

Emergency Responder Radio Coverage in Buildings



Requirements for the Installation of a Fire Fighter Communication System

The Boston Fire Department has developed these requirements in conjunction with the requirements of the Massachusetts Building Code as amended on April 11, 2014.

The installation and operation of radio based fire fighter communication systems must comply with this document.

The voluntary installation of a radio based fire fighter communication system must comply with all of the requirements of this document.

The in-building radio system is an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable firefighter communications at the required signal strength within the specified areas

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A. Emergency Responder Radio Coverage in Buildings

1. Emergency responder radio coverage shall be provided in all new buildings
2. Buildings shall have approved radio coverage for Fire Fighters within the building based upon the existing coverage levels of the Boston Fire Radio System at the exterior of the building. This shall not require improvement of the existing Boston Fire Radio System.
3. Exceptions:
 - A. One and 2 family dwellings
 - B. Buildings that have sufficient levels of radio coverage
4. Existing buildings undergoing substantial renovation, a change of occupancy, or the installation of a new fire alarm system are required to provide radio coverage for fire fighters.
5. Buildings and structures that cannot support the required level of radio coverage shall be equipped with a system that includes a bi-directional amplifier(s) to achieve the required level of radio coverage.
6. RF emitting devices and cabling used in the installation of the BDA system shall be approved by the Boston Fire Department. All RF emitting devices shall have the certification of the FCC and be suitable for public safety use prior to installation.

B. Waiver of Radio Coverage System

1. Buildings that have sufficient levels of radio coverage to satisfy the requirements may request a waiver by submitting a Permit Application indicating a waiver is being requested along with an RF survey showing sufficient levels of radio coverage. Coverage will be verified by BFD radio technicians.
2. Waivers are valid for 5 years and must be renewed
3. At any time it is determined by the Boston Fire Department, that radio coverage is not adequate, the waiver will be withdrawn and the property owner is then required to provide radio coverage as required.

C. Approval and Permit

1. Prior to the installation of a Fire Fighter Communication System, a permit for the installation of a signal booster must be submitted to:

Boston Fire Department - Communications Section
59 Fenway Boston, MA 02115
bfd-radioshop.bfd@cityofboston.gov

2. The permit application shall include:

- a. Detailed drawings showing the location of the amplification equipment and associated antenna systems which includes a view showing building access to the equipment
- b. Schematic drawings of the electrical system, backup power, antenna system and any other associated equipment relative to the amplification equipment including panel locations and labeling.
- c. Manufacturer's data sheets on all equipment to be installed.

3. Upon approval, a permit for the installation of a signal booster will be issued. Any field changes that occur during construction shall be incorporated into new As-Built plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. As-Built plans, if required due to system changes, shall be submitted for approval.

4. The Boston Fire Departments assumes the responsibility of registering approved signal boosters with the FCC.

5. Property owners who maintain compliance with this document are granted permission to operate a signal booster on frequencies licensed to the Boston Fire Department by the Federal Communications Commission. The failure to maintain compliance with this specification will result in the automatic withdrawal of said permissions.

D. Radio Coverage

1. General building areas shall be provided with 90 percent floor area radio coverage.
2. Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical, shall be provided with 99 percent floor area radio coverage.

E. System Design

1. The distributed antenna system may be a radiating cable, fixed antennas or a combination of both.
2. The system must comply with all applicable sections of FCC Rules. (appendix A).
3. Permanent external filters or attachments shall not be permitted.
4. Assembly/installation of all components shall comply with the National Electrical Code.
5. Survivability from attack by fire shall meet NFPA 72.
6. All system components shall be installed, tested, inspected, and maintained in accordance with the manufacturers' published instructions.
7. The system design, and installation, shall not exceed the FCC's OET 65 standards.
8. The system shall be normally powered on and continuously provide passing of required frequencies.
9. Shall be compatible with both analog and digital communications, simultaneously at the time of installation.
10. BDA systems shall have lightning protection that complies with NFPA 780.
11. Maximum propagation delay is 15us (microseconds)

F. Signal Strength

1. A minimum inbound (downlink) signal strength of -95 dBm shall be provided throughout the coverage area. The inbound signal level shall be sufficient to provide a minimum of DAQ 3.0 for either analog or digital signals.
2. A minimum outbound (uplink) strength of -95 dBm shall be provided at the Boston Fire Department receivers. The outbound signal level shall be sufficient to provide a minimum of DAQ 3.0 for either analog or digital signals.

