



EMERGENCY RESPONDER RADIO COVERAGE

GUIDELINE

I. INTRODUCTION

- A. Purpose: The purpose of this document is to establish a consistent guideline for:
1. The design, installation, operation, and maintenance of emergency responder radio coverage systems.
 2. The procedures utilized by the Los Angeles County Fire Department regarding evaluation for the need of these systems and subsequent plan review, inspection, and permitting of these systems.
- B. Scope: This document applies to buildings subject to the requirements of the Los Angeles County Fire Code pertaining to emergency responder radio coverage.
- C. Author: The Deputy Chief of the Prevention Services Bureau, through the Assistant Fire Chief (Fire Marshal) of the Fire Prevention Division, is responsible for the content, revision, and periodic review of this document.
- D. Authority:
1. 2020 Los Angeles County Fire Code (LA County Title 32).
 2. California Code of Regulations, Title 16 (Professional and Vocational Regulations).
 3. Code of Federal Regulations, Title 47 (Telecommunication).
- E. 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 72 (2016 edition)** – National Fire Alarm and Signaling Code
 3. **NFPA 1221 (2016 edition)** – Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
 4. **NTIA Report 99-358** – Delivered Audio Quality Measurements on Project 25 Land Mobile Radios, U.S. Department of Commerce, 1998-11
- F. Terminology/Definitions:
1. **AGC/ALC** – Automatic Gain Control / Automatic Level Control.
 2. **APCO** - Association of Public-Safety Communications Officials.
 3. **BDA** – Bi-directional amplifier.
 4. **CCR** – California Code of Regulations.
 5. **CFR** – Code of Federal Regulations.
 6. **DAQ** – Delivered Audio Quality.
 7. **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).
8. **dBd** – Decibels referenced to a dipole antenna (as opposed to dBi, which is decibels referenced to an isotropic theoretical antenna in free space).
 9. **dBm** – Decibel milliwatt.
 10. **Donor Antenna** – An antenna located at the site of the ERRCS (i.e., at the “microsystem”) that is used to communicate with the larger wide-area communications system (i.e., with the “macrosystem”). The donor antenna is part of the ERRCS/microsystem, whereas its macrosystem counterpart (with which it communicates) is the donor site.
 11. **Donor Site** – The specific wide-area communications (i.e., “macrosystem”) site designated by the macrosystem operator as the communications site through which the individual ERRCS donor antenna (i.e., the “microsystem”) shall link into the macrosystem. The donor site is part of the macrosystem, whereas its ERRCS/microsystem counterpart is the donor antenna.
 12. **Downlink** – The signal from the base station/tower site to the portable radio.
 13. **ERP** – Effective Radiated Power (ERP), synonymous with Equivalent Radiated Power.
 14. **ERRC** – Emergency Responder Radio Coverage. This can also sometimes be referred to as Emergency Responder Communication Coverage (**ERCC**).
 15. **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.
 16. **et seq.** – and what follows (used in page-/section-number references).
 17. **FCC** – Federal Communications Commission.
 18. **LA-RICS** – Los Angeles Regional Interoperable Communications System.
 19. **LAC** – Los Angeles County.
 20. **LACFC** – Los Angeles County Fire Code. This can also be referred to as the County of Los Angeles Fire Code, or the Fire Code of the Los Angeles County Fire Protection District, L A County Title 32.
 21. **LACoFD** – Los Angeles County Fire Department, which is the fire authority for the Los Angeles County Fire Protection District.
 22. **LASD** – Los Angeles County Sheriff’s Department.
 23. **Macrosystem** – 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. In the case of radio systems, industry sometimes refers to this as the “macro radio system”, or similar.

- 24. **Microsystem** – See definition of “ERRCS”.
- 25. **NEMA** – National Electric Manufacturers Association.
- 26. **NFPA** – National Fire Protection Association.
- 27. **NTIA** – National Telecommunications and Information Administration.
- 28. **RF** – Radio Frequency.
- 29. **Signal booster**. A device or system that automatically receives, amplifies, and retransmits signals from wireless stations into and out of building interiors, tunnels, shielded outdoor areas and other locations where these signals would otherwise be too weak for reliable communications. Signal booster systems may contain both Class A and Class B signal boosters as components.
- 30. **SINR** – Signal-to-Interference-plus-Noise Ratio.
- 31. **§** – Section, as in a section number of a code, law, or standard.
- 32. **Uplink** – The signal from the portable radio to the base station/tower site.
- 33. **UPS** – Uninterrupted Power Supply.

