



Roseville Fire Department

Fire & Life Safety Division

316 Vernon Street Suite 480 · Roseville, CA 95678 · (916) 774-5800 · FLSDivision@roseville.ca.us

Fire & Life Safety Standard

Title: Emergency Responder Communication Coverage

Note: *This standard is a summary of Roseville Fire Department clarifications of City, State and Federal codes and regulations. Information contained herein applies to typical circumstances and may not address all situations.*

PURPOSE

This standard was developed with safety as the principle objective, pursuant to the California Fire Code (CFC) the fire code official is authorized to render interpretations of the CFC, and to adopt policies, procedures, rules and regulations in order to clarify the application of its provisions. Such interpretations, policies, procedures, rules and regulations shall be in compliance with the intent and purpose of the CFC and shall not have the effect of waiving requirements specifically provided for in the CFC.

SCOPE

Approved in-building, two-way emergency responder communication coverage shall be provided in all new and existing buildings when required by the fire code official. The emergency responder communication system shall be designed and installed in accordance with the CFC and this standard.

Technical Requirements

Emergency responder radio coverage system installation, components, and operation, shall comply with all applicable Federal regulations, including but not limited to, the Federal Communications Rules specified in Title 47 of the Code of Federal Regulations, including 47 CFR 90.219. Amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC shall not be installed without prior coordination and express written consent of the FCC license holder.

Radio Coverage

Radio coverage shall be provided throughout the building as a percentage of floor area with uplink and downlink signal levels of no less than -95 dBm and shall be tested in accordance with the CFC with the following additional conditions:

- When an emergency responder radio coverage system is required, general building areas shall be provided with 95% floor area radio coverage at no less than - 95 dBm and a minimum delivered audio quality (DAQ) of 3.4 as defined in National Telecommunications and Information Administration (NTIA) Report 99-358.
- Delivered audio quality (DAQ) is defined as follows:

DAQ	Definition
1	Unusable. Speech present but not understandable.
2	Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion.
3	Speech understandable with slight effort. Requires occasional repetition due to noise or distortion.
3.4	Speech understandable without repetition. Some noise or distortion present.
4	Speech easily understandable. Little noise or distortion.



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- Any active amplification system installed to meet these requirements shall operate on the following frequencies which use APCO 25 Phase I or Phase II trunking:

Ch. #	System Transmit	System Receive
1	851.2375 MHz	806.2375 MHz
2	851.5750 MHz	806.5750 MHz
3	851.8750 MHz	806.8750 MHz
4	852.0500 MHz	807.0500 MHz
5	852.1250 MHz	807.1250 MHz
6	852.3750 MHz	807.3750 MHz
7	852.8250 MHz	807.8250 MHz
8	853.0500 MHz	808.0500 MHz
9	853.3500 MHz	808.3500 MHz
10	853.5500 MHz	808.5500 MHz

Propagation Delay

- The allowable emergency responder radio coverage system propagation delay is 15 microseconds. Should this propagation delay be exceeded within the building, there shall be a minimum differential of 16 dB between the signal a portable radio receives from the signal booster and the signal a portable radio receives from the radio system.

Donor Site

- Donor Site Name: Roseville Police Department
- Donor Site Address: 1051 Junction Blvd.

Interference

- The emergency responder radio coverage system shall not interfere with or reduce the performance of any public safety radio communications system or other FCC licensed radio communications system.
- If interference to the public safety radio system is detected the system shall be turned off within 24 hours when requested by the fire code official.
- No system or equipment in the structure may cause any interference to, or reduce the performance of, the emergency responder radio coverage system.
- Bidirectional amplifiers shall have oscillation prevention circuitry and software. Oscillation prevention shall be activated in all bidirectional amplifiers.

Components: Signal Booster and/or Fiber Optic DAS

- If Signal Booster Components and/or Fiber Optic DAS Components are used, they shall meet the following requirements:
 - Signal boosters shall be located in the fire control room or other area approved by the fire code official.



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- Signal boosters and other radio frequency signal generating components shall have FCC certification prior to installation and shall be NFPA 1221 and CFC compliant.
- All signal boosters and distributed antenna systems shall be compatible with digital FDMA (Project 25 Phase I) and digital TDMA (Project 25 Phase II) modulation simultaneously at the time of installation.
- External filters are permitted to be located adjacent to the bidirectional amplifier, fiber headend and fiber remote units.

