



**CHELMSFORD FIRE DEPARTMENT**  
**FIRE PREVENTION OFFICE**

50 Billerica Road – Chelmsford, MA 01824  
(978) 251-4288

*"Smoke Detectors Save Lives"*



# REQUIREMENTS FOR RADIO BASED EMERGENCY RESPONDER RADIO COVERAGE IN BUILDINGS

Revision v3

*Issued March 10, 2020*

The Chelmsford Fire Department has developed these requirements in conjunction with the requirements of the Massachusetts Building Code.

The installation and operation of radio based emergency responder communication systems must comply with this document.

A radio based emergency responder communication system installed where not required by applicable codes 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 communications for public safety personnel at the required signal strength within the specified areas. **An in-building radio system functions as part of a properly functioning fire alarm system.**

## 1. General Provisions

- 1.1. **Emergency responder radio coverage shall be required in all new buildings and all existing buildings undergoing extensive (Level 3) Renovations.** No occupancy of the building will be permitted prior to the submittal of an RF survey that meets the signal strength requirements outlined in this document.
- 1.2. Buildings shall have approved radio coverage for Emergency Responders within the building based upon the existing coverage levels of the Chelmsford Fire and Police Radio Systems at the exterior of the building. This shall not require improvement of the existing Chelmsford Fire or Police Radio Systems.
- 1.3. Exceptions
  - 1.3.1. One- and two-family dwellings
  - 1.3.2. Buildings that have sufficient levels of radio coverage
  - 1.3.3. Wood framed residential buildings not exceeding six units
  - 1.3.4. Wood framed residential townhouses
- 1.4. 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. Wired communication systems (fire phones) are not allowed under any circumstances.
- 1.5. RF emitting devices and cabling used in the installation of the BDA system shall be approved by the CFD. All RF emitting devices shall have the certification of the FCC and be suitable for public safety use prior to installation.
- 1.6. Waiver of Radio Coverage Systems
  - 1.6.1. 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. The RF survey shall be signed by a vendor who will provide proof of FCC-GROL certification. Coverage will be verified by CFD Fire Prevention and/or third party testing.
  - 1.6.2. Waivers are valid for 5 years and must be renewed.
  - 1.6.3. Any time it is determined by CFD that radio coverage is not adequate, the waiver will be withdrawn and the property owner is then required to provide radio coverage as required.
  - 1.6.4. Five Year RF Survey
    - 1.6.4.1. *For buildings that received a waiver for coverage as a result of their initial testing, an RF survey must be conducted a minimum of once every five (5) years to ensure that radio coverage has not deteriorated to a point that would require a BDA system according to standards for new construction.*
    - 1.6.4.2. *All test reports shall be forwarded to the CFD Fire Prevention Office.*
    - 1.6.4.3. *In the event of a failure of the RF survey, the building owner shall install a BDA system within ninety (90) days of the date of the failed test. Any BDA system installed must comply with this standard.*

## 1.7. Application and Permit

1.7.1. Prior to the installation or modification of an Emergency Responder Communication System, a permit application for the installation or modification of a signal booster must be submitted online using the Chelmsford Fire Department online permitting system.

1.7.2. The permit application shall include:

1.7.2.1. *Detailed drawings showing the location of the amplification equipment and associated antenna systems which includes a view showing building access to the equipment*

1.7.2.2. *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.*

1.7.2.3. *Manufacturer's data sheets on all equipment to be installed.*

1.7.2.4. *Plan review charge of \$50, payable to the Town of Chelmsford*

1.7.2.5. *Permit application on CFD Emergency Responder Radio Coverage Permit form*

1.7.3. 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.

1.7.4. The Chelmsford Fire Departments assumes the responsibility of registering approved signal boosters with the FCC.

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

## 1.8. Radio Coverage

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

1.8.2. Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, elevator shaftways, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical, shall be provided with 100 percent floor area radio coverage.

### 1.8.3. Signal Strength

1.8.3.1. *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 3.4 for either analog or digital signals. See Section 3.3.2 for DAQ level definitions.*

1.8.3.2. *A minimum outbound (uplink) signal strength of -95 dBm shall be provided at Chelmsford Public Safety receivers. The outbound signal level shall be sufficient to provide a minimum of DAQ 3.4 for either analog or digital signals. See Section 3.3.2 for DAQ level definitions.*

1.8.4. Radio coverage and if necessary a BDA system shall be provided for and installed/operational before the final fire prevention inspection for occupancy.

