


ERCES for AHJs

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ERCES / Bi-Directional Amplifier Systems for AHJs




- Overview of Public Safety Radio Systems
- Introduction to the ERCES / BDA Solution
- Code Requirements – NFPA 1, NFPA 101, IBC, IFC, IEBC, NFPA 72, NFPA 1221, NFPA 1225, UL 2524, FCC
- Assuring Compliance
- Specification, Inspection & Enforcement
- Questions & Answers



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ERCES / BDA Systems

Introduction to Emergency Responder Communication Enhancement Systems



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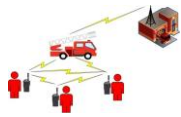
Reliable radio coverage is not a luxury.
It is a necessity.
Lives Depend Upon It!

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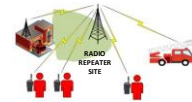
Two-Way Radio Communications

DIRECT Radio to Radio or "**Simplex**" Radio Communications where radios "talk" directly and there is no need for a central radio site.




Advantage: Simple and Reliable for short-range
Disadvantage: Short-range; only acceptable for smaller buildings

REPEATED or "**Duplex**" frequency systems where all communications go through the repeater site. All transmissions are received & rebroadcasted with higher power by the repeater.




Advantage: Good radio coverage over wide area
Disadvantage: Radio signals must reach repeater site to work

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Emergency Responder Communication Enhancement Systems (ERCES)

THE COVERAGE PROBLEM



THE BDA SOLUTION



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Coverage Problems are NOT Just in Highrise Buildings

THE COVERAGE PROBLEM

THE BDA SOLUTION

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ERCES Also Cover Police, EMS and Mutual Aid Frequencies

TYPICAL BDA SYSTEM

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BDA System Components

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Typical RF Site Survey = 20 Equal Grids

- Surveys are done by an FCC GROL-certified technicians.
- Minimum 20 readings per floor.
- Test all critical areas.
- Report submitted to AHJ.

Signal Survey Report Example

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Minimum Inbound / Outbound Signal Strength

AN EXAMPLE: INSUFFICIENT UPLINK EVEN WITH SUFFICIENT DOWNLINK RESULTS IN OVERALL "FAIL"

DONOR SITE TRANSMIT ERP* 50W or 47 dBm

PATH LOSS = 132 dB

DOWNLINK: 47 dBm - 132 dB = -85 dBm

PORTABLE RADIO TRANSMIT ERP* 3W or 34 dBm

UPLINK: 34 dBm - 132 dB = -98 dBm

-85dBm is the inbound signal strength, and 13 dB is the signal strength difference (47 dBm - 34 dBm)
 The outbound signal strength, in this example, would only be -98 dBm (-85 dBm - 13 dB), which does not meet code.
 Example based on requirements of NFPA 72, 2013 Edition, Chapter 24.5.2.2

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Delivered Audio Quality

- Signal strength is quantified by measuring signal with spectrum analyzer at **-95 dBm** (which leaves 15 dB margin in case of adverse conditions).
- Radios will receive signals as weak as -120 dBm +/- 3dB
- Biggest issue with DAQ testing 3.0 (in perfect conditions vs. real life conditions) is that communication may fail in borderline conditions.

NFPA 1221 2016 / 2019 Editions

Delivered Audio Quality Metrics (DAQ):

DAQ 1 Unusable. Speech present but not understandable. Requires frequent repetition due to noise/distortion.

DAQ 2 Speech understandable with considerable effort. Requires frequent repetition due to noise/distortion. Requires frequent repetition due to noise/distortion.

DAQ 3 Speech understandable with slight effort. Requires occasional repetition due to noise/distortion.

DAQ 3.4 Speech understandable without repetition. Some noise/distortion present.

DAQ 4 Speech easily understood. Occasional noise/distortion present.

DAQ 5 Speech easily understood.

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RF Propagation Study & Riser Diagram

The slide displays three heatmaps on the left showing signal strength distribution in a building, and a riser diagram on the right showing the layout of fire alarm components. The AFAA logo is in the bottom left corner.

