



El Segundo Fire Department Fire Prevention Division

Regulation E-3-a

Emergency Responder Radio Coverage

INTRODUCTION

Purpose: The purpose of this regulation is to establish a consistent standard for the design, installation, operation, and maintenance of Emergency Responder Radio Communications Systems (ERRCS).

Scope: This regulation applies to every structure hereafter constructed and to those existing structures designated by the Fire Chief.

Authority: El Segundo Municipal Code Sections 13-10-1, Title 47 Code of Federal Regulations Section 90.219 (FCC Rules & Regulations), 2022 California Fire Code Sections 104.1, 510 and 1103.2 (California State Fire Code), 2022 California Code of Regulations Title 16 (Professional and Vocational Regulations).

Referenced Standards:

1. **APCO Project 25** - A suite of standards for interoperable digital two-way radio products. It can also be referred to as "P25".
2. **NFPA 70** (2020 edition) – National Electrical Code
3. **NFPA 72** (2022 edition) – National Fire Alarm and Signaling Code
4. **NFPA 780** (2020 edition) - Standard for the Installation of Lightning Protection Systems
5. **NFPA 1221** (2019 edition) – Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
6. **NTIA Report 99-358** – Delivered Audio Quality Measurements on Project 25 Land Mobile Radios, U.S. Department of Commerce, 1998-11
7. **UL 2524** - ANSI/CAN/UL Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems

Terminology/Definitions:

8. **AGC/ALC** – Automatic Gain Control / Automatic Level Control.
9. **APCO** - Association of Public-Safety Communications Officials.

10. **BDA** – Bidirectional Amplifier.
11. **BBU** – Backup Battery Unit.
12. **CBC** – California Building Code.
13. **CCR** – California Code of Regulations.
14. **CFC** – California Fire Code.
15. **CFR** – Code of Federal Regulations.
16. **DAQ** – Delivered Audio Quality.
17. **DAS** – Distributed antenna system. 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 (47CFR§90.219).
18. **dBm** – Decibels referenced to 1 milliwatt.
19. **Donor Antenna** – An antenna located at the site of the ERRCS that is used to communicate with the larger wide-area communications system (i.e., with the “macro system”). The donor antenna is part of the ERRCS/microsystem, whereas its macro system counterpart (with which it communicates) is the donor site.
20. **Donor Site** – The specific wide-area communications (i.e., “macro system”) site designated by the macrosystem operator as the communications site through which the individual ERRCS donor antenna shall link into the macrosystem. The donor site is part of the macrosystem, whereas its ERRCS counterpart is the donor antenna.
21. **Downlink** – The signal from the base station/tower site to the portable radio.
22. **ERP** – Effective Radiated Power (ERP), the power emitted from the donor antenna, which includes all gains and losses in the RF transmission system.
23. **ERRC** – Emergency Responder Radio Coverage. This can also sometimes be referred to as Emergency Responder Communication Coverage (ERCC).
24. **ERRCS** – Emergency Responder Radio Communications System. An infrastructure solution installed within a building to enhance the communications capabilities for first responders that utilizes solutions such as a signal booster, voting receiver, base station, or other technology capable of enhancing the radio frequency (RF) to ensure effective public safety communications. This can also sometimes be referred to as a “microsystem”, or an Emergency Responder Communication Enhancement System (ERCES). System types include, but are not limited to, a radiating cable system and a distributed antenna system (DAS) with FCC-certified signal boosters.
25. **et seq.** – and what follows (used in page-/section-number references).
26. **FCC** – Federal Communications Commission.
27. **Macro System** – The wide-area communications system within which, and from which, a microsystem, such as an ERRCS, must gain permission to operate. For the purposes of this document, the macrosystem is the wide-area

communications system used by the fire, police, and/or other public-safety agencies having jurisdiction.

28. **NEMA** – National Electric Manufacturers Association.

29. **NFPA** – National Fire Protection Association.

30. **NTIA** – National Telecommunications and Information Administration.

31. **OSHA** – Occupational Safety and Health Administration of the United States Department of Labor.

32. **RF** – Radio Frequency.

33. **Service Antenna** – See DAS.

34. **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 or Class B signal boosters as components, although only Class A signal boosters are allowed under this regulation.

35. **SINR** – Signal-to-Interference-plus-Noise Ratio.