## 2. SYSTEM DESIGN AND TECHNICAL SPECIFICATIONS

### 2.1. System Design

2.1.1. The distributed antenna system may be a radiating cable, fixed antennas or a combination of both.

2.1.2. The system must comply with all applicable sections of FCC Rules. (Appendix A).

2.1.3. Permanent external filters or attachments shall not be permitted.

2.1.4. Assembly/installation of all components shall comply with the National Electrical Code.

2.1.5. Survivability from attack by fire shall meet NFPA 72 (2013).

2.1.6. All system components shall be installed, tested, inspected, and maintained in accordance with the manufacturers' published instructions.

2.1.7. The system design, and installation, shall not exceed the FCC's OET 65 standards.

2.1.8. The system shall be normally powered on and continuously provide passing of required frequencies.

2.1.9. The system shall be compatible with both analog and digital communications, simultaneously at the time of installation.

2.1.10. BDA systems shall have lightning protection that complies with NFPA 780.

2.1.11. Maximum propagation delay is 14us (microseconds)

2.1.12. All active components of BDA units shall be UL 2524 listed or listed for the purpose with which they are designed. The system must also comply with the requirements of NFPA 72 (2013)

2.1.13. Non-OEM external filters, filters, power supplies or other non-OEM additions or modifications of the original equipment shall not be allowed.

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

### 2.2. Pathway Survivability

2.2.1. Levels shall be as described in NFPA 72 (2013).

2.2.2. Shall have a pathway survivability of Level 1, Level 2, or Level 3.

2.2.3. Radiating cable shall not be required to be installed in metal raceway.

2.2.4. Feeder and riser coaxial cables shall be rated as plenum cables.

2.2.4.1. *Feeder coaxial cables shall be connected to the riser coaxial cable using hybrid coupler devices of a value determined by the overall design.*

2.2.4.2. *Riser coaxial cables shall be rated as riser cables and routed through a 2-hour-rated enclosure or as required by NFPA 72*

2.2.5. 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

2.3. Distributed Antenna Systems

2.3.1. The distributed antenna system may utilize radiating cable, conventional cable, fixed antennas or a combination of all three.

2.3.2. A secondary user of the distributed antenna system (DAS) must comply with all requirements of the CFD Fire Prevention Office so as to not degrade the operational standards of the system. Notice will be made to the CFD Fire Prevention Office as part of the permit application if the DAS will have frequencies other than public safety frequencies installed.

2.4. System Radio Frequencies

2.4.1. The BDA shall be capable of transmitting all radio frequencies assigned to the CFD and the CPD, and must be capable of using any modulating technology in current use by the CFD and the CPD.

2.4.2. Assigned Frequencies

2.4.2.1. *Chelmsford Fire Department – Dispatch and Ops*

2.4.2.1.1. Downlink – 482.775 MHz, PL 88.5

2.4.2.1.2. Uplink – 485.777 MHz, PL 88.5

2.4.2.2. *Chelmsford Police Department – Dispatch and Ops*

2.4.2.2.1. Downlink – 482.5125 MHz, PL 146.2

2.4.2.2.2. Uplink – 485.5125 MHz, PL 146.2

2.4.3. 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.

2.5. Power Supplies

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

2.5.2. The primary power source shall be supplied from a 20 ampere dedicated branch circuit and comply with NFPA 72 (2013, et seq.)

2.5.3. The secondary power supply shall be a battery system with a dedicated battery charger powered by a separate dedicated and independent electrical circuit of sufficient size.

2.5.4. The secondary power supply shall provide power automatically when the primary power supply is lost.

2.5.5. The secondary power supply shall be capable of operating the ERRC system for a period of at least 24 hours.

2.5.6. The battery system shall automatically charge in the presence of external power input.

2.5.7. The battery charger and all other electronic components must be fully enclosed in a non-vented NEMA Type 4 enclosure. Batteries shall be enclosed in a separate vented NEMA rated enclosure.