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Typical Deployment Process

- **DESIGN** documents are submitted to the electrical engineer and/or architect and then to the AHJ for review & approval.
- **PERMIT** for installation of a BDA system is obtained by the BDA vendor, as required by the AHJ.
- **INSTALL** Licensed Electrical Contractor installs cable, connects power and makes connections to the fire alarm system. BDA vendor installs the antennas, terminations and other RF components.
- **TEST** BDA vendor commissions, tests and documents the system in accordance with technical requirements of **CMR 780**.
- **FINAL REPORT** is submitted to the AHJ along with a request for inspection.
- **INSPECT** AHJ inspects the system and verifies the radio coverage with sample DAQ radio checks from different parts of the building and all critical areas.
- **COMPLIANCE** AHJ signs off on the system and provides a compliance certificate.
- **MAINTENANCE** AHJ verifies ongoing maintenance is done per code requirements.

The slide includes three circular images: a riser diagram, a technician in a hard hat working on a system, and a technician in a hard hat looking at a tablet. The AFAA logo is in the bottom left corner.

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Code Requirements

Codes & Standards for ERCES


The slide features the AFAA logo in the top left and a vertical logo on the left side that reads 'Automatic Fire Alarm Association'.

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Code Requirements

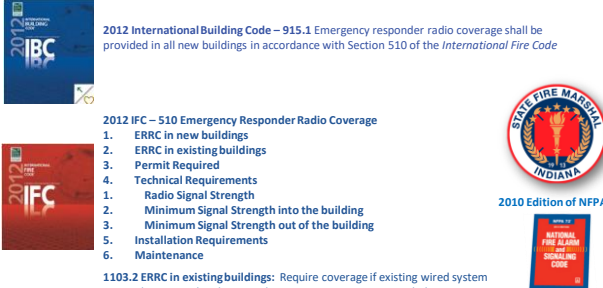


<p>IBC 918 IEBC</p> <p>IFC 510 IFC 907 IFC 1103.2</p>	<p>NFPA 1 NFPA 101 NFPA 72 NFPA 1221 NFPA 1225</p>	<p>Federal</p>	<p>North America</p>	<p>State & Local Title 675, Article 22</p>
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2012 International Building Code – 915.1. Emergency responder radio coverage shall be provided in all new buildings in accordance with Section 510 of the *International Fire Code*



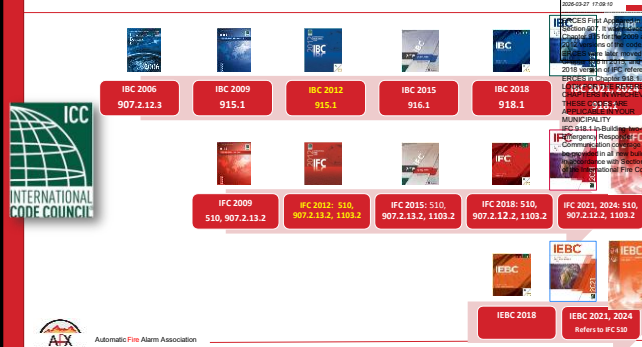
2012 IFC – 510 Emergency Responder Radio Coverage

- ERRC in new buildings
- ERRC in existing buildings
- Permit Required
- Technical Requirements
 - Radio Signal Strength
 - Minimum Signal Strength into the building
 - Minimum Signal Strength out of the building
- Installation Requirements
- Maintenance


1103.2 ERRC in existing buildings: Require coverage if existing wired system cannot be repaired, unless AHJ determines system is not needed



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IBC 2006: 907.2.12.3
IBC 2009: 915.1
IBC 2012: 915.1
IBC 2015: 916.1
IBC 2018: 918.1
IBC 2018: 510, 907.2.13.2
IBC 2018: 510, 907.2.13.2, 1103.2
IBC 2018: 510, 907.2.12.2, 1103.2
IBC 2021, 2024: 510, 907.2.12.2, 1103.2
IBC 2021, 2024: 510, 907.2.12.2, 1103.2
IFC 2021, 2024: 510, 907.2.12.2, 1103.2



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Timeline of NFPA 1225 2022 (ref. 44.2524):