II. RESPONSIBILITY

- A. Individuals and entities who own or manage structures that require ERRCS’s or that require the evaluation for the need of an ERRCS, pursuant to the Los Angeles County Fire Code, shall be guided by this document.
- B. The Los Angeles County Fire Department shall be guided by this document in its evaluation, plan review, inspection, and permitting procedures pertaining to ERRCS’s.

III. POLICY

- A. All ERRCS installations within the jurisdiction of the Los Angeles County Fire Department shall be designed, installed, and maintained in accordance with all applicable laws, codes, and standards; see the “Authority” section hereof. This document shall serve to provide procedural and technical guidance towards achieving and maintaining such compliance.

IV. PROCEDURES

A. Evaluation of Need for an ERRCS:

1. 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) shall be evaluated for the need of an ERRCS (2020 LACFC §510.1). The evaluation shall include empirical determination of the extent to which the existing coverage levels of the public safety communication systems (i.e., the “macrosystems”) utilized by the jurisdictional fire and police authorities, measured at the exterior of the building, are reduced within the building itself. Building criteria triggering evaluation are as follows:
 - a. **Stories (any of the following):**
 - (1) 2 or more above grade plane.
 - (2) Any basement or level that extends below grade plane.
 - b. **Total Building Area:** 10,000 square feet or more.
 - c. **Fire Code Official Determination:** Buildings determined by the fire code official as requiring evaluation based upon fire- and life-loss potential.

Exceptions: One- and two-family dwellings and townhouses shall not require evaluation.
2. The building shall be considered to have acceptable radio coverage for emergency responders when signal-strength measurements in 95 percent of all areas, and 100 percent of critical-coverage areas, on each floor of the building, meet the minimum signal-strength requirements in the 2020 LACFC, 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 Marshal, or a person specifically authorized by the Fire Marshal to conduct such evaluation.

Critical coverage areas are defined as (2020 LACFC §510.4.1):

1. At all fire alarm control panels.
2. At fire fighter’s smoke control panels.
3. At the main electrical panel(s).
4. Throughout emergency and standby power rooms.
5. Throughout a fire command center complying with Section 508.

6. Throughout interior exit stairways.
 7. Throughout areas of refuge.
 8. Throughout fire pump rooms.
 9. Throughout elevator machine rooms and elevator lobbies.
 10. Throughout building lobbies.
 11. Within elevator cars.
 12. Locations as determined by the fire code official.
3. Structures with construction that does not maintain the lesser of the two following performance criteria shall be equipped with an ERRC system approved by the fire code official in order to achieve the required radio coverage, unless exempted by the macrosystem FCC license holder:
- a. Uplink and downlink signal strengths *within the building* equal to or exceeding the minimum signal-strength requirements described in #2, above.
 - b. Uplink and downlink signal strengths *within the building* equal to the signal strengths that exist at the location of the building site prior to development (i.e., as if no building existed at the site in question).

B. **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. **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 2020 LACFC, Section 510.5.3, with the following additional conditions:
 - a. **Critical-Coverage Areas** – Critical-coverage areas shall be provided with 100 percent floor area radio coverage with received uplink and downlink power of no less than -95 dBm and a minimum delivered audio quality (DAQ) of 3.4 as defined in NTIA Report 99-358 (see “c.”, below, for the DAQ scale). For a list of critical-coverage areas, see Section “A.”, above.

- b. General Building Areas – General building areas shall be provided with 95 percent floor area radio coverage with received uplink and downlink power of no less than -95 dBm and a minimum DAQ of 3.4 as defined in NTIA Report 99-358 (see “c.”, immediately below).
- c. NTIA Report 99-358 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. **LACoFD Frequencies.** Any active amplification system installed to meet these requirements shall operate on the following frequencies which use APCO Project-25, Phase II:

Frequencies will be assigned by LACoFD representatives on a case-by-case basis. Frequency determination requires individual consideration by the LACoFD representative due to various factors, some of which may change over time, even for a single geographical location.

4. **LACoFD Donor Site.** A donor site will be assigned by LACoFD representatives for each individual project.

The donor site will be assigned by LACoFD representatives on a case-by-case basis. Donor site determination requires individual consideration by the LACoFD representative due to various factors, some of which may change over time, even for a single geographical location.