2.6. Component Enclosure

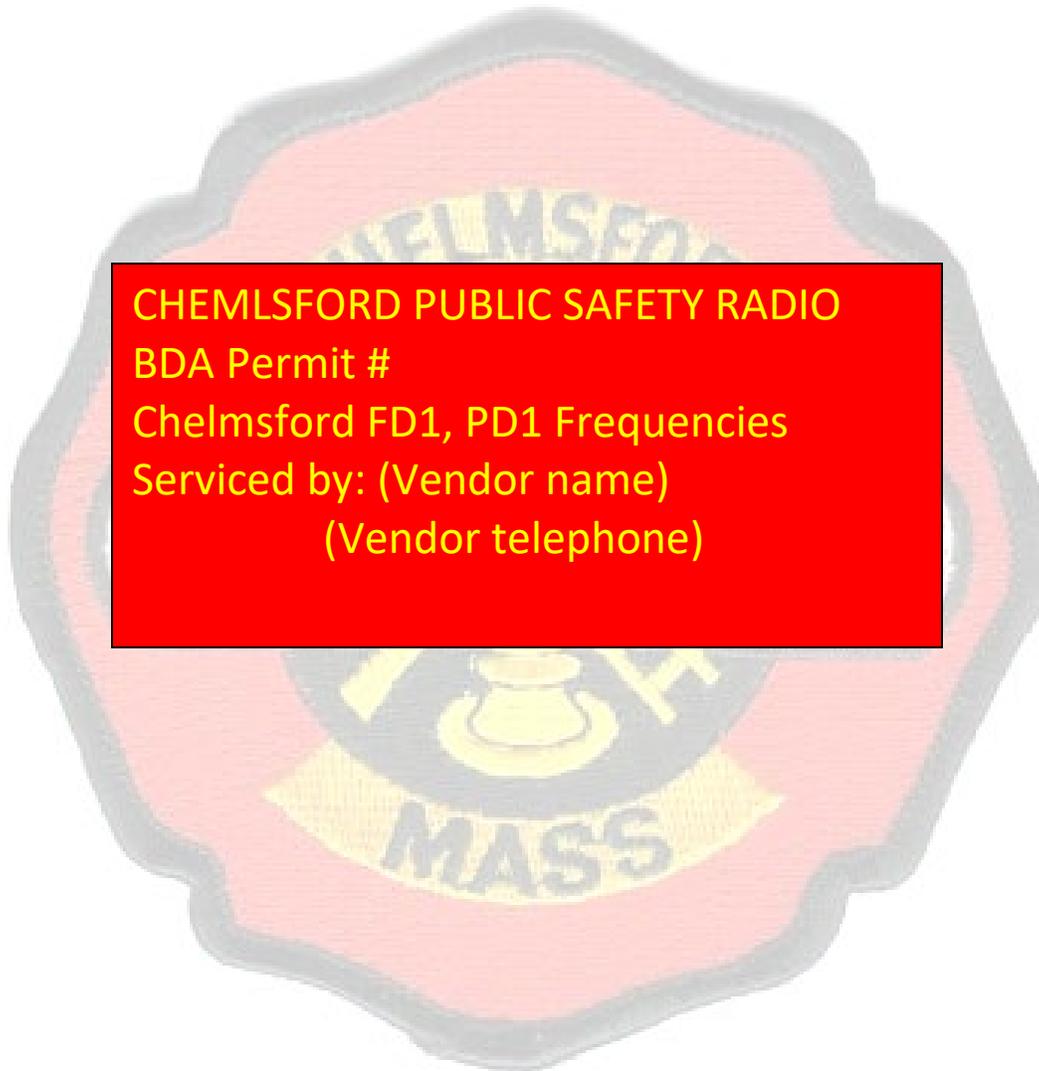
2.6.1. All BDA components, RF filters, and battery system components shall be contained in a NEMA4- or NEMA4X-type enclosure(s).

2.6.2. 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.

