



El Segundo Fire Department Fire Prevention Division

Regulation E-3-a Emergency Responder Radio Coverage

I. INTRODUCTION

- A. **Purpose:** The purpose of this regulation is to establish a consistent regulatory standard for the design, installation, operation, and maintenance of Emergency Responder Radio Coverage Systems.
- B. **Scope:** These regulations apply to every structure hereafter constructed and to those existing structures designated by the Fire Chief.
- C. **Authority:** El Segundo Municipal Code Sections 13-10-1, California Fire Code, Sections 104.1, 510 and 1103.2

II. RESPONSIBILITY

- A. Individuals and Entities who own or manage structures that require emergency responder radio coverage systems pursuant to Section 510 of the 2019 California Fire Code shall be responsible for compliance with this regulation.
- B. The Fire Prevention Division of the El Segundo Fire Department shall issue permits for the installation of emergency responder radio systems and verify compliance with this regulation.

III. APPLICABILITY

- A. Sections 510.1 and 1103.2 of the 2019 California Fire Code (CFC) shall be interpreted to mean any portion of a new building constructed or in existing buildings where radio coverage signal strength levels are not consistent with Section 510.4.1 of the 2019 CFC

IV. POLICY

- A. New and existing buildings are required to support the required level of radio coverage as defined in the 2019 California Fire Code.
- B. The building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of the building meet the signal strength requirements in the 2019 California Fire Code, Sections 510.4.1.1 and 510.4.1.2. An evaluation to determine whether a building supports the minimum level of acceptable radio coverage shall be performed only by the fire code official, or a person specifically authorized by the fire code official to conduct such evaluation.
- C. Structures with construction which does not allow for the minimum required signal strength (transmit and receive) shall be equipped with an emergency responder radio coverage system (radiating cable system, a distributed antenna system with FCC certified signal boosters or other system) approved by the fire code official in order to achieve the required radio coverage.
- D. To provide for consistent application and enforcement, the Fire Department has developed specific requirements to be used in the design, installation, testing, operation, and maintenance, of emergency responder radio coverage systems. Failure to comply with the applicable provisions of Title 24 of the California Code of Regulations, Title 47 of the Code of Federal Regulations, and this Regulation will result in enforcement actions.

V. REQUIREMENTS

A. System Design

1. 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 47CFR 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.
2. 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 2019 CFC, Section 510.5.3 (1)

through (8) with the following additional conditions:

- a. Critical Areas – Critical areas such as the fire command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler valve locations, and other areas deemed critical by the fire code official, shall be provided with 99 percent floor area radio coverage at no less than - 95 dBm and a minimum delivered audio quality (DAQ) of 3.4 as defined in NTIA Report 99-358.
- b. General Building Areas – When an emergency responder radio coverage system is required, general building areas shall be provided with 95 percent floor area radio coverage at no less than - 95 dBm and a minimum delivered audio quality (DAQ) of 3.4 as defined in NTIA Report 99-358.
- c. 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.

3. Any active amplification system installed to meet these requirements shall operate on the following frequencies which use APCO 25 Phase I and Phase II trunking.

EL SEGUNDO FIRE & POLICE DEPARTMENTS FREQUENCIES & DONOR SITES				
Trunked Simulcast System			Conventional Repeater System	
Downlink (MHz)	Uplink (MHz)		Downlink (MHz)	Uplink (MHz)
470.0125	473.0125	cc	506.6750	509.6750
470.0375	473.0375	cc		
470.3125	473.3125		Downlink (MHz)	Uplink (MHz)
470.8125	473.8125		472.5375	475.5375
471.1125	474.1125			
471.3375	474.3375		Donor Site	
482.5000	485.5000	cc	Punta Place	
482.6000	485.6000	cc	33°47'21.80" N	118°24'7.57" W
506.0125	509.0125			
506.0375	509.0375			
506.1625	509.1625			
506.5000	509.5000			
Preferred Donor Site				
El Segundo Water Tower				
400 Lomita Street, El Segundo, CA				
33°55'14.00" N	118°24'26.86" W			
Additional Simulcast Donor Sites				
Gardena City Hall				
33°52'58.43" N	118°18'27.57" W			
Punta Place				
33°47'21.80" N	118°24'7.57" W			
SBRPCA				
33°55'10.4" N	118°21'13.1" W			
Torrance City Hall				
33°50'16.7" N	118°20'28.8" W			

