CITY AND COUNTY OF DENVER	POLICY	DENVER FIRE DEPARTMENT
Subject: **Emergency Responder Radio Enhancement Coverage System (RES/BDA)**		
Reference: **Denver Fire Code Sections 510**.		
Approved:  Manuel Almagure, Division Chief		
Number: **IFC 510-1**	Effective Date: December 1, 2016	Page 1 **of 6**

This policy is meant to provide general guidance on 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/BDA) in accordance with IFCA Section 510.

II. GENERAL

The RES/BDA 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.

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

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.

Initial RF Grid and DFD RF Survey Information Document must be submitted to the Denver Fire Department Lineshop prior to any RES/BDA system installation work. After approval of the initial RF Grid and permitted installation of the BDA/RES

system, a second RF Grid with passing RF Levels is required to be submitted to DFD Lineshop before scheduling final inspection of the new BDA/RES system.

V. INITIAL BUILDING TEST

Before any RES/BDA installation will be permitted, the test procedure below must be performed. RF grid layout drawings shall be submitted to Denver Fire Prevention Division and Lineshop. The Department will determine if a RES/BDA system is needed. Buildings where RF grid results pass the test will not be authorized to install an RES/BDA system. Upon owner request and with department approval, RES/BDA system wiring may be installed for future use. Drawing submittals and City permits are required. If the results of the ACCEPTANCE TEST PROCEEDURE are a Fail, only RF Grids of "Areas of Refuge" are needed for initial RF Grid submittal. Where the building RF grids produced from the test fail and with department approval, an RES/BDA system shall be installed.

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

Submitted RF Grids shall consist of all RF level measurements plotted on the building floor plan in accordance with the acceptance test procedures.

VI. ACCEPTANCE TEST PROCEDURE

1. Test Grid
    - **a.** Create a uniform grid over each floor with 20 X 20 foot squares. The measurement to be taken in the center of each square grid point.
    - **b.** At each accessible grid location, using a test receiver with sensitivity and thermal noise floor equal to or better than the Department of Safety radio, take at least one sample measurement of the radio system control channel.
    - **c.** Repeat Step b for each grid point.
    - **d.** Calculate the service area reliability:

Service Area Reliability (%) = $\left(T_p / T_t\right)$ **x** 100%

Where:

T_p = total number of grid points passed; i.e., control channel >-100dBm

T_t = total number of grid points measured.

2. The installation contractor must perform the "Signal Booster Uplink Noise Test Procedure" which can be obtained from DFD Lineshop and record test results on the "Denver Fire Department RF Survey Information Document". After completing the above procedure, the RES/BDA amplifier is to be set to the minimum gain level possible. Upon direction of DFD Lineshop 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.

3. Careful consideration must be taken in all RES/BDA 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 RES/BDA 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 RES/BDA 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 Lineshop can assist installation contractors in choosing the most appropriate simulcast site to select. Acceptance of the design and performance of the completed RES/BDA communication system will be subject to approval by the fire code official.

4. On all new RES/BDA installations and every 5-year test, the installation contractor shall perform antenna isolation testing between the donor and distribution antennas. The minimum isolation required is 20dB greater than the RES/BDA gain. (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.

Radio Frequency Maintenance Plan

Building owners are required to maintain the installed Department of Safety Radio Enhancement System (RES/BDA) 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 level signal shall be at least -100dBm at 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 or stronger.

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:

1. Prohibit the use of any electronic systems known to degrade the effectiveness of RES communications.

2. 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.

3. Be incorporated into the lease of every tenant.

Annual testing.

All active RES/BDA system components, such as amplifiers, power supplies and backup batteries shall be tested annually. Amplifiers shall be tested and monitored to ensure the gain has not degraded from the installed value. Backup batteries and power supplies shall be tested under load for a period of at least four hours to verify that they will properly operate during an actual power outage. Annual tests shall be performed in accordance with the acceptance test procedures described above and shall be conducted in all common areas, garages, stairwells, elevators and corridors. Measurements shall be taken with calibrated radio receivers by technicians with appropriate knowledge and training and licensed by the Denver Fire Department. Test results shall be certified by a professional engineer licensed by the State of Colorado and submitted to the Department.

Five-year testing.

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. 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 Lineshop within 30 days of each 5-year interval following system installation. An inspection shall be scheduled with DFD Lineshop to inspect the RES/BDA system and verify system performance. Test measurement results shall also be verified with calibrated radio receivers by Denver Fire Department radio technicians. 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 shared with the property owner, agent or lessee. The testing agency shall obtain an operational permit for system 5-year testing.

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, RES/BDA 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 RES/BDA systems shall be accomplished by certified installers possessing a valid Denver Fire Department license and after obtaining the appropriate Department permit.
Modification, alteration, repair or removal of the RES/BDA system or any system component is specifically prohibited without the approval of the fire code official.

Upon completion of work, the Denver Fire Department Lineshop 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.

VII. RECORDS

Records of all system inspections, RES/BDA uplink and downlink gain settings, system maintenance, acceptance tests, annual tests and 5-year test results shall be maintained on the premises in the "RES/BDA System Maintenance & Test Results Log Book" which shall remain on the building premises and shall be made available to the fire code official upon request.