36. **§** – Section, as in a section number of a code, law, or standard.

37. **Uplink** – The signal from the portable radio to the base station/tower site.

38. **UPS** – Uninterruptable Power Supply.

RESPONSIBILITY

Individuals and entities who own or manage structures that require ERRCS pursuant to Section 510 of the 2022 California Fire Code shall be responsible for compliance with this regulation.

The El Segundo Fire Department shall issue permits for the installation of ERRCS and verify compliance with this regulation. The FCC License Holder or its designee will issue a Permit to Operate a Signal Booster pursuant to FCC Rules & Regulations, and the Permit shall be renewed annually or the ERRCS shut down.

APPLICABILITY

The following buildings and/or portions of buildings (either newly proposed and/or constructed, or otherwise triggering the application of the current code, such as by a change of occupancy classification or use, addition of low emissivity materials, major tenant improvement, or removal of an existing wired communication system) shall be evaluated for the need of an ERRCS. The evaluation shall include empirical determination of the extent to which the existing coverage levels of the public safety communication systems (i.e., the “macro systems”) utilized by the jurisdictional police, fire, and emergency medical, authorities,

measured at the exterior of the building, are reduced within the building itself. Building criteria triggering evaluation are any of the following:

1. Stories (any of the following):
 - a. 2 or more stories above grade plane.
 - b. Any basement or level that extends below grade plane.
2. Total Building Area: 10,000 square feet or more.
3. Fire Code Official Determination: Buildings determined by the Fire Code Official as requiring evaluation based upon fire- and life-loss potential.
Exception: Wood frame one- or two-family dwellings shall not require evaluation.

POLICY

A building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of general areas, and 99% of critical areas as defined in 3(A) below, on each floor of the building meet the intelligibility requirements in the 2022 California Fire Code, Sections 510.4.1.1 and 510.4.1.2, uplink and downlink received signal strength is no less than -95 dBm, and in the presence of a Project 25 digital signal, received signal to noise plus interference (SINR) is no less than 17, and bit error rate (BER) is no greater than 2%. An evaluation to determine whether a building supports the minimum level of acceptable radio coverage shall be performed only by a person specifically authorized by the Fire Code Official to conduct such evaluation.

Structures with construction which does not allow for the minimum required signal strength (transmit and receive) shall be equipped with an ERRCS (a radiating cable system, a distributed antenna system, with FCC certified signal boosters, or other RF emitting devices) approved by the Fire Code Official and the FCC License Holder in order to achieve the required radio coverage.

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 ERRCS. 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.

REQUIREMENTS

System Design - When an ERRCS is required, the following design criteria shall apply:

1. **Federal Compliance** - ERRCS 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. **UL 2524 Listing** – All bidirectional amplifiers, fiber optic DAS, and backup power systems, shall be certified to UL 2524 by a Nationally Recognized Testing Laboratory (NRTL) recognized by OSHA pursuant to Title 29 CFR §1901.7 et seq. to conduct UL 2524 testing.
3. **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 2022 CFC, Section 510.5.3 (1) through (8) with the following additional conditions:

A. **Critical Areas** – Critical areas, defined as:

- i. Fire alarm control panels.
- ii. Fire fighter's smoke control panels.
- iii. The main electrical panel(s).
- iv. Throughout emergency and standby power rooms.
- v. Throughout a fire command center complying with Section 508.
- vi. Throughout interior exit stairs.
- vii. Throughout areas of refuge.
- viii. Throughout fire pump rooms.
- ix. Throughout elevator machine rooms and elevator lobbies.
- x. Throughout building lobbies.
- xi. Within elevator cars.
- xii. Locations as determined by the Fire Code Official.

Shall be provided with 99 percent floor area radio coverage with received uplink and downlink power levels of no less than -95 dBm and minimum delivered audio quality (DAQ) of 3.4 as defined in NTIA Report 99-358.

B. **General Building Areas** – When an ERRCS is required, general building areas shall be provided with 95 percent floor area radio coverage with received uplink and downlink power levels of no less than -95 dBm and minimum delivered audio quality (DAQ) of 3.4 as defined in NTIA Report 99-358.

C. **DAQ** - 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.

4. **Operating Frequencies** - Any ERRCS installed to meet these requirements shall operate on the following frequencies which use APCO 25 Phase I and Phase II trunking.

