedures. The test plan should ensure testing throughout the building. Test procedures should be as directed by the AHJ or the frequency license holder(s). The following information is provided to guide the AHJ or the frequency license holder(s) on several types of testing methods that can be used when testing an in-building emergency responder communications enhancement system.

Methods of Determining DAQ. One method of determining DAQ is conducting voice tests according to the standard ITU–T P.863 (POLQA). It can be used on narrowband, wideband, analog, digital, or LTE signals. It is graded qualitatively using a DAQ scale. A second method of determining DAQ for narrowband, analog, or P25 digital systems is quantitatively measuring a minimum signal-to-interference-plus-noise ratio (SINR) value of 18dB and a maximum BER value of 2.5 percent, or to other values provided by the licensee frequency license holder(s) and the AHJ. A third method of determining DAQ is to manually test the system using portable radios as specified by the AHJ. Manually testing the system with portable radios is typically more subjective than utilizing calibrated test equipment. The important factor of any of these test methods is to determine if there is signal strength and quality to provide a DAQ of 3.0 so that the emergency responders can communicate from within the building.

Testing procedures typically are performed on a grid system. A grid is overlaid onto a floor area to provide 20 grid cells. Grid cells are provided with definite minimum and maximum dimensions. For most buildings, using a minimum grid dimension of 20 ft (6.1 m) and a maximum grid dimension of 80 ft (24.4 m) will suffice to encompass the entire floor area. Where a floor exceeds 128,000 ft^2 (11,900 m^2), which is the floor area that can be covered by the maximum grid dimension of 80 ft (24.4 m), it is recommended that the floor be subdivided into sectors each having an area less than or equal to 128,000 ft^2 (11,900 m^2). It is also recommended that each sector be tested individually with 20 grid cells in each sector.

Signal strength measurements should be taken at the center of each grid, where required.

The DAQ scale is often cited in system designs and specifications, using the following measures:

(1) DAQ 1: Unusable, speech present but unreadable.

(2) DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.

(3) DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.

(4) DAQ 3.4: Speech understandable with repetition only rarely required. Some noise/distortion.

(5) DAQ 4: Speech easily understood. Occasional noise/distortion.

(6) DAQ 4.5: Speech easily understood. Infrequent noise/distortion.

(7) DAQ 5: Speech easily understood.

The DAQ scale comes from TIA-TSB-88.1-E, *Wireless Communications Systems Performance in Noise and Interference-Limited Situations Part 1: Recommended Methods for Technology-Independent Narrowband Performance Modeling*. A DAQ test is preferred to absolute RF signal levels because the DAQ test is useful regardless of the type of modulation or system technology used (e.g., analog, digital, P25, LTE, or broadband). It measures what really matters — how the signal sounds to the user — regardless of manufacturer specifications or intervening transmission technology.

Initially, DAQ testing was somewhat subjective, but now it can be performed objectively, in an automated fashion, with repeatable results. One option is to use the standard test method ITU-T P.863. This international standard has been in use for over 10 years by all the major cellular carriers. ITU-T P.863, called POLQA, is available from three vendors and comprises a suite of hardware and software tools that allow for the rapid, repeatable, objective, and automated testing in two directions of both narrow and wide band radio communications systems.

20.3.10.1 Initial Acceptance Test Requirements.

20.3.10.1.1
All new systems shall be initially acceptance tested to verify that the system as installed meets the performance requirements of Section 18.9.

20.3.10.1.2
Qualifications of testing personnel shall be submitted to the AHJ for approval and acceptance.

20.3.10.1.3
All systems initial acceptance testing documentation shall include a listing of the following:

(1) All system equipment utilized

(2) Manufacturer's data sheets

(3) Installation, testing, and maintenance documentation

(4) As-built drawings showing all equipment locations

(5) Written documentation acceptable to the AHJ of the initial system testing, including system performance measurements at all locations covered by the installed system

(6) Secondary power calculations

(7) List of assigned frequencies

(8) Where signal boosters are used, system isolation test results

(9) Measured signal source levels

(10) Identification of the type of signal source

(11) The settings of all frequency channels or bands subbands, channel/band gains, and filter bandwidths, and all configurable parameters of automatic gain control (AGC) modes used during the installation and testing

17.1.2.2
The primary and secondary power sources supplied to all required circuits and devices of the system shall be monitored for integrity.