- 2007:** NFPA 72-2007 (6.10.2)
- 2010:** NFPA 72-2010 (24.5.2)
- 2013:** NFPA 72-2013 (24.5.2)
- 2016:** NFPA 72-2016 (24.9 (moved to 1221))
- 2019:** NFPA 2019 (24.9 (see NFPA 1221))
- 2021:** NFPA 2021, 2025 (24.9 (see NFPA 1221))
- 2022:** NFPA 1225 2022 (ref. 44.2524)

Intermediate Editions:

- 2013:** NFPA 1221 2013 (9.3.1.2)
- 2016:** NFPA 1221 2016 (9.6)
- 2019:** NFPA 1221 2019 (9.6)

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Intermediate Editions:

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- 2016:** NFPA 1221 2016 (9.6)
- 2019:** NFPA 1221 2019 (9.6)

Notes: NFPA 1221, A.3.9.1.2, in existing buildings, it might be difficult to achieve minimum radio signal strength required by NFPA 1221. The authority having jurisdiction might determine that coverage areas of buildings do not meet the radio signal strength coverage required by NFPA 1221. The authority having jurisdiction might also determine that the radio signal strength coverage required by NFPA 1221 is not feasible.

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International Codes-Adoption by State (JANUARY 2025)

Table 1: NFPA 1225 2022

Jurisdiction	IBC	IFC	ESBC
Alabama	21	21	21
Alaska	21	21	21
Arizona	18	18	18
Arkansas	18	18	18
California	24	24	24
Colorado	24	24	24
Connecticut	21	21	21
Delaware	18	18	18
District of Columbia	15	15	15
Florida	21	21	21
Georgia	24	24	24
Hawaii	21**	21**	21**
Idaho	18	18	18
Illinois	12*	12	12
Indiana	18	18	18
Iowa	18	18	18
Kansas	18	18	18
Kentucky	18	18	18
Louisiana	18	18	18
Maine	18	18	18
Maryland	18	18	18
Massachusetts	18	18	18
Michigan	18	18	18
Minnesota	18	18	18
Mississippi	18	18	18
Missouri	18	18	18
Montana	18	18	18
Nebraska	18	18	18
Nevada	18	18	18
New Hampshire	21	21	21
New Jersey	21	21	21
New Mexico	21	21	21
New York	21	21	21
North Carolina	21	21	21
North Dakota	18	18	18
Ohio	21	21	21
Oklahoma	18	18	18
Oregon	18	18	18
Rhode Island	21	21	21
South Carolina	21	21	21
South Dakota	18	18	18
Tennessee	18	18	18
Texas	24	24	24
Utah	18	18	18
Vermont	18	18	18
Virginia	18	18	18
Washington	18	18	18
West Virginia	18	18	18
Wisconsin	18	18	18
Wyoming	24	24	24

Table 2: NFPA 101

Jurisdiction	IBC	IFC	ESBC
Alabama	18	18	18
Alaska	18	18	18
Arizona	18	18	18
Arkansas	18	18	18
California	24	24	24
Colorado	24	24	24
Connecticut	21	21	21
Delaware	18	18	18
District of Columbia	15	15	15
Florida	21	21	21
Georgia	24	24	24
Hawaii	21**	21**	21**
Idaho	18	18	18
Illinois	12*	12	12
Indiana	18	18	18
Iowa	18	18	18
Kansas	18	18	18
Kentucky	18	18	18
Louisiana	18	18	18
Maine	18	18	18
Maryland	18	18	18
Massachusetts	18	18	18
Michigan	18	18	18
Minnesota	18	18	18
Mississippi	18	18	18
Missouri	18	18	18
Montana	18	18	18
Nebraska	18	18	18
Nevada	18	18	18
New Hampshire	21	21	21
New Jersey	21	21	21
New Mexico	21	21	21
New York	21	21	21
North Carolina	21	21	21
North Dakota	18	18	18
Ohio	21	21	21
Oklahoma	18	18	18
Oregon	18	18	18
Rhode Island	21	21	21
South Carolina	21	21	21
South Dakota	18	18	18
Tennessee	18	18	18
Texas	24	24	24
Utah	18	18	18
Vermont	18	18	18
Virginia	18	18	18
Washington	18	18	18
West Virginia	18	18	18
Wisconsin	18	18	18
Wyoming	24	24	24

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ASSURING COMPLIANCE

Avoiding Interference with Municipal Emergency Communications Systems

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Concerns About Non-Compliant BDA Systems

#1 – OSCILLATION Interference

Improper installation or a failure could lead to Oscillation (donor antenna signal feeds back into the DAS), creating harmful interference to Public Safety Radio System.

