


CITY AND COUNTY OF DENVER		POLICY	DENVER FIRE DEPARTMENT
Subject:	Emergency Responder Radio Enhancement Coverage System (RES)		
Reference:	Denver Fire Code Sections 510		
Approved:			Manuel Almaguer Division Chief, Fire Prevention Division
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This Policy 510-1 provides additional code for the 2016 Denver Amendments to the 2015 International Fire Code and Denver Fire Department requirements where emergency responder public safety communication systems are installed. Application is subject to the discretion of the Fire Code Official.

I. SCOPE

This policy applies to the procedures required for the installation, alteration, repair, maintenance, and testing of emergency responder radio enhancement coverage systems (RES) in accordance with IFCA Section 510.

II. GENERAL

The Public Safety RES (Radio Enhancement System) is a network of amplifiers, fiber optic cable, coaxial cable, and radiating cable and/or discrete antennas with or without a distributed antenna system (DAS) controller, or an equivalent technology installed on or inside the property to enhance indoor public safety radio communications. All Installations shall comply with 510.3.

Where required in accordance with IFCA Section 510, RES shall be installed in new and existing buildings.

III. PURPOSE

RES systems shall provide adequate coverage within buildings for emergency responder communications over the Public Safety network. The system shall be dedicated for public safety use and no components may be shared with any other user or system.

IV. REQUIREMENTS

Effective 2-1-2018 A maximum of one (1) Public Safety BDA (Bi-Directional Amplifier) will be permitted per structure. Multiple buildings, structures, towers, underground buildings, and high rises connected by common floors, parking levels, hallways, stairwells or walkways will be considered as one structure. Some extended long walkways may be exempt as determined by the Fire Code Official. Structures with multiple Public Safety BDA configurations prior to

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2-1-2018 may be subject to upgrading to a one (1) BDA configuration at the discretion of the Fire Code Official. All Installations shall comply with 510.3.

Any amplifier installed to provide in-building radio enhancements to the Denver 800MHz public safety radio network will require internal or external pass-band filters that only pass 806-816MHz and 851-861MHz.

All installation, annual testing, five-year testing, design, modification, replacement, repair or inspection of any Public Safety RES system shall be the responsibility of the building owner.

FCC Compliance and Requirements

The Public Safety RES or emergency responder radio coverage system installation and components shall be (FCC)-certified and comply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219. All RES active components including UPS, BDA and battery backup units must be OEM (original equipment manufacturer) factory approved, engineered, designed and assembled.

INITIAL BUILDING TEST

Before any Public Safety RES installation will be permitted, the Acceptance Test Procedure below must be performed, and RF grid layout drawings shall be submitted to Denver Fire Prevention Division and Line shop. The Department will determine if a Public Safety RES system is needed. Buildings where RF grid results Pass the Acceptance Test, will not be authorized to install a Public Safety RES system. Upon owner request and with department approval, Public Safety RES wiring and indoor antenna systems may be installed for future use. Drawing submittals and City permits are required.

Buildings with or without an existing Public Safety RES that pass the Acceptance Test Procedure will require submittal of Passing RF Grids and the DFD RF Survey Information Document prior to scheduling an inspection.

If the results of the Initial Acceptance Test Procedure are a Fail, only RF Grids of “Areas of Refuge” are required for the “initial” RF Grid submittal. Where the building RF grids produced from the test are a Fail and with department approval, a Public Safety RES system shall be installed. A second set of passing RF Grids are required prior to scheduling final inspection of the new Public Safety RES system.

Plans and specifications will be submitted for approval in accordance with the Denver Fire Code.

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ACCEPTANCE TEST PROCEDURE

A. Test Grid

Create a uniform grid over each floor with 20 X 20-foot squares. The measurements to be taken in the center of each square grid point. At each accessible grid location, using a test receiver or appropriate test equipment with sensitivity and thermal noise floor equal to or better than the Department of Safety radio, take at least one sample measurement of the:

1. Radio system control channel RSS (Received signal strength) OR future P25 BER (Bit error rate).
2. Repeat Step b for each grid point.
3. Calculate the service area reliability:

$$\text{Service Area Reliability (\%)} = \left(\frac{T_p}{T_t} \right) \times 100\%$$

Where:

T_p = total number of grid points passed; i.e., control channel >-100dBm control channel signal strength or BER (bit error rate) of 2.4% or less.

T_t = total number of grid points measured.