5. **Police Agency Frequencies, Donor Site, and System Information.** The applicant shall contact the applicable jurisdictional police agency/agencies for their required frequencies and other technical criteria.
6. **Donor Path Rights.** Any person or entity constructing a new structure which blocks the donor path of existing ERRCS installations shall be responsible for resolving coverage and system performance degradation experienced by existing

ERRCS installations at its expense.

7. **Interference Prohibited:**

- a. **With Other Systems.** 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. **With the ERRC in Question.** No system or equipment in the structure may cause any interference to, or reduce the performance of, the ERRCS.
 - c. **Downlink Signal Power.** 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 radio system.
 - d. **Oscillation Prevention.** Bidirectional amplifiers shall have oscillation prevention circuitry and software. Oscillation prevention shall be activated in all bidirectional amplifiers.
8. **Design User Radio.** Motorola model APX-8000 portable radios are utilized by the Fire Department and shall be used for system design and testing. System design shall assume use of a portable radio on the user's hip. Contact the jurisdictional police agency for its requirements.
9. **Signal Boosters, DAS.** If Signal Booster Components and/or Fiber Optic DAS Components are used, they 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 be located in the fire control room or other area approved by the fire code official.
 - c. Signal boosters and other radiofrequency signal-generating components shall have FCC certification prior to installation and shall be NFPA 1221, 2016 edition, and 2020 LACFC compliant.
 - d. All signal boosters and distributed antenna systems shall be compatible with analog FM, digital FDMA (Frequency-Division Multiple Access; APCO Project 25, Phase I) and digital TDMA (Time-Division Multiple Access; APCO Project 25, Phase II) modulation simultaneously at the time of installation.
10. **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 macrosystem.

11. **External Filters.** External filters in protective enclosures are permitted adjacent to the:
 - a. Bidirectional amplifier.
 - b. Fiber headend.
 - c. Fiber remote units.
12. **Near-Far Effect – Measures to Prevent.**
 - a. 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.
 - b. Systems 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 buildings, except that spacing of 80 feet apart may be allowed in large open areas such as parking garages.
13. **Noise – Maximum Allowable.** 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. 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.
14. **RF Isolation Between Antennas.** 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.
15. **Uplink Gain.** Amplifier uplink gain shall be set to the minimum necessary to comply with the radio coverage requirements set forth herein, and not exceed 65 dB unless an exception has been approved in writing by the fire code official .

16. **BDA Signage.** Bidirectional amplifiers shall be clearly labeled on the front of the enclosure with the maximum permissible uplink and downlink gain.
17. **Pathway Survivability.**
- a. Pathway survivability levels shall be as described in NFPA 1221, 2016 edition, Section 5.10 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-hour.
 - 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. An alternative minimum 2-hour pathway survivability performance methodology may be approved by the fire code official .
18. **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-3R, 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.
19. **Power Sources.**
- a. At least two independent and reliable power sources shall be provided for all active components; one primary and one standby power source.
 - b. The primary power source shall be supplied from a dedicated branch

circuit and comply with NFPA 72, 2016 edition, Section 10.6.5.1

- c. The standby power source shall comply with one of the following:
 - (1) 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.
 - (2) 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 2 hours at 100 percent system operation capacity and designed in compliance with NFPA 72, 2016 edition, Section 10.6.10 et seq.
 - d. Bidirectional amplifiers (BDA's) shall be equipped with power switches adjacent to the BDA(s). These switches shall be in accordance with the following:
 - (1) One switch shall both disconnect and reapply AC power to the battery power supply.
 - (2) Another switch shall be employed to disconnect and reapply power to each BDA.
 - (3) All switches shall have protection against water intrusion.
 - (4) All switches shall have a lockout/tagout feature.
 - e. All components shall be mounted at least 12 inches above the floor.
20. **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 and/or antenna mast 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.
 - (1) 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 8 feet above the top of their mounting point shall provide structural design submittals prepared by, and bearing the

stamp of a registered design professional.

21. 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 (American wire gauge).
- d. No copper wire shall come into direct contact with aluminum, tinned aluminum, or plated aluminum.
- e. All ground bus bars shall be copper.
- f. No copper bus bar shall come into direct contact with aluminum.
- g. Donor antenna feedline 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 feedline building entry point as possible.
 - (1) Surge protection shall be grounded to the master building ground bus.
 - (2) An additional ground attachment shall be made to grounded structural steel at the building entry point whenever possible.
 - (3) 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 large enough to provide the antenna feedline with a minimum bending radius of 10 times the diameter of the feedline cable, and shall be a minimum of 18 inches tall by 18 inches wide by 6 inches deep.
 - b. Conduit from the building to the enclosure shall be continuous.
 - (4) All exterior antenna feedline shall be enclosed in solid conduit. There shall be no exposed outdoor feedline except at the connection to the antenna.
- i. Donor antenna mounting structures shall be grounded to the master building ground.