G. Isolation

1. Antenna isolation shall be maintained between the donor antenna and all inside antennas to a minimum of 20dB under all operating conditions.

H. Pathway Survivability

1. Levels shall be as described in Section 5.10. (CMR780)
2. Shall have a pathway survivability of Level 1, Level 2, or Level 3.
3. Radiating cable shall not be required to be installed in metal raceway.
4. Feeder and riser coaxial cables shall be rated as plenum cables.
 - A. Feeder coaxial cables shall be connected to the riser coaxial cable using hybrid coupler devices of a value determined by the overall design.
 - B. Riser coaxial cables shall be rated as riser cables and routed through a 2-hour-rated enclosure.
5. 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 fire-stopped to 2-hour ratings.

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

1. No amplification system capable of operating on frequencies or causing interference on frequencies assigned to the Boston Fire Department by the FCC shall be installed without prior coordination and approval of the Boston Fire Department.
2. The property owner shall suspend and correct equipment installations that degrade the performance of the Boston Fire radio system or the BDA.
3. BDA 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 required level of performance, regardless of the amount of traffic carried by the non-public safety services.
4. Secondary users must furnish a complete list of transmit and receive frequencies along with an intermodulation (IM) study that will accompany the permit application. The IM Study will consist of the following calculations: $IM = Q * F$, $IM = F1 + F2 + F3$, $IM = F1 + F2 - F3$, $IM = Q1 * F1 + Q2 * F2$, and $IM = Q1 * F1 - Q2 * F2$ for all frequencies up-link and down-link. These calculations will be done to the 5th order.

J. System Radio Frequencies

1. The BDA shall be capable of transmitting all radio frequencies, assigned to the Boston Fire Department, and be capable of using any modulation technology in current use by the Boston Fire Department.

2. Assigned Frequencies

Downlink	Uplink
483.1625	486.1625
483.1875	486.1875
483.2125	486.2125
483.2375	486.2375

3. Class B Amplifier Pass Band

The downlink (from BFD) pass band of the BDA shall have a center frequency of 483.2 +/- 75Khz. The uplink (to BFD) pass band of the BDA shall have a center frequency of 486.2 +/- 75Khz.

K. Frequency Changes

1. The BDA system shall be upgradeable to allow for changes or additions to system frequencies to maintain radio system coverage as it was originally designed.

L. Radio Survey

1. The building owner shall have the in-building radio system tested to insure that two-way radio coverage on each floor of the building meets or exceeds the required signal strength.

2. Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of two (2) areas will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be calibrated annually and of the frequency selective type incorporating a flexible antenna similar to the ones used on BFD hand held transceivers.

3. RF plots indicating the initial assessment of radio coverage and the enhanced coverage shall be submitted at the time of acceptance testing.

4. All compliance testing to be done with 50 ohm loads in place of the donor antenna to avoid interference to the BFD radio system. The BFD Communications Section is to be notified prior to any testing. (617-343-2875)

5. Unattended operation of the BDA is not permitted until the completion of acceptance testing.

M. Power Supplies

1. At least two independent and reliable power supplies shall be provided for all RF emitting devices and any other components of the system.