Design

- System design shall be based on a portable radio at hip level using a lapel microphone for communications.
- Systems shall be designed to support two portable radios transmitting simultaneously on different talk paths, channels, or frequencies, one within 10 feet of a service antenna, and one at the farthest possible distance from a service antenna while still in the designed service area of the service antenna, with no degradation of performance experienced by either radio.
- Bidirectional amplifiers shall not exceed -43 dBm uplink noise within the authorized passband and shall not exceed -70 dBm at 1 MHz outside the authorized passband when in a quiescent state. A reduction in quiescent noise may be required depending upon the distance of the bidirectional amplifier from the donor site. Muting and squelch features shall be adjusted to place the uplink power amplifier in a dormant state when the bidirectional amplifier is not receiving an uplink signal of at least -95 dBm.
- Amplifier uplink gain shall not exceed 65 dB unless an exception has been approved in writing by the fire code official.
- Systems shall be designed with a sufficient density of indoor service antennas to minimize the required amplifier gain as much as possible.
- Radio Frequency (RF) isolation between the outdoor donor antenna and the indoor service antennas shall not be less than 20 dB greater than the maximum system gain.
- Bidirectional amplifiers shall be clearly labeled on the front of the enclosure with the maximum permissible uplink and downlink gain.

Pathway Survivability

- Pathway survivability levels shall be in accordance with the current version of NFPA 1221.
- Donor antenna feeder cables, riser cables, cables providing connection between amplification equipment, and/or other active signal distribution devices, all connections made between backbone and antenna distribution coaxial and fiber optic cables, and all fiber optic cables, are defined as "Backbone" cabling.
- Emergency responder radio coverage system active equipment and backbone cabling shall have a survivability which matches the building's fire rating, and in no event shall be less than 2-hours.
- All backbone, antenna distribution, radiating, and fiber optic cables shall be rated as plenum cables.



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- Exposed coaxial and fiber optic cables shall be enclosed within electrical metallic tubing (EMT) conduit and metal junction boxes. In addition, this conduit provides against accidental cuts and kinks in cabling.
 - An alternative pathway survivability performance methodology may be approved by the fire code official.

Protection Against Water Intrusion

- All amplifiers, active devices, fiber optic headend, and fiber optic remote units, shall be enclosed within NEMA-4, or NEMA-4X, rated enclosures.
- All standby battery units, battery chargers, power supplies, and external filters, shall be enclosed within NEMA-3R, NEMA-4, or NEMA-4X, rated enclosures.
- All alarm and power connections, power dividers, and hybrid couplers, located at the headend shall be enclosed within watertight enclosures.
- All connections into and out of NEMA rated, water resistant, and watertight enclosures shall maintain protection against water intrusion using watertight entry ports or boots and liquid tight flexible nonmetallic conduit (LFNC).

Redundant Power Sources

- The primary power source shall be supplied from a dedicated branch circuit and comply with the current version of NFPA 1221.
- The secondary power source shall comply with one of the following:
 - A storage battery dedicated to the system with at least 24 hours at 100 percent system operation capacity and designed in compliance with the current version of NFPA 1221.
 - A generator with internal combustion engine and a fuel supply providing 24 hours of continuous operation at 100 percent system operation capacity serving the dedicated branch circuit shall be used with a storage battery dedicated to the system with at least 12 hours at 100 percent system operation capacity and designed in compliance with the current version of NFPA 1221.
 - Bidirectional amplifiers (BDA's) shall be equipped with a power switch adjacent to the main FACP. The switch shall both disconnect and reapply power and shall have a protective cover to prevent accidental actuation of the switch.
 - Battery backup power system components shall be mounted at least 12 inches above the floor.

Donor Antennas

- Donor antennas shall be highly-directional.
- Antenna elements shall be welded, and antennas shall be anodized.



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- The antenna gain shall not be less than 10 dBd.
- The antenna azimuth (horizontal) half-power (-3 dB) beam width shall not exceed 45 degrees.
- The antenna front to back ratio shall not be less than 20 dB.
- The antenna, antenna mast or non-penetrating antenna mount, shall be secured to a structure strong enough to carry the weight of the installation with necessary allowances for wind and vibration, and shall be securely anchored to the structure.
- Attachment to the riser cable conduit is permissible if the conduit is appropriately supported and secured to structural elements of the building on the roof.
- Antennas shall not be attached to, or supported by, vent pipes.
- Mast supports and guy wire anchors shall be secured in such a way that the supporting structure is not damaged or weakened.
- Masts which extend more than ten feet above the top of their mounting point shall be strengthened with three (3) or more substantial guy wires at intervals of not more than ten feet of height.