- 22. System Monitoring.** The ERRCS monitoring shall include automatic supervisory and trouble signals for malfunctions of the signal booster, and for malfunctions of the power supplies. These supervisory and trouble signals shall

be annunciated by the fire alarm system which itself shall be monitored by an approved supervising station monitoring company in accordance with NFPA 72 unless approved by the fire code official to be monitored at a constantly attended location on site. The following shall also apply:

- a. Monitoring for integrity of the system, circuits, and various components, including but not limited to signal boosters and power supplies, shall comply with NFPA 1221, 2016 edition, especially Sections 9.6.12.3, 9.6.13 et seq., and 12.6.
- b. System and signal-booster supervisory signals shall include the following:
 - (1) Donor antenna malfunction.
 - (2) Signal booster failure.
 - (3) Active RF emitting device malfunction.
 - (4) Low-battery indication when 70 percent of the 24-hour operation capacity has been depleted.
 - (5) Low-fuel level indication when 70 percent of the backup generator fuel capacity has been depleted (when applicable).
 - (6) Failure of the communications link between the fire alarm system and the ERRCS.
- c. Power supply signals shall include the following for each signal booster.
 - (1) Loss of commercial AC power.
 - (2) 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 and shall be clearly marked with: "In-Building Radio System Status." and "When In Alarm Use Direct Radio Channels." The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
 - (1) Donor Antenna Trouble
 - (2) Signal Booster Failure
 - (3) Active RF Device Malfunction
 - (4) Normal AC Power
 - (5) AC Power Loss
 - (6) Battery Charger Failure
 - (7) Low Battery
 - (8) Low Generator Fuel (when applicable)
 - (9) Failure of the communications link between the fire alarm system and the ERRCS.
- e. Remote Control. 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 bidirectional amplifier (BDA) to allow the

system to be remotely monitored and controlled by the County.

C. System Submittal.

1. Permit, Approved Plans, and Inspection Report Required. A permit must be obtained prior to the construction or modification of an indoor ERRCS. A copy of the operational permit, approved plans, and commissioning report shall be posted visibly on the main active component, or at the point of primary system operation.
2. Plans shall require review and approval by the fire code official . Plan check and acceptance testing fees will be assessed for these services.
3. No permit shall be issued without approved plans. A minimum of 3 complete sets of plans, associated documentation and one electronic copy of plans and documentation shall be submitted. Such plans shall contain at a minimum the following elements:
 - a. Pursuant to CCR Title 16, Sections 832.07 and 832.10, the minimum qualification of the system-installing entity shall be a valid classification C7 (Low Voltage Systems Contractor) or C10 (Electrical Contractor) California Contractors License.
 - b. The minimum qualifications of the system designer and lead installation personnel shall be in compliance with Section 510.5.2 of the 2020 Los Angeles County Fire Code and include:
 - (1) A valid FCC-issued general radio operator license; and
 - (2) Certification of in-building system training issued by an approved nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.
 - (3) These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the fire code official is provided.
4. Plans shall be size "E", scaled or dimensioned with dimensions or scale clearly noted, and of resolution sufficient for the verification of compliance with detailed requirements. 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.
5. Provide both paper and electronic high-resolution PDF versions of the plans.
6. Plan view of the subject building, building construction type and surrounding property shall be provided. Plan view shall clearly indicate the location and orientation of any outdoor antennas associated with the proposed ERRC system.
7. Specify the antenna grounding, surge and lightning protection in accordance with the California Electrical Code and this guideline. Include drawings of the location and method of all grounding connections.

8. 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.
9. Include a schematic diagram of the proposed distributed antenna system (DAS) showing every component with:
 - a. The gain or loss of the component.
 - b. The total system gain for both uplink and downlink.
 - c. The donor site signal peak and average strengths measured at the approximate location of the donor antenna.
 - d. The calculated uplink signal strength radiated by the donor antenna.
 - e. The calculated downlink signal strength radiated by each distribution antenna.
10. Include a link budget analysis for every service antenna showing uplink and downlink system 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.
11. Include a color-coded propagation model displaying predicted signal strength provided by the system on each floor or level throughout the structure, with critical-coverage areas highlighted.
12. 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. Show the locations and indicate the times at which measurements were taken.
13. Include peak and average downlink signal-strength measurements taken from at least four areas on the roof of the structure. Show the locations and indicate the times at which measurements were taken.
14. 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. Floors or levels of exceptionally large size may be required to be considered in sections in order to keep the individual grid test areas of reasonable 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. On APCO Project-25 digital channels, downlink DAQ shall be measured using an instrument which decodes the APCO Project-25 bitstream and provides a SINR or SNR measurement. A passing SINR or SNR is 20 dB or greater, and a passing Bit Error Rate, BER, or FBER is no greater than 2%. Include calculated

uplink power and the formula used to calculate uplink power.