THE SOLUTION: Oscillation Suppression

1. BDA Detects Oscillation & Reduces Gain until the oscillation is neutralized
2. BDA Sends Trouble Signal to Fire Alarm Control Panel
3. BDA Indicates Trouble on Remote Annunciator / Monitor
4. BDA Continues normal operation with the maximum allowable gain



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Concerns About Non-Compliant BDA Systems

#2 - NOISE Interference:

Noise on uplink can potentially add up & cause signal degradation for fire radio systems.

THE SOLUTION- Noise Suppression Feature:

Most BDAs normally generate a small amount of noise when idle. This small amount of noise can negatively affect donor or receiver sites that are very close to the BDA.

Uplink noise can be mitigated with proper design and by using BDA with uplink noise suppression (a.k.a. squelch) feature.





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Concerns About Non-Compliant BDA Systems

#3 - SUPERVISION:
 Failure of a System Component may go unnoticed without proper monitoring & supervision (required by NFPA 1221 / 1225), resulting in the system NOT being available when you need it the most.

THE SOLUTION – UL-Certified Supervision and Monitoring:



1. Supervision as required by IBC / IFC and NFPA
2. SUPERVISED Dedicated Monitoring Annunciator Panel
3. Dedicated connections for Fire Alarm Panel Supervisory
4. Monitoring Of:
 - Battery
 - Power Supplies (Primary & Secondary)
 - Antenna
 - BDA Diagnostics

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What About Code Compliance, Reliability & Safety?

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Protecting Municipal Emergency Comm's Systems

OSCILLATION PREVENTION



NON-INTERFERENCE



CODE-REQUIRED SUPERVISION



FCC-LICENSED TECHNICIANS



MANUFACTURER TRAINING



NICET[®]
 In-Building Public Safety Communications (IBPSC)



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Specification, Inspection & Enforcement
Authorities Having Jurisdiction (AHJ) Requirements



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Technical Specifications and Requirements


Technical criteria. The fire code official shall maintain a document providing the specific technical information and requirements for the in-building, two-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.



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Technical Specifications and Requirements


- General Contact Information for the Jurisdiction
- Procedural and Permit Requirements Specific to the Jurisdiction
- Applicable Code References
- Frequency Requirements
- Radio System Site Locations and Transmit Power
- Maximum Allowed Propagation Delay
- Any Other Radio System Related Technical Requirements
- Requirements for Ongoing Maintenance and Reporting



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Technical Specifications and Requirements


- **General Contact Information for the Jurisdiction**
 - Contact for Permit Applications and Submittals
 - Contact for Coordination of Inspections
 - Contact for Coordination of Testing and Signal Surveys (Radio Dispatch)
 - Contact for Ongoing Maintenance



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Technical Specifications and Requirements


- **Procedural and Permit Requirements Specific to the Jurisdiction**
 - Is the Permit Required?
 - If Required, Outline the Process for Obtaining the Permit, Forms, etc.
 - Any Applicable Permit Fees?
 - Expiration Date for the Permit?
 - Technical Submittal Requirements
 - Typically: System Diagrams, Equipment Locations, Technical Specifications with UL 2524 Listing and FCC I.D., Personnel Qualifications.
 - Any Other Initial Submittal Requirements



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Technical Specifications and Requirements

- **Applicable Code References**
 - IBC Section 916 (2015 Edition), IBC Section 918 (2018 Edition)
 - IFC Section 510 (2015 through 2024 Edition)
 - NFPA 72 (2022 Edition)
 - NFPA 1221 (2019 Edition)
 - NFPA 1225 (2022 Edition)



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Technical Specifications and Requirements

• Frequency Requirements

- List all Radio Systems that Need to be Included in the ERCES BDA (i.e., Fire, Police, County, EMS, Mutual Aid, etc.)
 - For each system, include the following information:
 1. Site locations (list all transmit and receive sites)
 2. Output Power of each transmitter
 3. Uplink and Downlink Frequency for each
 4. PL-DPL Tone Information for each channel
- Include any planned upcoming system upgrades or changes if known
- Include any preferences for Donor Sites, if applicable



