AFX 2025.ai

Educational Session

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The Bronx fire

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Why Public Safety Radio?

Firefighters, EMTs, Law Enforcement Officers, and other Emergency Responders rely on two-way radios for communications in everyday operations

Reliable radio coverage is not a luxury.

It's a necessity.

Lives depend on it!

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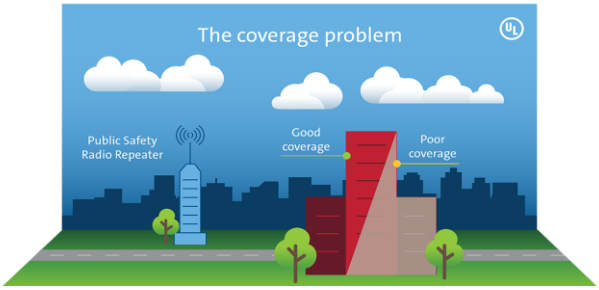
What is ERCES?



Public safety radio signals must cover commercial buildings' interior spaces.

Sometimes, outdoor tower-based public safety radio system signals cannot penetrate the building to an acceptable level and/or quality

ERCES takes outdoor public safety radio signals, amplifies them and distributes them within a building to enable reliable 2-way radio communications

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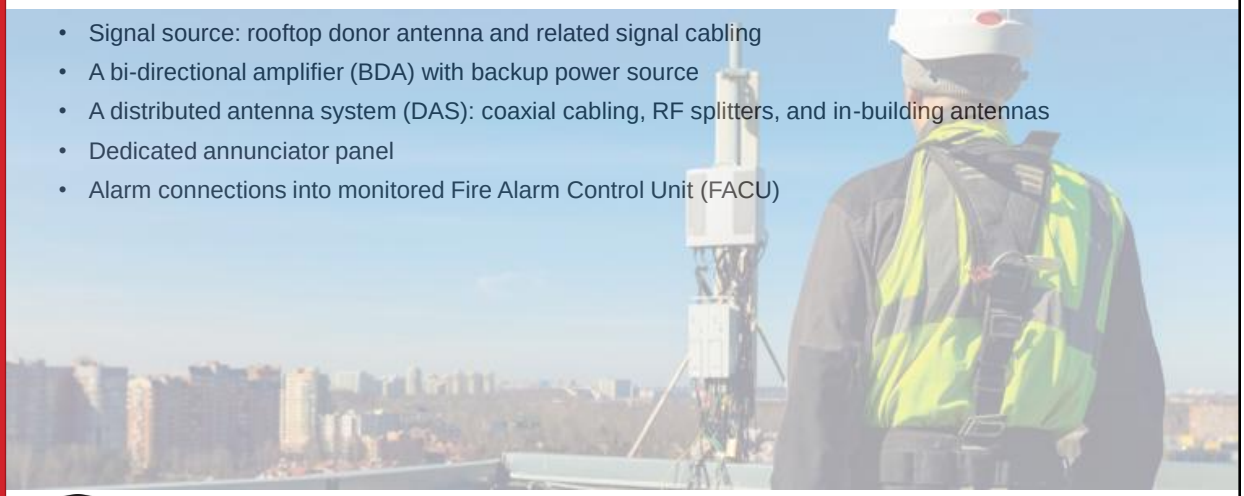
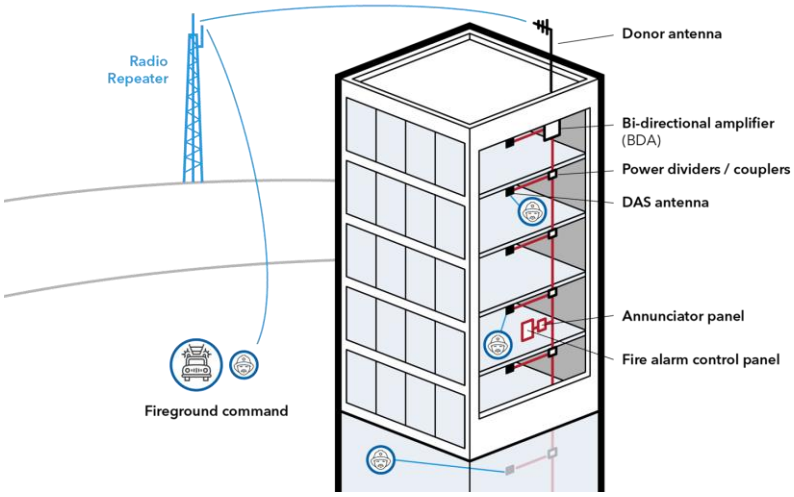
What is ERCES?