Control channel signal strength or BER results must meet or exceed 510.1.1 coverage requirements. Submitted RF Grids shall consist of the Denver Public Safety radio systems control channel signal strength measurements plotted on the building floor plan. After Denver transitions to P25 Technology, control channel signal strength measurements will no longer be required. The new P25 RF Grids shall consist of the Denver Public Safety radio systems control channel P25 BER (Bit Error Rate) measurements plotted on the building floor plan. Test measurement results shall be verified with calibrated radio receivers, spectrum analyzer or equivalent test equipment by licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5.

On new RES installations, “as is” design submittals will be required prior to inspection.

- B.** The installation contractor must perform the “Signal Booster Uplink Noise Test Procedure” which can be obtained from DFD Line shop and record test results on the “Denver Fire Department RF Survey Information Document”. After completing the above procedure, the Public Safety RES amplifier is to be set to the minimum gain

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level possible. Upon direction of DFD Line shop personnel, the installer will set uplink gain to the predetermined level calculated in the test procedure. Denver Fire Department Radio Technicians will verify the uplink gain levels are properly set by performing on/off tests of the system amplifier to verify that the new system is not creating any harmful interference. If the system is found to be causing interference, the system will be re-tested by the installation contractor to realign the uplink gain level as necessary to achieve proper balance.

- C. Careful consideration must be taken in all Public Safety RES design and construction to use an adequate number of interior service radiating antennas or leaky coax as to prevent areas of each floor from having very strong down link signal levels while other areas of the floor having very weak signal levels close to -100dbm. Ideally, a properly designed and balanced Public Safety RES system will have control channel signal strength of -70dbm to -80dbm throughout the building structure. Consistent strong signal strength measurements on interior structure floors may be subject to possible redesign, adding more interior service antennas, installing fixed attenuators, directional couplers, or adjusting downlink amplifier gains where needed to properly balance the Public Safety RES system. Choosing the most appropriate simulcast site to point the donor antenna is an important part of proper design, it is best to use a simulcast site a minimum of a mile away rather than using the closest one. The DFD Line shop can assist installation contractors in choosing the most appropriate simulcast site to select. Acceptance of the design and performance of the completed Public Safety RES communication system will be subject to approval by the fire code official.
- D. On all new Public Safety RES installations and every 5-year test, the licensed technician, contractor or installer shall perform an antenna isolation test between the donor antenna and distribution antennas. The minimum isolation required shall be 20db greater than the BDA amplifiers maximum gain limit. (i.e. an 80dB gain BDA requires isolation of, $80+20=100$ dB.) Extra caution should be taken while performing the “Isolation Test” to avoid transmitting a test signal through the coax going to the roof donor antenna which can transmit interference into the simulcast site. A sweep test of coaxes/transmission lines between the donor antenna and BDA is required.

Licenses Required

All installation, annual testing, five-year testing, design, modification, replacement, repair or inspection of any Public Safety RES system shall be performed by licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5.

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Radio Frequency Maintenance Plan

Building owners are required to maintain the installed Department of Safety Radio Enhancement System (Public Safety RES) to permit Emergency Response personnel to communicate over their department radios in the event of an emergency. These communications are within the frequency range 806-816 and 851-861Megahertz (MHz). The radio system control channel signal levels shall meet or exceed Acceptance Test requirements in 95% or more of locations measured in accordance with the adopted Fire Code Section 510. Service area reliability shall be 95% or greater on each floor of the structure and parking areas. All designated areas of refuge, Fire Command Centers, stairwells, main building lobbies and elevator lobbies shall have 100% signal coverage of >-100dbm control channel signal strength or BER (bit error rate) of 2.4% or less.

The radio frequency maintenance plan is a document developed and distributed by the building owner for the purpose of maintaining the Department of Safety radio system from harmful interference generated on the property or otherwise under the control of the owner.

The plan shall comply with the following at a minimum:

- A. Prohibit the use of any electronic systems known to degrade the effectiveness of RES communications.
- B. Permit Department site access during reasonable business hours when necessary to assess the source of interference to RES communications. During such inspection, Department personnel shall be accompanied by a member of building management at all times.
- C. Be incorporated into the lease of every tenant.

Annual testing

Licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5 shall perform at a minimum the following Public Safety RES system inspections and tests on all active and passive system components.

Public Safety RES Visual inspection of entire RES system must be performed to insure system shows no visible signs of damage, and is in a safe and operating condition. RES System must pass the control channel signal level requirements as per Acceptance Test procedure in all areas of refuge, located on the buildings main floor at ground level. Documented RF Grids are not required for the Annual testing. All installations shall

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comply with 510.3. Test results shall be maintained on the premises in the “RES System Maintenance & Test Results Log Book,” endorsed by the licensed RES technician, contractor or installer which shall remain on the building premises and shall be made available to the fire code official upon request.