Frequencies will be assigned by the FCC License Holder or its designee on a case-by-case basis. Frequency determination requires individual consideration by the FCC License Holder due to various factors, some of which may change over time, even for a single geographical location. A Technical Information Document providing the Operating Frequencies will be provided pursuant to §510.4.2.2 CFC.

5. **Donor Site** – A Donor Site will be assigned for each project by the FCC License Holder or its designee on a case-by-case basis. Donor Site determination requires individual consideration by the FCC License Holder due to various factors, some of which may change over time, even for a single geographical location. A Technical Information Document providing the Donor Site will be provided pursuant to §510.4.2.2 CFC.

6. **ERRCS Propagation Delay** - The maximum allowable ERRCS 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 macro radio system.

7. **Frequency Changes** - The building owner shall modify or expand the ERRCS at its expense in the event frequency changes are required 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 from this section.

8. Interference Prohibited

- A. The ERRCS shall not interfere with, or reduce the performance of, any public safety radio communications system or other FCC licensed radio communications system.
- B. No system or equipment in the structure may cause any interference to, or

reduce the performance of, the ERRCS.

- C. When measured outside the structure(s) served by the ERRCS at the exterior perimeter of the structure(s), downlink radio signal power from the ERRCS shall be at least 20 dB less than the measured radio signal power from the donor (macro) radio system, unless an exception is made by the Fire Code Official due to low macro downlink power levels.
 - D. Bidirectional amplifiers shall have oscillation prevention circuitry and software. Oscillation prevention shall be activated in all bidirectional amplifiers.
9. **Portable Radio Testing Requirement** - Motorola model APX-6000 and APX-8000 portable radios are utilized by the Fire and Police Departments and shall be used for ERRCS design and testing. ERRCS design shall assume use of a portable radio worn on the user's hip.
10. **Signal Booster Components and/or Fiber Optic DAS Components** - Shall meet the following requirements:
- A. Signal Boosters shall be channelized to operate only on the specific frequencies assigned and no other frequencies.
 - B. Signal Boosters shall have a discrete automatic gain control or automatic level control for each individual channel.
 - C. Signal Boosters shall have a discrete gain setting for each individual channel.
 - D. Signal Boosters shall have muting or squelch features, which 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.
 - E. Signal Boosters shall be equipped with sufficient RF filtering to employ a single donor antenna port and a single service antenna port.
 - F. Signal Boosters shall be located in the fire control room or other area approved by the Fire Code Official.
 - G. Signal Boosters and other radiofrequency signal generating components shall have FCC certification prior to installation and shall be NFPA 1221, 2019 edition and CFC 510.1 compliant.
 - H. 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. **External Filters** – Filters in protective enclosures are permitted adjacent to the bidirectional amplifier, fiber headend, and fiber remote units.
12. **Antenna Density**
- A. ERRCS shall be designed with a sufficient density of indoor service antennas to

minimize the required amplifier gain and the near-far effect. Indoor (service) antennas should be spaced no more than 50 feet apart within occupied areas, and no more than 80 feet apart in open areas such as parking garages, auditoriums, conference centers, and ballrooms.

- i. When antennas are installed in a wood frame structure with the intent that antennas on one floor will provide service to another floor, antenna spacing shall be reduced to compensate for attenuation caused by building materials.

- B. ERRCS 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.

13. Uplink Noise - Bidirectional amplifiers shall not exceed -150 dBm uplink noise at the donor site, -43 dBm ERP uplink noise within the authorized passband, and -70 dBm ERP uplink noise 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.

14. Isolation - 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 ERRCS gain.

15. Amplifier Gain - Bidirectional amplifiers shall use the minimum gain required to meet the performance requirements herein. Amplifier uplink gain shall not exceed 65 dB unless an exception has been approved in writing by the Fire Code Official and the FCC License Holder, or designee(s).

16. Labeling Requirements

A. Bidirectional Amplifiers

- i. Shall be clearly labeled on the front of the enclosure with 24/7 contact information for the following.
 - a. ERRCS Maintenance Contractor.
 - b. Building Owner.
 - c. Building Manager.
 - d. Building Engineer.
- ii. Shall be clearly labeled on the front of the enclosure with the maximum permissible uplink and downlink gain based on measured isolation.
- iii. Shall be clearly labeled on the front of the enclosure with the annual

Permit to Operate issued by the FCC License Holder or designee.