- Signal source: rooftop donor antenna and related signal cabling
- A bi-directional amplifier (BDA) with backup power source
- A distributed antenna system (DAS): coaxial cabling, RF splitters, and in-building antennas
- Dedicated annunciator panel
- Alarm connections into monitored Fire Alarm Control Unit (FACU)



Typical ERCES System



When and Where ERCES is Required

- Authority Having Jurisdiction (AHJ)
- Defines and enforces radio coverage & ERCES requirements and applicable fire code
- National, state, and local fire codes require all new commercial buildings to provide adequate indoor radio coverage for first responders
- High-rise buildings, multi-use properties, senior living, healthcare facilities, performance halls, schools, factories, retail, warehouses, etc.
- Regulations take the form of standards set by National Fire Protection Association (NFPA) and/or the International Fire Code (IFC)
- The building owner is required to comply with fire code to receive a Certificate of Occupancy

ERCES Process: Radio Coverage Test

- New construction or substantial building remodel
- Initial radio coverage grid test required to determine if ERCES even required
- Radio coverage test valid only after building construction 'substantially complete': all floors, interior/exterior walls, windows, and roof
- Timing issue: by the time a valid radio test is viable, very little time for ERCES design/build without impacting the schedule or destroying walls for cable paths.

Radio Signal Degradation

Radio signals are attenuated by:

Concrete, Metal & Other Materials
Low-E Glass
Below-Ground Structures
Other Obstructions
Radio Frequency Interference

The consequence:

Poor in-building Fire Fighter radio signal coverage and “dead spots”
Emergency responders lose communications

Radio Signal Degradation

Attenuation

- 3 dB = 50% reduction
- 6 dB = 75% reduction
- 23 dB = 99.5% reduction
- 30.6 dB = 99.999% reduction

Attenuation by Material @ 900MHz

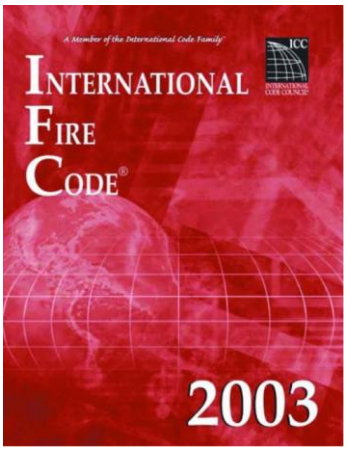
Material	Attenuation
Glass 0.25”	0.8 dB
Glass 0.5”	2 dB
Lumber 3”	2.8 dB
Brick 3.5”	3.5 dB
Brick 7”	5 dB
Brick 10.5”	7 dB
Concrete 3”	12 dB
Masonry Block 8”	12 dB
Brick Faced Concrete	14 dB
Masonry Block 16”	17 dB
Concrete 4”	23 dB
Reinforced Concrete 3.5”	27 dB
Masonry Block 24”	28 dB
Low E Glass	30 dB
Concrete 12”	35 dB

IFC 2003

907.2.12.3 Fire department communication system.

An approved two-way, fire department communication system designed and installed in accordance with NFPA 72 shall be provided for fire department use. It shall operate between a fire command center complying with Section 509 and elevators, elevator lobbies, emergency and standby power rooms, fire pump rooms, areas of refuge, and inside enclosed exit stairways. The fire department communication device shall be provided at each floor level within the enclosed exit stairway.

Exception: Fire department radio systems were approved by the fire department.



IFC 2006

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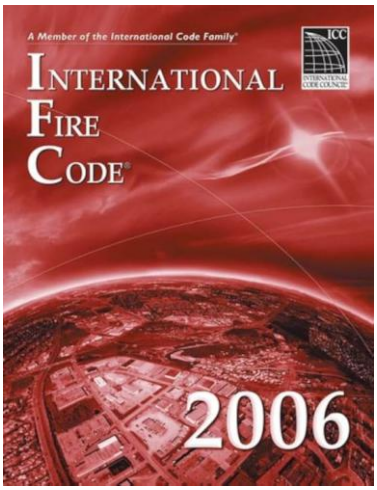


IFC 2009

SECTION 510

EMERGENCY RESPONDER RADIO COVERAGE

510.1 Emergency responder radio coverage in buildings.

All buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building. This section shall not require improvement of the existing public safety communication systems.