Grounding, Bonding, and Lightning Protection

- All active devices shall be grounded to the master building ground bus.
- All ground connections shall be made with stranded copper wire no smaller than 2 AWG.
- No copper bus bar or copper wire shall come into direct contact with aluminum.
- All ground bus bars shall be copper.
- Donor antenna feedline shall include protection against electrical surge caused by lightning or electrostatic discharge.
- Surge protection shall be located within the building and as close as possible to the antenna feedline building entry point.
- Surge protection shall be grounded to the master building ground bus.
- An additional ground attachment shall be made to grounded structural steel at the building entry point whenever possible.
- Donor antenna mounting structures shall be grounded to the master building ground bus.

System Submittal Requirements

- A permit must be obtained prior to the construction or modification of an indoor emergency responder radio coverage system.



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- A copy of the approved plans and field inspection record shall be posted visibly on the main active component, or at the point of primary system operation.
- The plans will be reviewed and recommended for approval by the fire code official. Plan check and acceptance testing fees will be assessed for these services.
- No permit shall be issued without approved plans. Plans shall contain the following elements:
 - Pursuant to Section 7028 B&P Code, the minimum qualification of the system installing entity shall be a valid classification C7 or C10 California Contractors License.
 - The minimum qualifications of the system designer and lead installation personnel shall be in compliance with the CFC and include a valid FCC-issued general radio operators' license and certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.
 - Plans shall be submitted in accordance with the Development Services Department's Electronic Plan Review Document Submittal Requirements.
 - Plan view of the subject building, building construction type and surrounding property shall clearly indicate the location and orientation of any outdoor antennas associated with the proposed system.
 - The antenna grounding, surge and lightning protection shall be in accordance with the California Electrical Code and Include the location and method of all grounding connections.
 - Plan view of each interior floor where indoor antenna systems are proposed shall include antenna numbers, coax routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. If no coverage enhancement is required on a floor, a plan view of that floor must be included and marked as such.
 - Include a schematic diagram of the proposed distributed antenna system (DAS) showing every component with the gain or loss of the component, the total system gain for both Uplink and Downlink, the Donor Site signal peak and average strengths measured at the approximate location of the Donor Antenna, the calculated Uplink signal strength radiated by the Donor Antenna, and the calculated Downlink signal strength radiated by each Distribution Antenna.
 - Include a link budget analysis chart showing system operating parameters in dBm for each channel (FCC Class A) or frequency band (FCC Class B).
 - Include peak and average Downlink signal strength measurements taken at ground level, from the exterior of the structure, at the approximate center of each side of the structure.
 - Include peak and average Downlink signal strength measurements taken from at least four areas on the roof of the structure.



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- Provide the runtime of the proposed DAS while running exclusively on backup power calculated using the power requirements of the Signal Booster and any associated active components and the rated capacity of the backup power system.
- Include the detailed manufacturers' specifications for each component and the calculations used to derive the 24-hour minimum runtime.
- Specify the backup power source. Provide supply calculations to verify the system shall be capable of operating on an independent battery system, and generator where applicable, for a period of at least 24 hours without external power input. The battery system shall automatically charge in the presence of an external power input.
- Provide copies of the manufacturer's specification sheets for amplifiers, antennas, coax, couplers, splitters, combiners, or any other passive components proposed.
- Backup battery and charging system, and generator (if applicable) specifications.
- Provide the following note on plans: The emergency responder radio coverage system shall not be powered on unless it is employed on a non-radiating load and not on a live DAS system, prior to the final inspection by the fire code official.
- Provide the following note on plans: The emergency responder radio coverage system shall be approved by the fire code official and documentation identifying the approval shall be on site during installation and operation of the emergency responder radio coverage system.