BDA (Bi-Directional Amplifier) is operating correctly, no alarms/faults, a supervisory signal is reported at FACP when the amplifier is powered down, correct frequency band is being amplified, (806-816/851-861Mhz), amplifier downlink and uplink power is adequate to achieve passing results for the “Acceptance Test Procedure”, Uplink power must be set to the most minimum level possible while still achieving passing performance standards. If the BDA has a display it is readable and functional.

UPS (Uninterruptable Power Supply) (Note: “UPS” refers to both the main unit and additional external battery packs,) UPS will power the entire RES for a minimum of a 4-hour test, UPS shows no signs of damage/failure, ventilation ports are unobstructed and clean as necessary.

Donor Antenna, donor antenna and cable show no visible signs of damage, donor antenna and roof mount are secured and tight.

Radio Coverage, all “Areas of Refuge” Fire Command Centers, stairwells, main building lobbies and elevator lobbies must meet minimum control channel signal performance as stated in the Acceptance Test Procedure on the buildings main ground level floor. Documented RF Grids are not required for the Annual testing.

Five-year testing. All 5-year Public Safety RES system inspections and testing must include with passing results, all annual testing requirements above and shall now meet all current 2016 Denver Amendments and DFD Policy 510-1 requirements. Every five (5) years a radio coverage test with new RF Grids in accordance with the Acceptance Test procedure above shall be performed to ensure the system provides continued adequate radio coverage. Coaxes/transmission lines from BDA to donor antenna must pass a sweep test.

Test measurement results shall be verified with calibrated radio receivers, spectrum analyzer or equivalent test equipment by licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5. All Installations shall comply with 510.3. Documentation of all 5-year test results, new RF Grids and new “Denver Fire Department RF Survey Information Document” shall be submitted to the DFD Fire Prevention Bureau Engineering and Line shop within 30 days of each 5-year interval following system installation. An inspection shall be scheduled with DFD Line shop to inspect the Public Safety RES system and verify system performance.

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The property owner, agency or lessee shall compensate the City and County of Denver through approved Department of Safety channels at a rate established by the Manager of Safety for no less than two Denver Fire Department radio technicians. Test results shall be maintained on the premises in the “RES System Maintenance & Test Results Log Book,” endorsed by the Licensed RES technician, contractor or installer which shall remain on the building premises and shall be made available to the fire code official upon request and shall be shared with the property owner, agent or lessee. The testing agency shall obtain an operational permit for system 5-year testing.

Audio Quality, all new installations and 5-year inspections the DFD Fire Code Official will perform Pass/Fail testing for audio quality. Passing DAC (Delivered audio quality) must be 3.4 or higher. After Denver transitions to P25 technology, BER (Bit error rate) testing **must be performed by** licensed technicians, contractors, or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5 and must verify (either from the Denver Public Safety radio system or via BDA downlink where equipped) the control channel BER (Bit error rate) is 2.4% or less at each grid location used in the Acceptance Test Procedure.

Emergency responder radio coverage in existing buildings. For existing high-rise, underground buildings, I-1, I-2 and I-3 occupancies and airport buildings, when required by Denver Fire Code Section 916, the building shall be tested in accordance with the acceptance test above. Where signal coverage is deficient, Public Safety RES coverage shall be provided. Buildings with currently acceptable signal strength shall be retested at five-year intervals to ensure continued compliant radio coverage.

System maintenance, modification, and repair

All work on Public Safety RES systems shall be accomplished by licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department license as defined in sections 114.2, 114.2.10, 510.5. All Installations shall comply with 510.3 and after obtaining the appropriate Department permit. Modification, alteration, repair or removal of the Public Safety RES system or any system component is specifically prohibited without the approval of the fire code official.

Upon completion of work, the Denver Fire Department Line shop shall be notified to schedule an acceptance test. The extent of the test and documentation needed shall be at the Department’s discretion as necessary to confirm proper operation and system coverage.

Note: Any RES system deficiencies or test procedures resulting in a fail, shall be repaired within 72 hours as per 510.2.1.3.

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V. RECORDS

Records of all Public Safety RES installation, annual testing, five year testing, modification, replacement, repair, maintenance, uplink/downlink settings, and inspection of any Public Safety RES system shall be performed by licensed technicians, contractors or installers with appropriate knowledge, holding a valid Denver Fire Department License as defined in sections 114.2, 114.2.10, 510.5 and shall be maintained on the premises in the “RES System Maintenance & Test Results Log Book,” endorsed by the licensed technicians, contractors or installers which shall remain on the building premises and shall be made available to the fire code official upon request.