Exceptions:

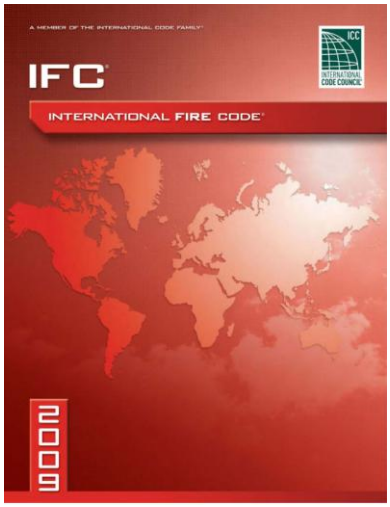
1. Where approved by the building official and the fire code official, a wired communication system in accordance with Section 907.2.13.2 shall be permitted to be installed or maintained in lieu of an approved radio coverage system.

2. 2. Where it is determined by the fire code official that the radio coverage system is not needed.

510.2 Radio signal strength. The building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of the building meet the signal strength requirements of Sections 510.2.1 and 510.2.2.

510.2.1 Minimum signal strength into the building. A minimum signal strength of -95 dBm shall be receivable within the building.

510.2.2 Minimum signal strength out of the building. A minimum signal strength of -100 dBm shall be received by the agency's radio system when transmitted from within the building.



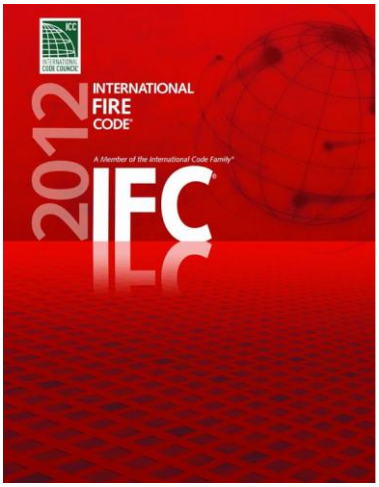
IFC 2012

510.1 Emergency responder radio coverage in new buildings. All new buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction 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 in lieu of an approved radio coverage system.

2. Where it is determined by the fire code official that the radio coverage system is not needed.

3. In facilities where emergency responder radio 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 radio coverage system.



IFC 2012 Continued

510.3 Permit required.

510.4 Technical requirements. shall comply with Sections 511.4.1 through 511.4.2.5.

- 510.4.1 Radio signal strength.
- 510.4.2 System design.
  - 510.4.2.1 Amplification systems allowed.
  - 510.4.2.2 Technical criteria.
  - 510.4.2.3 Secondary power.
  - 510.4.2.4 Signal booster requirements.
  - 510.4.2.5 Additional frequencies and change of frequencies.

510.5 Installation requirements. accordance with Sections 510.5.1 through 510.5.5.

- 510.5.1 Approval prior to installation.
- 510.5.2 Minimum qualifications of personnel.
- 510.5.3 Acceptance test procedure.
- 510.5.4 FCC compliance. FCC 47 CPR Part 90.219.

510.6 Maintenance. accordance with Sections 510.6.1 through 510.6.3.

- 510.6.1 Testing and proof of compliance.
- 510.6.2 Additional frequencies.
- 510.6.3 Field testing.

2010 NFPA-72 Chapter 24 — Emergency Communications Systems (ECS)

24.3.5.8

Two-way radio communications enhancement systems shall comply with 24.3.5.8.1 and 24.3.5.8.2.

24.3.5.8.1

Where a two-way radio communications enhancement system, exclusive of the antennae, is used in lieu of a two-way in-building wired emergency communications system, it shall have a pathway survivability of Level 2 or Level 3.

24.3.5.8.2

Where a two-way radio communications enhancement system is used in lieu of a two-way in-building wired emergency communications system, the design of the system shall be approved by the authority having jurisdiction.

2010 NFPA-72 Chapter 24 — Emergency Communications Systems (ECS)

24.5.2* Two-Way Radio Communications Enhancement Systems.

24.5.2.2.1 Critical Areas.

Critical areas, such as the emergency command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the authority having jurisdiction, shall be provided with 99 percent floor area radio coverage.

24.5.2.3.3 Isolation.

If a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas and shall be a minimum of 15 dB above the signal booster gain under all operating conditions.

24.5.2.6.1 Fire Alarm System.

The public safety radio communications enhancement system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supply(ies) that are annunciated by the fire alarm system and comply with the following:

(1) The integrity of the circuit monitoring signal booster(s) and power supply(ies) shall comply with 10.17.1.