- iv. Shall be clearly labeled on the front of the enclosure with the model and serial numbers of the equipment.
- v. Shall be clearly labeled on the front of the enclosure with the location of the circuit breaker panel, panel number, and circuit number.

B. Backup Battery Units

- i. Shall be clearly labeled on the front of the enclosure with the location of the circuit breaker panel, panel number, and circuit number.

17. Donor Path Rights - Any person or entity constructing a new structure which blocks the donor path of existing ERRCS shall be responsible for resolving coverage and system performance degradation experienced by existing ERRCS at its expense.

18. Pathway Survivability

- A. Pathway survivability levels shall be as described in NFPA 1221, 2019 edition, section 5.5 except as stated herein.
- 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. ERRCS 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.
 - i. An alternative minimum 2-hour pathway survivability performance methodology may be approved by the Fire Code Official.
- D. All backbone, antenna distribution, radiating, and fiber optic cables shall be rated as plenum cables.
- E. Coaxial and fiber optic cables shall be enclosed within electrical metallic tubing (EMT) conduit and metal junction boxes.
- F. Coaxial cables shall be supported to the point of termination.
- G. Fiber optic cables shall be supported and protected to the point of termination.

19. Protection Against Water Intrusion

- A. All amplifiers, active devices, fiber optic headend, 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 headend shall be enclosed within NEMA-4, or NEMA-4X, 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) or equivalent.
- E. All penetrations into enclosures shall be fully sealed to prevent water intrusion.
 - F. All components shall be mounted at least 12 inches above the floor to protect against water intrusion due to flooding.

20. Power Sources

- A. At least two independent and reliable power supplies shall be provided for all active components, one providing primary operating power, and one providing backup power.
- B. The primary power source shall be supplied from a dedicated branch circuit and comply with NFPA 70, 2020 edition and NFPA 72, 2022 edition, section 10.6.5.1
- C. The secondary power source shall comply with one of the following:
- D. A storage battery dedicated to the ERRCS with at least 24 hours at 100 percent ERRCS operation capacity and designed in compliance with NFPA 70, 2020 edition and NFPA 72, 2022 edition, section 10.6.10 et seq.
- E. A generator with internal combustion engine and a fuel supply providing 24 hours of continuous operation at 100 percent ERRCS operation capacity serving the dedicated branch circuit shall be used with a storage battery dedicated to the ERRCS with at least 12 hours at 100 percent ERRCS operation capacity and designed in compliance with NFPA 70, 2020 edition and NFPA 72, 2022 edition, section 10.6.10 et seq.
- F. Power Switches - Bidirectional amplifiers (BDA's) shall be equipped with two power switches adjacent to the BDA.
 - i. One switch shall both disconnect and reapply AC power to the battery power supply.
 - ii. The second switch shall both disconnect and reapply power to the BDA.
 - iii. Both switches shall have protection against water intrusion.
 - iv. Both switches shall have a lockout/tagout feature.
 - v. Exception: If the circuit breaker is located in the same room as the battery power supply, the AC disconnect switch shall not be required.

21. Donor Antennas

- A. Donor antennas shall be highly-directional.
- B. Antenna elements shall be welded.
- C. Antennas shall be anodized unless an exception has been granted.
- D. The antenna gain shall not be less than 10 dBd.
- E. The antenna horizontal half-power (-3 dB) beam width shall not exceed 45 degrees.
- F. The antenna front to back ratio shall not be less than 20 dB.

- G. Antenna must be permanently mounted to the structure. Non-penetrating antenna mount only to be used with approval of Fire Code Official or designee.
- H. 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 of the antenna to the riser cable conduit is permissible if the conduit is sufficiently strong and is appropriately supported and secured to structural elements of the building on the roof.
- I. Antennas shall not be attached to, or supported by, vent pipes.
- J. Mast supports shall be secured in such a way that the supporting structure is not damaged or weakened.
- K. Masts which extend ten feet or more above the top of their mounting point are engineered structures which are to be constructed under a separate building permit.