15. Backup Power.

- a. 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.
- b. Include the detailed manufacturers' specifications for each component and the calculations used to derive the 24-hour minimum runtime.
- c. 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.

16. Provide copies of the manufacturer's specification sheets, including those for:

- a. Amplifiers, fiber remotes, and other active components proposed.
- b. Antennas, coax, couplers, splitters, combiners, and/or any other passive components proposed.
- c. Backup battery and charging system, and generator (if applicable).

17. Provide the following notes on the plans:

- a. The ERRCS shall not be powered on prior to the final inspection by the fire code official, unless it is employed on a non-radiating load and not on a live antenna system.
- b. The ERRCS shall be approved by the fire code official . Approved plans and associated documentation shall be retained on site during installation and for the life of the system. Said plans and documentation shall be available at the request of the fire code official and located as required by the fire code official.

D. **Acceptance Test.**

1. Acceptance and operational testing shall be in accordance with Section 510.5.3 of the 2020 Los Angeles County Fire Code with the following clarifications:

- a. 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 Marshal to conduct acceptance tests.
- b. 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.
- c. Acceptance test will include the following:
 - (1) A visual inspection of the physical installation of the ERRCS.

- (2) Backup batteries and backup power supplies will be tested under load for 1-hour.
- (3) In the presence of the fire code official, a calibrated spectrum analyzer and other suitable test equipment will be utilized to evaluate the system for all frequencies included in the ERRCS.
- (4) The following tests are required:
 - a. Measure downlink power at the BDA donor port
 - b. Measure maximum quiescent system uplink noise with donor and service antennas connected.
 - c. Measure amplifier spurious emissions with donor antenna connected.
 - d. Measure donor antenna return loss.
 - e. Measure isolation between the donor (outdoor) and service (indoor) antennas.
 - f. Measure uplink and downlink amplifier gain.
 - g. Measure signal strength from the donor site(s), in multiple areas of the building rooftop with a clear line of sight to the donor site(s).
 - h. Measure downlink and uplink signal levels.
 - i. 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 jurisdictional fire and police agencies.
- d. A portable radio of the type currently in service with the applicable fire and police agencies, 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.
- e. On APCO Project-25 digital channels, downlink DAQ shall be measured using an instrument which decodes the APCO 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. Maintenance and Recurring Testing.

- 1. **System Maintenance.** The ERRCS shall be maintained operational at all times in accordance with Section 510.6.1 through 510.6.3 of the 2020 Los Angeles County Fire Code.
- 2. **Frequency Maintenance.** The building owner or manager shall modify or expand the ERRCS at their expense in the event frequency changes are required

by the FCC, other radio licensing authority, or the fire code official, 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 (2020 LACFC §510.6.2).

3. **Annual Inspections.** Annual Inspections shall be conducted by the fire code official or specially authorized representative thereof. No person may conduct an annual test unless that person has been specifically approved by the Fire Marshal to conduct annual inspections.
4. **Annual Testing.** Annual testing and proof of compliance shall be in accordance with Section 510.6.1 of the 2020 Los Angeles County Fire Code and with this guideline.
 - a. Annual testing will be done at no expense to the City or County.
 - b. Annual tests results shall be filed with the fire code official as directed.
 - c. All building levels for which radio coverage amplification systems are provided shall be tested. For those levels one and two levels away from the levels using radio coverage amplification systems, full testing shall be conducted for the acceptance test in order to establish a baseline. Subsequent annual testing of those levels one and two levels away shall consist of the following:
 - (1) 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.
 - (2) 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.
 - (3) 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.
 - (4) This method may be employed for each floor/level 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.

- d. 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.
 - 5. **Unscheduled Testing or Investigation.** The fire code official 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. **ERRCS Failure – Required Response.** 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 jurisdictional fire and police agency dispatch centers within 8 hours of any service-affecting outage.