(2) System and signal booster supervisory signals shall include the following:

(a) Antenna malfunction

(b) Signal booster failure

(3) Power supply supervisory signals shall include the following for each signal booster:

(a) Loss of normal AC power

(b) Failure of battery charger

(c) Low-battery capacity, alarming at 70 percent of battery capacity

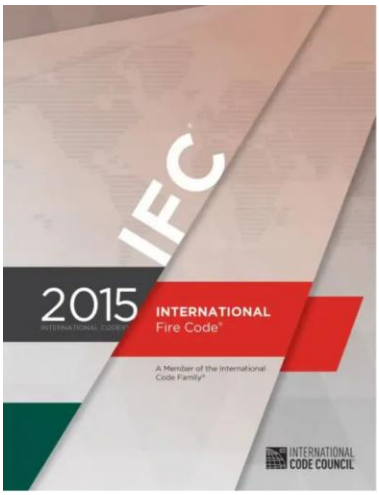
IFC 2015

510.1 Emergency responder radio coverage in new buildings. All new buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction 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 in lieu of an approved radio coverage system.

2. Where it is determined by the fire code official that the radio coverage system is not needed.

3. In facilities where emergency responder radio 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 radio coverage system.



2013 NFPA-72 Chapter 24 — Emergency Communications Systems (ECS)

2013 NFPA-72 Chapter 24 — Emergency Communications Systems (ECS)

24.3.6.8 Two-way radio communications enhancement systems shall comply with 24.3.6.8.1 through 24.3.6.8.4.

24.3.6.8.1* Where a two-way radio communications enhancement system is used in lieu of a two-way in-building wired emergency communications system, it shall have a pathway survivability of Level 1, Level 2, or Level 3.

Exception: Where leaky feeder cable is utilized as the antenna, it shall not be required to be installed in metal raceway.

24.3.6.8.1.1 The feeder and riser coaxial cables shall be rated as plenum cables.

24.3.6.8.1.2 The feeder coaxial cables shall be connected to the riser coaxial cable using hybrid coupler devices of a value determined by the overall design.

24.3.6.8.2 Where a two-way radio communications enhancement system is used in lieu of a two-way in-building wired emergency communications system, the design of the system shall be approved by the authority having jurisdiction.

24.3.6.8.3* Riser coaxial cables shall be rated as riser cables and routed through a 2-hour-rated enclosure.

24.3.6.8.4 The connection between the riser and feeder coaxial cables shall be made within the 2-hour-rated enclosure, and passage of the feeder cable in and out of the 2-hour-rated enclosure shall be firestopped to 2-hour ratings.

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2013 NFPA-72 Chapter 24 — Emergency Communications Systems (ECS)

24.5.2* Two-Way Radio Communications Enhancement Systems.

24.5.2.2.1 Critical Areas.

Critical areas, such as the fire command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the authority having jurisdiction, shall be provided with 99 percent floor area radio coverage.

24.5.2.3.3 Isolation.

If a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas and shall be a minimum of 15 dB above the signal booster gain under all operating conditions.

24.5.2.6 System Monitoring.

24.5.2.6.1 Fire Alarm System. The public safety radio communications enhancement system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supply(ies) that are annunciated by the fire alarm system and comply with the following:

(1) The integrity of the circuit monitoring signal booster(s) and power supply(ies) shall comply with 10.6.9 and Section 12.6.

(2) System and signal booster supervisory signals shall include the following:

- (a) Antenna malfunction
- (b) Signal booster failure
- (c) Low-battery capacity indication when 70 percent of the 12-hour operating capacity has been depleted.

(3) Power supply signals shall include the following for each signal booster:

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

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IFC 2018

510.1 Emergency responder radio coverage in new buildings.

510.4 Technical requirements.

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 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.

IFC 2018

510.4.2 System design. The emergency responder radio coverage system shall be designed in accordance with Sections

510.4.2.1 through 510.4.2.8 and NFPA 1221.

510.4.2.3 Standby power changed from 24hr to 12hr or 2hr when connected to a facility generator.

510.4.2.4 Signal booster requirements.

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

Bi-Directional Amplifiers (BDAs) used in emergency responder radio coverage systems shall have oscillation prevention circuitry.

510.4.2.5 System monitoring.

Automatic supervisory signals 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 emergency responder radio enhancement system.

2016 NFPA-1221 Chapter 9 — Dispatching Systems

9.6 Two-Way Radio Communications Enhancement Systems.

9.6.2

Pathway survivability levels shall be as described in Section 5.10. [72:24.3.13.1]

9.6.2.1.1*

Where a two-way radio communications enhancement system is used in lieu of a two-way in-building wired emergency communications system, it shall have a pathway survivability of Level 1, Level 2, or Level 3. [72:24.3.13.8.1]

9.6.2.1.3*

Riser coaxial cables shall be rated as riser cables and routed through a 2–hour–rated enclosure. [72:24.3.13.8.3]

9.6.2.1.4

The connection between the riser and feeder coaxial cables shall be made within an enclosure matching the building's fire rating and pathway survivability, and passage of the feeder cable in and out of the enclosure shall be fire-stopped to the building's fire rating and pathway survivability.