4. 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.
5. The building owner or manager shall modify or expand the emergency responder radio coverage system at its expense in the event frequency changes are required by the City or additional frequencies are made available by the FCC. Prior approval of a public safety radio coverage system on previous frequencies does not exempt the building owner or manager from this section.

6. 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.
7. No system or equipment in the structure may cause any interference to, or reduce the performance of, the emergency responder radio coverage system.
8. Bidirectional amplifiers shall have oscillation prevention circuitry and software. Oscillation prevention shall be activated in all bidirectional amplifiers.
9. Motorola model APX-6000, APX-7000, and APX-8000 portable radios are utilized by the Fire and Police Departments and shall be used for system design and testing. System design shall assume use of a portable radio on the user's hip.
10. If Signal Booster Components and/or Fiber Optic DAS Components are used, they shall meet the following requirements:
 - a. Signal boosters shall be located in the fire control room or other area approved by the fire code official.
 - b. Signal boosters and other radiofrequency signal generating components shall have FCC certification prior to installation and shall be NFPA 1221, 2016 edition and CFC 510.1 compliant.
 - c. All signal boosters and distributed antenna systems shall be compatible with analog FM, digital FDMA (Project 25 Phase I) and digital TDMA (Project 25 Phase II) modulation simultaneously at the time of installation.
11. Power Supplies – At least two independent and reliable power supplies shall be provided for all active components; one primary and one secondary.
12. External Filters are permitted adjacent to: the bidirectional amplifier, fiber headend, and fiber remote units.
13. 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.

14. 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 dependent 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.
15. Systems shall be designed with a sufficient density of indoor service antennas to minimize the required amplifier gain.
16. 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.
17. Amplifier uplink gain shall not exceed 65 dB unless an exception has been approved in writing by the fire code official.
18. Bidirectional amplifiers shall be clearly labeled on the front of the enclosure with the maximum permissible uplink and downlink gain.
19. Any person or entity constructing a new structure which blocks the donor path of existing emergency responder radio coverage systems shall be responsible for resolving coverage and system performance degradation experienced by existing emergency responder radio coverage systems at its expense.
20. Pathway Survivability:
 - a. Pathway survivability levels shall be as described in NFPA 1221, 2016 edition, Section 5.10.
 - b. 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.
 - c. 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.

- d. All backbone, antenna distribution, radiating, and fiber optic cables shall be rated as plenum cables.
- e. Exposed coaxial and fiber optic cables shall be enclosed within electrical metallic tubing (EMT) conduit and metal junction boxes.
- f. An alternative minimum 2-hour pathway survivability performance methodology may be approved by the fire code official.

21. Protection Against Water Intrusion:

- a. All amplifiers, active devices, fiber optic head end, and fiber optic remote units, shall be enclosed within NEMA-4, or NEMA-4X, rated enclosures.
- b. All standby battery units, battery chargers, power supplies, and external filters, shall be enclosed within NEMA-3R, NEMA-4, or NEMA-4X, rated enclosures.
- c. All alarm and power connections, power dividers, and hybrid couplers, located at the head end shall be enclosed within watertight enclosures.
- d. 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).

22. Power Sources:

- a. The primary power source shall be supplied from a dedicated branch circuit and comply with NFPA 72, 2016 edition, section 10.6.5.1.
- b. The secondary power source shall comply with one of the following:
 - i. A storage battery dedicated to the system with at least 24 hours at 100 percent system operation capacity and designed in compliance with NFPA 72, 2016 edition, section 10.6.10 et seq.
 - ii. 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 NFPA 72, 2016 edition, section 10.6.10 et seq.

- c. 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.
- d. Battery backup power system components shall be mounted at least 12 inches above the floor.