22. Grounding, Bonding, and Lightning Protection

- A. All active devices shall be grounded pursuant to NFPA 780 (2020) 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, tinned aluminum, or plated aluminum.
- E. Ground lugs used with 2 AWG or larger copper wire shall be copper, tinned copper, or plated copper, with a crimped or welded connection to the wire, manufactured with holes permitting two bolts to be used for attachment to the ground bus bar.
- F. All ground bus bars shall be copper.
- G. No copper bus bar shall come into direct contact with aluminum.
- H. Donor antenna feedline shall include protection against electrical surge caused by lightning or electrostatic discharge.
- I. Surge protection shall be located within the building and as close to the antenna feedline 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.
 - iii. Exterior mounting of the surge protector is permitted within 24 inches of the building entry port provided the surge protector and copper ground bus bar are fully enclosed within a grounded metal NEMA-4, 4X, or 3R

enclosure.

- a. The grounded metal enclosure shall be sufficiently large to readily allow for maintenance, and no smaller than 18 inches tall by 18 inches wide by 6 inches deep.
 - b. Conduit from the building to the enclosure shall be continuous.
 - iv. All exterior antenna feedline shall be enclosed in solid conduit. There shall be no exposed outdoor feedline except at the connection to the antenna.
- J. Donor antenna mounting structures shall be grounded to the master building ground.

23. System Monitoring - The ERRCS shall include automatic supervisory and trouble for malfunctions of the signal booster, and power supplies that are annunciated by the fire alarm system which is monitored by an approved supervising station monitoring company in accordance with NFPA 72 or monitored at a constantly attended location at the building and comply with the following:

- A. Circuit Integrity - The integrity of circuit monitoring signal boosters and power supplies shall comply with NFPA 1221, 2019 edition, sections 5.5, 9.6.12.3, 9.6.13 et seq., 10.6.9 and 12.6.
- B. Signal Booster - Supervisory signals shall include the following:
 - i. Donor antenna malfunction.
 - ii. Signal booster failure.
 - iii. Active RF emitting device malfunction (Fiber Remote Units).
 - 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 ERRCS.
 - vii. Oscillation of active RF emitting device(s).
- 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 be clearly marked with: “In-Building Radio System Status.” and “When In Alarm Use Direct Radio Channels.” and 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. Oscillation of active RF emitting device(s)
- ix. Failure of the communications link between the fire alarm system and the ERRCS.

E. Remote Control and Monitoring

- i. All new and existing ERRCS shall be equipped to permit the FCC License Holder or its designee to remotely monitor and control the bidirectional amplifier (BDA) or other RF emitting device(s) pursuant to Title 47 CFR §90.219.
 - a. A 100 Mbps or faster Ethernet connection with active connection to the Internet and a DHCP assigned IP address shall be provided within 18 inches of the BDA.
 - b. A monitoring and remote-control component specified by the FCC License Holder shall be installed in a NEMA-4 or 4X, enclosure and shall provide monitoring of alarms from, and secure remote connectivity to, the BDA(s), fiber master or headend, and associated power supply(s).
 - c. The monitoring and control component shall be powered by the BDA primary and secondary (backup) power supplies.
- ii. It is the responsibility of the building owner to provide remote monitoring and control capability for the FCC License Holder or its designee.

24. System Submittal

- A. A permit must be obtained prior to the construction or modification of an ERRCS. 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 or Fire Code Official's designee. Plan check and acceptance testing fees will be assessed for these services.
- C. No permit shall be issued without approved plans. Such plans shall contain at a minimum the following elements:
 - i. Pursuant to CCR Title 16, Sections 832.07 and 832.10, the minimum qualification of the ERRCS installing entity shall be a valid classification C7 or C10 California Contractors License.
 - ii. The minimum qualifications of the ERRCS designer and lead installation personnel shall be in compliance with Section 510.5.2 of the 2022 California Fire Code and include:

- a. A valid FCC-issued General Radio Operators License (GROL); and
 - b. A NICET IB-PSC Certification: and
 - a. The Designer must hold a current Design certification.
 - b. The Commissioning Engineer must hold a current Level 3 certification.
 - c. The Lead Installer must hold a current Level 2 or higher certification.
 - c. A certificate issued by the manufacturer of the equipment being installed.
 - d. 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 electronic high-resolution PDF, E size, 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. 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 ERRCS.
- F. Specify the antenna grounding, surge, and lightning, protection in accordance with the California Electrical Code and this regulation. Include drawings of the location and method of all grounding connections.
- G. Plan view of each interior floor where indoor antenna systems are proposed shall include antenna numbers, coax routes, and the locations of any other ERRCS 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.
- H. Include a schematic diagram of the proposed distributed antenna system (DAS) showing every component with the gain or loss of the component, the total ERRCS 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.
- I. Include a link budget analysis for every service antenna showing uplink and downlink ERRCS operating parameters in dBm for radios operating near each antenna, and as far from each antenna as possible while in the operating area of the antenna, for each included frequency range.
- J. Include a color-coded propagation model displaying signal strength on each floor or level throughout the structure.
- 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.
 - i. Conduct this assessment using a calibrated Spectrum Analyzer or other approved test instrument to measure the Downlink signal strength throughout every floor or level of the structure.
 - ii. Divide each floor or level into 20 grid test areas of approximately the same size.
 - iii. 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.
 - a. Include the formula used to calculate uplink power.
 - iv. Subjective Downlink and Uplink DAQ shall be determined using two radios of the same make and model of those in service with the Police and Fire Departments.
 - v. On Project 25 digital channels, Downlink DAQ shall be measured using an instrument which decodes the Project 25 bitstream and provides a SINR or SNR measurement.
 - a. Passing SINR or SNR is 20 dB or greater, and passing Bit Error Rate, BER, or FBER is no greater than 2%.
 - 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 ERRCS shall be capable of operating on an independent battery power supply, and generator where applicable, for a period of at least 24 hours without external power input. The battery power supply 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:

- S. The ERRCS shall not be powered on unless it is employed on a non-radiating load and not on a live antenna system, prior to the final inspection by the Fire Code Official or the Fire Code Official's designee.
- T. The ERRCS shall be approved by the Fire Code Official or Fire Code Official's designee and documentation identifying the approval shall be on site during installation and operation of the ERRCS.

25. Testing

- A. Acceptance testing shall be in accordance with Section 510.5.3 of the 2022 California Fire Code with the following clarifications.
- B. The final ERRCS Acceptance test shall be conducted by a person holding a General Radiotelephone Operators License issued by the FCC, a NICET IB-PSC Level 3 certification, and a certification by the manufacturer of the equipment being inspected.
 - i. No person may conduct an Acceptance test unless that person has been specifically approved by the Fire Code Official and the FCC Licensee to conduct Acceptance Tests.
 - ii. A person holding a NICET IB-PSC Level 1 or 2 certification may conduct an Acceptance test provided that person is directly supervised by a person holding a NICET IB-PSC Level 3 certification, and the inspection report is certified by the person holding the Level 3 certification.
- C. An Acceptance test shall not be deemed to have been successfully completed until accurate as-built plans have been received by the Fire Code Official or Fire Code Official's designee.
- D. Acceptance tests shall include the following:
 - i. A visual inspection of the physical installation of the ERRCS with detailed photographic documentation.
 - ii. Backup batteries and backup power supplies will be tested under load for 1-hour.
 - iii. Backup batteries and backup power supplies will be tested using a pulse load battery tester when the batteries are compatible with pulse load testing.
 - iv. A calibrated spectrum analyzer and other suitable test equipment will be utilized to evaluate the ERRCS for all included frequency ranges.
 - a. To ensure spurious uplink signals are not being generated.
 - a. The donor antenna shall be connected during this test.
 - b. To determine downlink power reaching the amplifier at the donor antenna port for each included frequency range.
 - c. To determine ambient radiofrequency (RF) noise from the donor and service antennas at the amplifier with the amplifier shut down.

- d. To ensure maximum quiescent ERRCS noise does not exceed -43 dBm ERP at the donor antenna and -153 dBm at the donor site.
 - a. The donor antenna shall be connected during this test.
- e. To determine the isolation between the donor (outdoor) and service (indoor) antennas and ensure isolation is at least 20 dB greater than the maximum amplifier gain.
- f. To determine uplink and downlink amplifier gain and maximum output power for each individual channel.
 - a. The donor antenna or service antennas shall be connected during this test.
- g. To determine donor antenna return loss.
- h. 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).
- i. To determine the power level of perimeter ERRCS signal leakage.
- j. 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.
- k. 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.
- v. A portable radio of the type currently in service with the Police and Fire Departments, as specified herein, 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.
- vi. On Project 25 digital channels, downlink DAQ shall be measured using an instrument which decodes the Project 25 bitstream and provides a SINR or SNR measurement. A passing SNR or SINR is 20 dB or greater, and a passing Bit Error Rate, BER, or FBER is no greater than 2%.