2.6.2.1. *Dedicated battery cabinets may be vented.*

2.6.3. The cabinet shall be painted red and equipped with a locking mechanism.

2.6.4. The cabinet shall be labeled (in bright yellow):



**CHEMLSFORD PUBLIC SAFETY RADIO**  
**BDA Permit #**  
**Chelmsford FD1, PD1 Frequencies**  
**Serviced by: (Vendor name)**  
**(Vendor telephone)**

## 2.7. Non-Interference and Non-Public Safety System degradation

- 2.7.1. No amplification system capable of operating on frequencies or causing interference on frequencies assigned to the CFD or CPD by the FCC shall be installed without prior coordination and approval of the CFD Fire Prevention Office.
- 2.7.2. The property owner shall suspend and correct equipment installations that degrade the performance of CFD and/or CPD radio systems or the BDA.
- 2.7.3. 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.
- 2.7.4. 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 downlink. These calculations will be done to the fifth order.
- 2.7.5. The BDA shall employ oscillation suppression to reduce or eliminate any possible interference with the public safety radio network.
- 2.7.6. To reduce the possibility of unwanted interference affecting the operation of the system, signal boosters shall be band or channel selective type. Wide-band signal boosters shall not be accepted.

## 2.8. System Monitoring

- 2.8.1. 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.
- 2.8.2. Trouble signals must be immediately reported to the radio service provider.
- 2.8.3. The CFD must be notified of any failures that extend past the two (2) hour time limit.
- 2.8.4. 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:
- 2.8.5. Monitoring for integrity of the system shall comply with NFPA 72, Chapter 10.
- 2.8.5.1. *System supervisory signals shall include the following:*
- 2.8.5.1.1. Donor antenna malfunction
  - 2.8.5.1.2. Active RF emitting device failure
  - 2.8.5.1.3. Low battery when 70% of the 24 hour operating capacity has been depleted
  - 2.8.5.1.4. System component failure
- 2.8.5.2. *Power supply supervisory signals shall include the following for each RF emitting device and system component*
- 2.8.5.2.1. Loss of normal AC power
  - 2.8.5.2.2. Failure of battery charger

2.8.5.3. *The communications link between the fire alarm system shall be monitored for integrity.*

2.8.6.A dedicated monitoring panel shall be provided at a location that is acceptable to the Fire Prevention Office to annunciate the status of all RF emitting devices and system component locations. The monitoring panel shall provide visual and labelled indications of the following for each system component and RF emitting device.

2.8.6.1. *Normal AC power*

2.8.6.2. *Loss of normal AC power*

2.8.6.3. *Battery charger failure*

2.8.6.4. *Low battery capacity (to 70 percent depletion)*

2.8.6.5. *Donor antenna malfunction*

2.8.6.6. *Active RF emitting device malfunction*

2.8.6.7. *System component malfunction*

2.8.7.The communications link between the dedicated monitoring panel and the BDA system must be monitored for integrity.

2.8.8.Unattended operation of the BDA is not permitted until the completion of Fire Department witnessed acceptance testing.

### 3. ACCEPTABLE PRACTICES FOR RADIO SURVEYS/TESTING

#### 3.1. Initial Building Radio Surveys

3.1.1.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. Both CFD and CPD radio frequencies shall be assessed as indicated in 2.4.2.

3.1.2.Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area 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 CFD/CPD hand held transceivers.

3.1.2.1. *During the initial RF testing, please be advised that the minimum acceptable inbound signal strength is -83 dBm. This accounts for the difference in signal power between downlink repeaters (45 W maximum ERP) and uplink handheld transceivers (3 W expected ERP).*

3.1.3.RF plots indicating the initial assessment of radio coverage shall be submitted to the Fire Prevention Office

3.1.4.All compliance testing to be done with 50 ohm loads in place of the donor antenna to avoid interference to the CFD/CPD radio system. The Chelmsford Public Safety Communications Center is to be notified prior to any testing. (978-250-5265).

3.1.5.All testing and inspections are to be conducted, documented and signed by a person in possession of an FCC GROL.

3.2. BDA Acceptance Testing

3.2.1.Delivered audio quality (DAQ) testing will be conducted by CFD Fire Prevention 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.

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

3.2.3.At the time of acceptance testing, the following is also required:

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

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

3.2.3.3. *RF Survey results of both the initial and improved radio coverage and the gain values of all amplifiers*

3.2.3.4. *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.*

3.2.3.5. *As built drawings (if needed)*

3.2.3.6. *BDA Manufacturer, Model #, Serial #, FCC Certification #*

3.2.3.7. *Link budget*

3.3. AHJ Acceptance Testing Procedure

3.3.1.For final fire department testing of system signal strength and quality, the testing shall be based on the DAQ system. A DAQ level below 3.4 shall be considered a failed test for a given grid cell.