System Acceptance Testing Requirements

- Acceptance and Operational testing shall be in accordance with the CFC.
- The final system acceptance test shall be conducted by the fire code official. No person may conduct an acceptance test unless that person has been specifically approved by the fire code official to conduct acceptance testing.
- The acceptance test shall not be deemed to have been successfully completed until accurate as-built plans have been received by the fire code official.
- Acceptance testing shall include the following:
 - A visual inspection of the physical installation of the emergency responder coverage system.
 - Backup batteries and backup power supplies will be tested under load for 1-hour.
 - A calibrated spectrum analyzer and other suitable test equipment will be utilized to evaluate the system for all included frequency ranges to ensure the following:
 - Spurious oscillations are not being generated.
 - Maximum quiescent system noise does not exceed -43 dBm.



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- To determine the isolation between the donor (outdoor) and service (indoor) antennas.
- To determine uplink and downlink amplifier gain.
- To determine the actual measured signal strength from the donor site(s), measured in an area of the building roof with a clear line of sight to the donor site(s).
- To determine downlink and uplink signal level is a minimum of -95 dBm within 95 percent of general areas and 99 percent of critical areas on each level of the building. This test is conducted on both amplified and non-amplified levels.
- Radiofrequency (RF) grid test measurements shall be gathered utilizing an omnidirectional antenna of the same model used on the portable radios currently in service with the Police and Fire Departments.
- A portable radio of the type currently in service with the Police and Fire Departments worn on the hip and using a remote speaker-microphone will be used to confirm each tested grid test area provides a minimum delivered audio quality (DAQ) of 3.4.

System Testing and Maintenance Requirements

- The emergency responder radio coverage system shall be operational at all times in accordance with the CFC.
- Annual testing and proof of compliance shall be in accordance with the CFC.
- The emergency responder radio coverage system shall have current contact information on file with the fire code official. Contact information shall be confirmed annually or with 48 hours of a change.
- Annual Inspections shall be conducted by the fire code official. No person may conduct an annual test unless that person has been specifically approved by the fire code official to conduct annual inspections.
- All building levels at least two levels away from those levels using radio coverage amplification systems shall be fully tested to establish a baseline. Subsequent annual testing of such levels shall consist of:
 - Dividing the level into four quadrants, each facing a different compass direction, and measuring the signal level as close to the center of each quadrant as possible.
 - Measuring the signal level at the point where the four quadrants meet, as close to the location of the center of the building as possible.
 - Provided that measured signal levels are equivalent to the baseline signal measurement, as determined by an FCC licensed technician, the floor shall be deemed as continuing to be compliant.
 - This method may be employed provided none of the following has occurred since the baseline test was completed:
 - There has been a coverage affecting change made to the donor radio system.



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- There has been a construction modification on the level.
 - There has been a wall or window covering changed or added on the floor.
 - There has been new construction within a 500-foot radius of the exterior wall of the building which exceeds the height of the highest level using a radio coverage amplification system.
 - The fire code official has directed otherwise.
 - If the 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.
- The fire code official may request reasonable access to investigate a case of interference with public safety communications systems.
 - Annual tests results shall be filed with the fire code official as directed.

System Monitoring Preferences

Monitoring Integrity of Power Sources.

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

Fire Alarm System

- The system shall include automatic supervisory signals for malfunctions of the two-way radio communications enhancement systems that are annunciated by the fire alarm system in accordance with NFPA 72 and shall comply with the following:
 - Monitoring for integrity of the system shall comply with NFPA 72.
 - System supervisory signals shall include the following:
 - Donor antenna malfunction
 - Active RF-emitting device failure
 - Low-battery capacity indication when 70 percent of the 12-hour operating capacity has been depleted
 - Active system component failure



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- Power supply supervisory signals shall include the following for each RF-emitting device and active system components:
 - Loss of normal ac power
 - Failure of battery charger
- The communications link between the fire alarm system and the two-way radio communications enhancement system shall be monitored for integrity.

Dedicated Annunciation

- A dedicated annunciator shall be provided within the fire command center to annunciate the status of all RF-emitting devices and active system component locations. This device shall provide visual and labeled indications of the following for each system component and RF-emitting device:
 - Normal ac power
 - Loss of normal ac power
 - Battery charger failure
 - Low-battery capacity (i.e., to 70 percent depletion)
 - Donor antenna malfunction
 - Active RF-emitting device malfunction
 - Active system component malfunction
- The communications link between this device and the two-way radio communications enhancement system shall be monitored for integrity.