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Technical Specifications and Requirements

• Radio System Site Locations and Transmit Power

- List the addresses and/or Lon/Lat for all Transmit Locations (i.e., repeater locations)
- List the addresses and/or Lon/Lat for all Additional Receive Locations (i.e., voting or remote receivers that are part of the radio system)
- For each site, it will also be helpful to included the antenna structure type (i.e., water tower, radio tower, high rise building, etc.)
- Include the ERP (effective radiated power) for each transmitter
- Please include any information about secondary or backup repeater locations as it is important to ensure that the BDA System will also work with those
- This information can be easily obtained from your two-way radio vendor



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Technical Specifications and Requirements

• Maximum Allowed Propagation Delay

- Typically, this is 15 microseconds (μ s)
- In some cases, for special radio systems, this number can be different. If so, please consult with your two-way radio vendor.

• Any Other Radio System Related Technical Requirements

- If your radio system has any special requirements, please include them in the specification.
- Please do not over-specify, as it is best to leave it up to the qualified vendors to deliver a system that is compliant with FCC, UL and adopted Fire Code requirements.



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Technical Specifications and Requirements

• Requirements for Ongoing Maintenance and Reporting

- It is very important to include the maintenance requirements in the specification.
- **Maintenance.** The in-building, two-way emergency responder communication coverage system shall be **maintained operational at all times.**
- Include a paragraph stating that the Building Owner is responsible for system maintenance and any updates.
- Include the reporting requirements (i.e., maintenance coverage certification with service vendor contact information, annual inspection reports, etc.)
- Report submittal process (i.e., email contact or Compliance Engine or similar)



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Technical Specifications and Requirements

- This document can be as simple as a one-page, or it can be much more elaborate.
- The most important is to provide frequency and radio site information for the system vendors, as well as any contact and procedural requirements specific to your jurisdiction.
- State and Local Fire Codes, NFPA, UL 2524 and FCC otherwise provide sufficient technical parameters to ensure a code-compliant system.



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AHJ Acceptance Inspection

The purpose of the inspection is to ensure that the system complies with the adopted Fire Codes

- Product functionality and code compliance are ensured by UL 2524 Certification.
- RF (radio frequency) compliance is ensured by FCC Compliance Certification.
- Compliance with Electrical and Building Code is ensured by the licensed Electrical Contractor that is responsible for the installation.
- Connections to the Fire Alarm Control Panel and Fire Alarm System Testing are the responsibility of the Integrator licensed in the installation of Fire Alarm Systems.
- Accuracy of the survey report is ensured by the FCC GROL Licensed Technician's signature
- The AHJ's responsibility is to ensure that the installation satisfies the above requirements, to verify the system coverage with sample radio testing (DAQ), and to verify the trouble reporting on the Fire Alarm Control Panel and the Dedicated Annunciator.



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AHJ Acceptance Inspection

Review of submittals to ensure product compliance (i.e., product is UL 2524 Listed, qualified designer & installer)

2. On-Site Inspection:

- a) Electrical work is done in accordance with building and electrical codes, this is normally verified by electrical / building inspector
- b) Inspect the UL Listing Label and Model matches what is in the submittals
- c) Inspect FCC Label and FCC ID
- d) Vendor to demonstrate the individual Troubles are coming up on BDA / remote annunciator and FACP
- e) Review the Signal Strength Survey Report and DAQ
- f) Perform sample radio checks with Fire Alarm / Dispatch,
- g) Perform DAQ Test in Critical Areas and other areas with the weakest signal readings
- h) A copy of the Closeout Documentation left with the system; a second for the AHJ
- i) Ensure that there is code-compliant ongoing maintenance for the system



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AHJ Acceptance Inspection

- A. Plans & Permits
- B. System Components
- C. Fire Alarm System Monitoring
- D. Signal Booster Dedicated Panel
- E. Critical Areas Radio Signal Coverage Test
- F. Closeout Documentation Requirements

ERCS Acceptance Checklist
Emergency Responder Communications Enhancement Systems - Illinois