2. The Primary Power Source Shall be supplied from a dedicated branch circuit and comply with NFPA 72.

3. The Secondary Power Source Shall consist of a storage battery dedicated to the system with 12 hours of 100% system operation capacity

N. Component Enclosures

1. All BDA components, RF filters, and battery system components shall be contained in a NEMA4- or NEMA4X-type enclosure(s).
2. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. External or exposed RF filters are unacceptable.
3. The cabinet shall be painted red and equipped with a locking mechanism.
4. The cabinet shall be labeled (in bright yellow):

BOSTON FIRE DEPT. RADIO
BDA Permit #
Serviced by: (Vendor name)
(Vendor telephone)

O. System Monitoring

1. A sign will be located at the dedicated monitoring panel with the name and telephone number of the radio service provider indicating that they shall be notified of any alarm.
2. Trouble signals must be immediately reported to the radio service provider.
3. The Boston Fire Department must be notified of any failures that extend past the two (2) hour time limit.
4. The building's Fire Alarm system shall include automatic supervisory signals for malfunctions of the BDA system that are annunciated by the fire alarm system in accordance with NFPA 72, and shall comply with the following:

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

(2) System supervisory signals shall include the following:

(a) Donor antenna malfunction

(b) Active RF emitting device failure

(c) Low-battery when 70% of the 12-hour operating capacity has been depleted

(d) System component failure

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

(a) Loss of normal ac power

(b) Failure of battery charger

O. System Monitoring cont'd

(4) The communications link between the fire alarm system and the BDA must be monitored for integrity.

5. A dedicated monitoring panel shall be provided within the fire command center to annunciate the status of all RF emitting devices and system component locations. The monitoring panel shall provide visual and labeled indications of the following for each system component and RF emitting device:

- (a) Normal ac power*
- (b) Loss of normal ac power*
- (c) Battery charger failure*
- (d) Low battery capacity (to 70 percent depletion)*
- (e) Donor antenna malfunction*
- (f) Active RF emitting device malfunction*
- (g) System component malfunction*

6. The communications link between the dedicated monitoring panel and the two-way radio communications enhancement system must be monitored for integrity.

P. Acceptance Testing

1. Delivered audio quality (DAQ) testing will be conducted by BFD radio personnel to ensure that two way radio coverage, on each floor of the building, meets the minimum coverage requirements. At least five (5) business days notice is required prior to the test being conducted.

2. It is the building owner's responsibility to ensure that acceptance testing occurs prior to Fire Alarm System testing for the building.

3. At the time of this test, the following are also required:

A. The approved radio technician shall certify that the in-building radio system was installed and tested in accordance with the requirements of the current BFD In-Building Radio Specification.

B. An approved radio service company shall certify that a maintenance contract is in effect that provides 24 hour by 7 day response within 2 hours of notification of a problem. This contract must be for a period of at least 1 year.

C. RF Survey results, gain values of all amplifiers

P. Acceptance Testing cont'd

- D. Small scale drawings (11" x 17" maximum) of the structure shall be provided by the owner/contractor. The plans shall show each floor divided into the grids. Each grid shall be labeled to indicate the DAQ result from the RF Survey.
- E. As built drawings (if needed)
- F. BDA Manufacturer, Model #, Serial #, FCC Certification #
- G. Link budget

Q. Testing Procedures:

1. For testing system signal strength and quality, the testing shall be based on the DAQ system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
2. Delivered Audio Quality Definitions:
 - DAQ 1: Unusable, speech present but unreadable.*
 - DAQ 2: Understandable with considerable effort. Frequent repetition due to noise / distortion.*
 - DAQ 3: Understandable with slight effort. Occasional repetition required due to noise/distortion.*
3. A number of cells per floor shall be selected at random. Signal strength measurements shall be taken at the center of each cell.
4. A maximum of two grid cells per floor will be allowed to fail the test. In the event that three of the areas fail the test, in order to be more statistically accurate, the testing grid resolution maybe doubled. If the number of grid cells is adjusted, the number of failed cells permitted shall be adjusted accordingly to meet the 90% coverage requirement.
5. Failures shall not be allowed in critical areas, including but not limited to the Fire Command Center, Fire Pump Room, Emergency Generator Room, Stairwells with a standpipe, Elevator Lobbies serving the Emergency Elevator, and other areas as identified by the Fire Department.
6. Both inbound and outbound signals shall be measured on each and every floor above and below ground including stairwells, basements, penthouse facilities and parking areas of the structure.
7. Measurements shall be made with the antenna held in a vertical position at three (3) to four (4) feet above the floor. (portable radio worn on the belt or turnout coat pocket).