23. Donor Antennas:

- a. Donor antennas shall be highly-directional.
- b. Antenna elements shall be welded and antennas shall be anodized.
- c. The antenna gain shall not be less than 10 dBd.
- d. The antenna azimuth (horizontal) half-power (-3 dB) beam width shall not exceed 45 degrees.
- e. The antenna front to back ratio shall not be less than 20 dB.
- f. 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.
 - i. 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.
- g. Antennas shall not be attached to, or supported by, vent pipes.
- h. Mast supports and guy wire anchors shall be secured in such a way that the supporting structure is not damaged or weakened.
- i. 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.

24. Grounding, Bonding, and Lightning Protection:

- a. All active devices shall be grounded pursuant to NFPA 780 (2017) unless otherwise directed herein.
- b. All active devices shall be grounded to the master building ground bus.
- c. All ground connections shall be made with stranded copper wire no smaller than 2 AWG.
- d. No copper wire shall come into direct contact with aluminum.
- e. All ground bus bars shall be copper.
- f. No copper bus bar shall come into direct contact with aluminum.
- g. Donor antenna feed line shall include protection against electrical surge caused by lightning or electrostatic discharge.
- h. Surge protection shall be located within the building and as close to the antenna feed line building entry point as possible.
 - i. Surge protection shall be grounded to the master building ground bus.
 - ii. An additional ground attachment shall be made to grounded structural steel at the building entry point whenever possible.
- i. Donor antenna mounting structures shall be grounded to the master building ground bus.

25. System Monitoring - The emergency responder radio coverage system shall include automatic supervisory and trouble for malfunctions of the signal booster, and power supplies that are annunciated by the fire alarm system and UL listed supervising station monitoring company or monitored at a constantly attended location at the building and comply with the following:

- a. The integrity of circuit monitoring signal boosters and power supplies shall comply with NFPA 1221, 2016 edition, sections 9.6.12.3, 9.6.13 et seq., 10.6.9 and 12.6.

- b. System and signal booster supervisory signals shall include the following:
 - i. Donor antenna malfunction.
 - ii. Signal booster failure.
 - iii. Active RF emitting device malfunction.
 - iv. Low battery indication when 70 percent of the 24 hour operation capacity has been depleted.
 - v. Low fuel level indication when 70 percent of the backup generator fuel capacity has been depleted (when applicable).
 - vi. Failure of the communications link between the fire alarm system and the emergency responder radio coverage system.
- c. Power supply signals shall include the following for each signal booster.
 - i. Loss of commercial AC power.
 - ii. Failure of battery charger.
- d. Dedicated Panel – A dedicated monitoring panel shall be provided in an area acceptable to the fire code official to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
 - i. Donor Antenna Trouble
 - ii. Signal Booster Failure
 - iii. Active RF Device Malfunction
 - iv. Low Battery
 - v. Low Generator Fuel (when applicable)
 - vi. AC Power Loss

vii. Battery Charger Failure

viii. Failure of the communications link between the fire alarm system and the emergency responder radio coverage system.

26. System Submittal

- a. A permit must be obtained prior to the construction or modification of an indoor emergency responder radio coverage system. 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.
- b. 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.
- c. No permit shall be issued without approved plans. A minimum of 3 complete sets of plans, associated documentation shall be submitted to El Segundo Building Safety for plan check processing. One electronic copy of plans and documentation must be submitted to the El Segundo Fire Department for transmittal to South Bay Regional Public Communications Authority (SBRPCA) for plan check and approval. SBRPCA will charge plan check and permit fees to the applicant separately. Such plans shall contain at a minimum the following elements:
 - i. 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.
 - ii. The minimum qualifications of the system designer and lead installation personnel shall be in compliance with Section 510.5.2 of the 2019 California Fire Code and include:
 - a. A valid FCC-issued general radio operators' license; and
 - b. 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.