26. Testing and Maintenance

- A. The ERRCS shall be maintained operational at all times in accordance with Section 510.6.1 through 510.6.3 of the 2022 California Fire Code.
- B. Annual Testing and proof of compliance shall be in accordance with Section 510.6.1 of the 2022 California Fire Code with the following clarifications.
- C. Annual Tests shall be conducted by a person holding a General Radiotelephone Operators License issued by the FCC, a NICET IB-PSC Level 3 certification, and

a certification by the manufacturer of the equipment being inspected.

- i. No person may conduct an Annual Test unless that person has been specifically approved by the Fire Code Official and the FCC Licensee to conduct Annual Tests.
- ii. A person holding a NICET IB-PSC Level 1 or 2 certification may conduct an Annual Test provided that person is directly supervised by a person holding a NICET IB-PSC Level 3 certification, and the inspection report is certified by the person holding the Level 3 certification.

D. Annual Tests shall include the following:

- i. A visual inspection of the physical installation of the ERRCS with detailed photographic documentation.
- ii. Backup batteries and backup power supplies will be tested under load for 1-hour.
- iii. Backup batteries and backup power supplies will be tested using a pulse load battery tester when the batteries are compatible with pulse load testing.
- iv. A calibrated spectrum analyzer and other suitable test equipment will be utilized to evaluate the ERRCS for all included frequency ranges.
 - a. To ensure spurious uplink signals are not being generated.
 - a. The donor antenna shall be connected during this test.
 - b. To determine downlink power reaching the amplifier at the donor antenna port for each included frequency range.
 - c. To determine ambient radiofrequency (RF) noise from the donor and service antennas at the amplifier with the amplifier shut down.
 - d. To ensure maximum quiescent ERRCS noise does not exceed -43 dBm ERP at the donor antenna and -153 dBm at the donor site.
 - a. The donor antenna shall be connected during this test.
 - e. To determine the isolation between the donor (outdoor) and service (indoor) antennas and ensure isolation is at least 20 dB greater than the maximum amplifier gain.
 - f. To determine uplink and downlink amplifier gain and maximum output power for each individual channel.
 - a. The donor antenna or service antennas shall be connected during this test.
 - g. To determine donor antenna return loss.
 - h. To determine the actual measured signal strength from the donor site(s).
 - a. Measured in an area of the building roof with a clear line of sight to the donor site(s).
 - b. Measured at the donor antenna port of the BDA.

- i. To determine the power level of perimeter ERRCS signal leakage.
 - j. 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 pursuant to Section E below.
 - k. 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.
 - v. A portable radio of the type currently in service with the Police and Fire Departments, as specified herein, 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.
 - vi. On Project 25 digital channels, downlink DAQ shall be measured using an instrument which decodes the Project 25 bitstream and provides a SINR or SNR measurement. A passing SNR or SINR is 20 dB or greater, and a passing Bit Error Rate, BER, or FBER is no greater than 2%.
- E. All building levels at least two levels away from those levels using ERRCS 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 the ERRCS.
 - e. The Fire Code Official has directed otherwise.

- f. If the communications appear to have degraded or if the tests fail to demonstrate adequate ERRCS performance, the owner of the building or structure is required to remedy the problem and restore the ERRCS in a manner consistent with the original approval criteria.
- F. The Fire Code Official and/or the Fire Code Official's designee may, at any time during routine business hours, conduct independent testing of the ERRCS 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 radio communications systems.
- G. Annual testing will be done at no expense to the City.
- H. Annual tests results shall be filed with the Fire Code Official as directed.

27. Service Affecting Failure - In the event of a service affecting failure of any portion of the ERRCS, an initial evaluation shall be made by a qualified technician within 24 hours and repairs shall be completed within 5 working days. The building owner or designee shall notify the on-duty Fire Battalion Chief within 8 hours of any service affecting outage.

Issue Date: November 1, 2022

Approved by : Nicole Pesqueira, Fire Marshal