3.3.2.Delivered Audio Quality Definitions:

3.3.2.1. *DAQ 1: Unusable, speech present but unreadable.*

3.3.2.2. *DAQ 2: Understandable with considerable effort. Frequent repetition due to noise / distortion.*

3.3.2.3. *DAQ 3: Understandable with slight effort. Occasional repetition required due to noise/distortion.*

3.3.2.4. *DAQ 3.4: Speech understandable without repetition. Some noise or distortion present.*

3.3.2.5. *DAQ 4: Speech easily understandable. Little to no distortion present.*

3.3.2.6. *DAQ 4.5: Speech easily understandable. Rare to no distortion.*

3.3.2.7. *DAQ 5: Perfect. No discernable noise or distortion present.*

- 3.3.3.A number of cells per floor shall be selected at random. Signal strength measurements shall be taken at the center of each cell. DAQ assessment will be tested at all critical areas.
- 3.3.4.A maximum of one grid cell per floor will be allowed to fail the test. In the event that two 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 95% coverage requirement.
- 3.3.5.Failures shall not be allowed in critical areas as defined by this policy.(1.8.2)
- 3.3.6.Both inbound and outbound signals shall be measured on each floor above and below ground including stairwells, basements, penthouse facilities and parking areas of the structure.
- 3.3.7.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).

#### 3.4. Annual Testing

- 3.4.1.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.
- 3.4.2.All passive components including the DAS shall be tested by conducting an annual RF survey.
- 3.4.3.Annual tests will be conducted by an authorized company and by a technician possessing a current FCC GROL certification.
- 3.4.4.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.
- 3.4.5.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.
- 3.4.6.Active components shall be tested to verify they are operating as designed by the manufacturer.
- 3.4.7.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.
- 3.4.8.The re-testing will be done at no expense to the Town as required in the original testing procedures.

#### 3.5. Maintenance and Servicing

- 3.5.1.At final acceptance or final inspection for occupancy, the building owner shall supply a letter to the Fire Prevention Office accepting the property owner's responsibilities as applicable. These responsibilities are as follows:

- 3.5.1.1. *Upgrades to BDA system as directed by the CFD Fire Prevention Office;*

3.5.1.2. *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.*

3.5.1.3. *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.*

3.5.1.4. *Annual Inspections as outlined in this standard and applicable sections of 780 CMR.*

3.5.1.5. *Agreement to perform 5-year RF surveys for buildings that had adequate levels of radio coverage without employing a BDA*

3.5.2. This letter is to be on company letterhead signed by the property owner or a legal representative.

3.5.3. At no time shall the CFD, CPD, or the Town of Chelmsford be required to bear the costs for installation, modification, or repair of BDA systems as required by this policy.

### 3.6. Modifications

3.6.1. Modification of an existing BDA System requires prior approval from the CFD Fire Prevention Office.

3.6.2. A permit application shall be submitted which includes a description of the work to be performed and drawings showing intended modification. (1.7)

3.6.3. Modification work must not degrade radio coverage at any time.

3.6.4. An RF Survey must be completed and submitted after any modification to an existing antenna system.

## 4. MISCELLANEOUS

### 4.1. Radio Service Providers

4.1.1. 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.

4.1.2. 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 in possession of an FCC General Radiotelephone Operator License (FCC GROL) or its equivalent.

4.1.3. Radio service providers will be issued call signs for use when transmitting on the CFD and CPD systems.

4.1.4. Reports of annual inspections and 5-year RF Surveys must be submitted to the CFD.

4.1.5. The CFD 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 #.

4.1.6. The CFD Fire Prevention Office shall be notified in writing upon the procurement of contractual agreements relating to in-building radios covered by this specification.

4.1.7. All testing personnel and system installers shall be certified and authorized by the BDA manufacturer in the installation and operation of their equipment.

4.2. Fire Department inspections

4.2.1. CFD 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.

4.3. Disclaimer

4.3.1. The CFD does not endorse, recommend or specify any specific product, service provider or configuration as the means to comply with this specification.