Plans and Permits

- If required, a permit shall be issued by the AHJ for the ERCS system (NFPA 1221 §9.6.6.1)
- BDA plans submitted for approval prior to installation (NFPA 1221 §9.6.6.3)
- FCC GRD license for technician and equipment manufacturer training (FCC §910.5.2)

System Components

- ERCS active components shall be UL 2524 Listed (IFC §510.4)
- AC power source shall be supplied from a dedicated branch circuit (NFPA 1221 §9.6.12.1)
- Storage battery with at least 12 hours of UL 2524-Certified battery run time (NFPA 1221 §9.6.12.2)
- Storage batteries shall be marked with the month and year of manufacture (NFPA 72 10.6.10)

Fire Alarm System Monitoring

- Antenna malfunction supervisory signal at FACP (NFPA 1221 §9.6.13.1)
- Signal booster failure supervisory signal at FACP (NFPA 1221 §9.6.13.2)
- Low battery capacity supervisory signal at FACP (NFPA 1221 §9.6.13.1)
- Loss of normal AC power supervisory signal at FACP (NFPA 1221 §9.6.13.1)
- Failure of battery charger supervisory signal at FACP (NFPA 1221 §9.6.13.1)
- System Component Failure supervisory signal at FACP (NFPA 1221 §9.6.13.1)



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AHJ Acceptance Inspection

- A. Plans & Permits
- B. System Components
- C. Fire Alarm System Monitoring
- D. Signal Booster Dedicated Panel
- E. Critical Areas Radio Signal Coverage Test
- F. Closeout Documentation Requirements

Signal Booster Dedicated Panel

- Normal AC power status at Dedicated Panel (NFPA 1221 §9.6.13.2.1)
- Signal booster trouble status at Dedicated Panel (NFPA 1221 §9.6.13.2.1)
- Control Antenna trouble (NFPA 1221 §9.6.13.2.2)
- Loss of normal AC power status at Dedicated Panel (NFPA 1221 §9.6.13.2.1)
- Failure of battery charge status at Dedicated Panel (NFPA 1221 §9.6.13.2.2)
- Low battery capacity status at Dedicated Panel (NFPA 1221 §9.6.13.2.1)
- System Component Failure supervisory signal at FACP (NFPA 1221 §9.6.13.1)

Critical Areas Radio Signal Coverage Test

- Fire command center (NFPA 1221 §9.6.7.3)
- Fire pump room (NFPA 1221 §9.6.7.3)
- Exit stairs (NFPA 1221 §9.6.7.3)
- Exit passageways (NFPA 1221 §9.6.7.3)
- Elevator lobbies (NFPA 1221 §9.6.7.3)
- Standpipe cabinets (NFPA 1221 §9.6.7.3)
- Sprinkler sectional valve locations (NFPA 1221 §9.6.7.3)
- Other critical location area as determined by fire official (NFPA 1221 §9.6.7.3)

Closeout Documentation Requirements

- As-Built Documents containing at a minimum: Riser Diagram, Equipment Locations, Cable Paths
- Equipment Technical Specifications (Manufacturer Specification Sheet)
- FCC ID number, UL 2524 Listing Certification
- Signal Survey Report as specified
- Maintenance Contract / Annual Inspection Certification, Proof of Compliance
- Minimum Qualification: design, testing and installation performed by qualified personnel (FCC GRD, License Number and Manufacturer Training Certification Required)
- Compliance Certification (Inspection report)



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Who Can Be the Service Provider?

- ERCES MUST be serviced annually as per the manufacturer's recommendations.
- Manufacturer-Certified Vendors are the only ones qualified to provide manufacturer-required service.



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Why is Maintenance so Important? What Happens if a BDA System Fails?

- A BDA system is an extension of the public safety radio system which operates on FCC licensed frequencies. If the BDA fails, it not only jeopardizes the safety of the building occupants and emergency responders, but it can also interfere with the public safety radio system.
- In some cases, failed BDAs have completely disabled public safety radio systems, preventing Fire department communications throughout the whole city!
- Not only does this present the obvious problem for public safety, but it also exposes the property owner to possible FCC fines and other liabilities.



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AFAA

When properly designed, installed, and maintained, ERCES save lives.



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Questions

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