R. Annual Test

1. All active components of the in-building radio system, including but not limited to amplifier, power supplies, and back-up batteries, shall be inspected a minimum of once every twelve (12) months.
2. Annual tests will be conducted by an authorized company
3. Amplifiers shall be tested to insure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
4. Back-up batteries and power supplies shall be tested under load for a period of one (1) hour to verify that they will operate during an actual power outage.
5. Active components shall be tested to verify they are operating as designed by the manufacturer.
6. If communications appear to have degraded or if the tests fail to demonstrate adequate system performance, the owner of the building or structure is required to remedy the problem and restore the system in a manner consistent with the original approval criteria.
7. The re-testing will be done at no expense to the City as required in the original testing procedures.

S. Five Year RF Survey

1. An RF Survey be conducted a minimum of once every five (5) years to insure that the radio system continues to provide the required level of radio coverage.
2. The procedure set forth in Section L shall apply to such tests.

T. Maintenance & Servicing:

1. At final acceptance the building owner shall supply a letter to the Fire Department accepting the property owner's responsibilities. These responsibilities are as follows:
 - A. Upgrades to system as directed by the Boston Fire Department;
 - B. Maintenance contract in place with name of authorized company, who will provide a 24 hour by 7 day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements.
 - C. Maintain a list of contact personnel with phone numbers at the BDA cabinet. The contact personnel shall have knowledge of the building and the BDA system and be available to respond to the building in the case of an emergency.
 - D. Annual Inspections
 - E. 5-year RF surveys
 - F. This letter is to be on company letterhead signed by the property owner or a legal representative.

U. Modifications

1. Modification of an existing BDA System requires prior approval from the Boston Fire Department.
2. A permit application shall be submitted which includes a description of the work to be performed and drawings showing intended modification.
3. Modification work must not degrade radio coverage at any time.
4. An RF Survey must be completed and submitted after any modification to an existing antenna system.

V. Radio Service Provider

1. An approved Radio Service Provider is a company that employs individual(s) that are qualified by the equipment manufacturer (in writing) to work on the bi-directional amplifier system and holds a valid FCC license or equivalent.
2. Design, Installation and Testing shall be conducted, documented, and signed by a technician qualified by the equipment manufacturer (in writing) to work on the bi-directional amplifier system and who is also in possession of one of the following:
 - A. FCC General Radiotelephone Operator License
 - B. APCO Radio Technician Certification
 - C. Certification from an industry organization acceptable to the BFD
3. Radio service providers will be issued call signs for use when transmitting on the Boston Fire Radio System.
4. Reports of annual inspections and 5-year RF Surveys must be submitted to the Boston Fire Department.
5. The Boston Fire Department shall be notified in writing at least thirty (30) days prior to cancellation of a maintenance contract. Such notice shall contain the date and time such cancellation is to take effect, BDA location, and BDA Permit #.
6. The BFD Radio Supervisor shall be notified in writing upon the procurement of contractual agreements relating to in-building radios covered by this specification.

W. Fire Department Inspections

1. Fire Department Radio personnel, after providing reasonable notice to the owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present.

X. Disclaimer

1. The Boston Fire Department does not endorse, recommend or specify any specific product, service provider or configuration as the means to comply with this specification.

Appendix A FCC Regulations

Title 47: Telecommunication

PART 90—PRIVATE LAND MOBILE RADIO SERVICES

Subpart I—General Technical Standards

§90.219 Use of signal boosters.

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

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

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

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

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

Deploy a signal booster. Install and/or initially adjust a signal booster.

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

Operate a signal booster. Maintain operational control over, and responsibility for the proper functioning of, a signal booster.

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

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

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

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

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

(2) [Reserved]

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

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

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

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

(3) Signal boosters must be deployed such that the radiated power of the each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts effective radiated power (ERP).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(4) On a label affixed to the device:

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

[78 FR 21564, Apr. 12, 2013]