9.6.3* Lightning Protection.

Systems shall have lightning protection that complies with NFPA 780.

9.6.8* Signal Strength.

The inbound and outbound signal levels shall be sufficient to provide a minimum of DAQ 3.0

2019 NFPA-1221 Chapter 9 — Dispatching Systems

9.6 Two-Way Radio Communications Enhancement Systems.

9.6.2 Approval.

Where a two-way radio communications enhancement system is used, the design of the system shall be approved by the AHJ and the frequency license holder.

9.6.2.3

Backbone cables shall be routed through an enclosure that matches the building's fire rating.

9.6.2.4

The connection between the backbone cable and the antenna cables shall be made within an enclosure that matches the building's fire rating, and passage of the antenna distribution cable in and out of the enclosure shall be fire-stopped.

9.6.3* Lightning Protection.

Systems shall have lightning protection that complies with NFPA 780.

9.6.8* Signal Strength.

The inbound and outbound signal levels shall be sufficient to provide a minimum of DAQ 3.0

2019 NFPA-1221 Chapter 9 — Dispatching Systems

9.6 Two-Way Radio Communications Enhancement Systems.

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IFC 2021

510.1 Emergency responder radio coverage in new buildings.

510.4 Technical requirements.

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.

510.5.1 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.

2022 NFPA-1225 Chapter 18 — In-Building Emergency Responder Communications Enhancement Systems

18.3.2* Oscillation Detection and Control.

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.

18.4* Lightning Protection.

Systems shall have lightning protection that complies with 18.4.1 through 18.4.4. Article 820 of NFPA 70.

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.

18.8* Radio Coverage.

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.

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2022 NFPA-1225 Chapter 18 — In-Building Emergency Responder Communications Enhancement Systems

18.12.3 Component Requirements.

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 NFPA 13 shall not be required to have a fire-resistance rating.

18.12.3.4*

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.

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2022 NFPA-1225
Chapter 20 — Testing (NFPA 1221)

20.3.10* Test and Inspection of In-Building Emergency Responder Communications Enhancement Systems.

Where in-building emergency responder communications enhancement systems 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.

20.3.10.1.2

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

20.3.10.2.1

All systems that are connected to fire alarm systems that are not monitored for alarm, supervisory, and trouble conditions off-site as defined by NFPA 72 shall be visually inspected weekly for the following conditions:

20.3.10.2.2

All systems that are connected to fire alarm systems that are monitored for alarm, supervisory, and trouble conditions off-site as defined by NFPA 72 shall be visually inspected semiannually for the following conditions:

(1) Normal ac power

(2) Loss of normal ac power

(3) Battery charger failure

(4) Low battery capacity

(5) Signal source malfunction

(6) Active RF-emitting device malfunction

(7) Active system component malfunction

(8) Loss of communication with the fire alarm control panel

(9) Signs of physical damage to components that could affect proper system operation

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2022 NFPA-1225
Chapter 20 — Testing (NFPA 1221)

20.3.10.2.3 Periodic Testing of Systems.

20.3.10.2.3.1

All systems shall be operationally tested at least annually to confirm system operation during normal operations.

20.3.10.2.3.2

Annual operational tests shall include the following:

(1) At least one quantitative DAQ test shall be in accordance with 18.9.1 and 18.9.2 on each floor. Where the floor area exceeds 128,000 ft2 (11,900 m2), additional quantitative tests shall be performed.

(2)* Signal boosters shall be tested to verify that the gain is the same as it was during the initial installation and acceptance or set to optimize the performance of the system.

(3) Backup batteries and power supplies shall be tested under load for a period of 1 hour.

(4) Other active components shall be checked to verify operation within the manufacturer's published specifications.

(5) All required supervisory monitoring signals shall be tested.

(6) A spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster.

(7) Where a donor antenna is used, isolation in accordance with Section 18.10 shall be verified.

(8) An inspection shall be made to evaluate if the building structural changes or alternations that have been made impact the communications coverage of the system as required in Section 18.8.

20.3.10.2.3.3

At least every five years systems shall be quantitatively tested to ensure that the system still provides the required DAQ values in accordance with Section 18.9.

20.3.10.2.3.4

The five-year test shall also confirm that there has been no deviation of coverage more than 5 percent from the initial installation documentation.

20.3.10.2.5

The five-year test shall confirm that there have been no changes in the frequencies utilized for the proper operation of the system.

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Questions

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