- c. These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the fire code official is provided.
- d. Plans shall be 11" x 17" or greater, scaled or dimensioned, with dimensions or scale clearly noted. North shall be indicated on plan views and elevations named in elevation views. Include site name, address, and elevation name or floor number on each plan sheet.
- e. Provide both paper and electronic PDF versions of the plans.
- f. Plan view of the subject building, building construction type and surrounding property. Plan view shall clearly indicate the location and orientation of any outdoor antennas associated with the proposed system.
- g. Specify the antenna grounding, surge and lightning protection in accordance to the California Electrical Code and this Regulation. Include the location and method of all grounding connections.
- h. 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.
- i. 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.
- j. Include a link budget analysis chart showing system operating parameters in dBm for each channel (FCC Class A) or frequency band (FCC Class B).
- k. 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.
- l. Include peak and average Downlink signal strength measurements taken from at

least four areas on the roof of the structure.

- m. If the building envelope has been closed, include a preliminary signal strength assessment. Conduct this assessment using a Spectrum Analyzer to measure the Downlink signal strength throughout every floor or level of the structure. Divide each floor or level into 20 grid test areas of approximately the same size. Measure and record the average Downlink signal strength within each grid test area and calculate the Uplink signal strength for the corresponding grid test area.
- n. 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.
- o. Include the detailed manufacturers' specifications for each component and the calculations used to derive the 24-hour minimum runtime.
- p. 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.
- q. Provide copies of the manufacturer's specification sheets, including:
 - i. Amplifiers, Antennas, Coax, Couplers, Splitters, Combiners, or any other passive components proposed.
 - ii. Backup battery and charging system, and generator (if applicable) specifications.
- r. Provide the following notes on the plans:
 - i. 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.
 - ii. 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.

27. Acceptance Test

- a. Acceptance and Operational testing shall be in accordance with Section 510.5.3 of the 2019 California Fire Code with the following clarifications:
 - i. 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 tests.
 - ii. 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.
- b. Acceptance test will include the following:
 - i. A visual inspection of the physical installation of the emergency responder coverage system.
 - ii. Backup batteries and backup power supplies will be tested under load for 1-hour.
 - iii. A calibrated spectrum analyzer and other suitable test equipment will be utilized to evaluate the system for all included frequency ranges.
 - a. To ensure spurious oscillations are not being generated.
 - b. To ensure maximum quiescent system noise does not exceed -43 dBm.
 - c. To determine the isolation between the donor (outdoor) and service (indoor) antennas.
 - d. To determine uplink and downlink amplifier gain.
 - e. 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).

- f. 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.
 - g. 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.
- iv. 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 as defined in NTIA Report 99-358.

28. Testing and Maintenance

- a. The emergency responder radio coverage system shall be maintained operational at all times in accordance with Section 510.6.1 through 510.6.3 of the 2019 California Fire Code.
- b. Annual testing and proof of compliance shall be in accordance with Section 510.6.1 of the 2019 California Fire Code. No person may conduct an annual test unless that person has been specifically approved by the fire code official to conduct annual testing.
- c. Annual Inspections shall be conducted by Fire Department staff.
- d. 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:
 - i. 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.
 - ii. 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.

- iii. 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.
 - iv. This method may be employed provided none of the following has occurred since the baseline test was completed.
 - a. There has been a coverage affecting change made to the donor radio system.
 - b. There has been a construction modification on the level.
 - c. There has been a wall or window covering changed or added on the floor.
 - d. 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.
 - e. The fire code official has directed otherwise.
 - f. 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.
 - e. The fire code official or SBRPCA may, at any time during routine business hours, conduct independent testing of the in- building system to verify proper operation and shall be provided unimpeded access at any time 24 hours a day, 365 days a year, to investigate a case of interference with public safety communications systems.
 - f. Annual testing will be done at no expense to the City.
 - g. Annual tests results shall be filed with the fire code official as directed.
29. In the event of a service affecting failure of any portion of the emergency responder radio coverage system, an initial evaluation shall be made by a qualified technician within 24 hours and repairs shall be complete within 5 working days. The building owner or designee shall notify the on-duty Fire Battalion Chief with 8 hours of any

service affecting outage.

Issue Date: May 5, 2020

Approved by : James Carver, Fire Marshal