
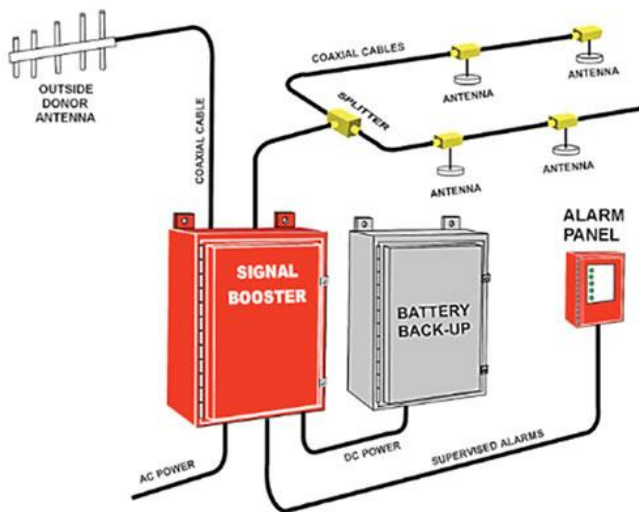


# Fire Systems - Emergency Responder Radio Coverage System

This handout outlines the conditions under which an Emergency Responder Radio Coverage System is required. During emergencies, fire fighters and other emergency response personnel use portable radios to communicate while inside of the building or structure. Buildings and structures interfere with the emergency responder’s ability to effectively communicate due to construction types and materials. These features can absorb or block the radio frequency energy used to carry the signals inside or outside of the building, which poses a significant safety hazard to the emergency response personnel and building occupants.

Apply On-Line at [MyBuildingPermit.com](http://MyBuildingPermit.com)

**Select:** King County | Fire | (Project Type) | (Activity Type) | Other Systems and Equipment

As a safety solution, the International Fire Code (IFC) and National Fire Protection Agency (NFPA) 1221 set forth requirements for certain new and existing buildings to be equipped with an emergency responder radio coverage system.

**Emergency Responder Radio Coverage.** All new buildings shall have approved radio coverage for emergency responders within the building installed in accordance with the IFC and with applicable provisions of NFPA 72, National Fire Alarm Signaling Code. This section shall not require improvement of the existing public safety communication system. Exceptions:

1. Buildings and area of buildings that have minimum radio coverage signal strength levels of the King County Regional 800 MHz Radio System within the building.
2. Buildings constructed primarily of wood frame that do not have storage or parking areas extending more than one level below grade.
3. Buildings thirty-five (35) feet high (As defined by International Building Code) or less that do not have below grade storage or parking areas extending more than one level below grade. Should construction that is thirty-five (35) feet high or less including subterranean storage or parking, then the requirements shall apply only to the subterranean areas.
4. One- and two-family dwellings and townhouses.

# Fire Systems – Emergency Responder Radio Coverage, continued

**Emergency Responder Radio Coverage in Existing Buildings.** Buildings constructed prior to the implementation of this code shall not be required to comply with the emergency responder radio coverage provisions except as follows:

1. Whenever an existing wired communication system cannot be repaired or is being replaced.
2. Buildings undergoing substantial alteration as determined by the Fire Code Official.
3. When buildings, classes of buildings or specific occupancies do not have minimum radio coverage signal strength, and the Fire or Police Chief determines a lack of minimum signal strength poses an undue risk to emergency responders that cannot be reasonably mitigated by other means.

## Obtaining a Fire Systems - Emergency Responder Radio Coverage System Permit

Go to [MyBuildingPermit.com](http://MyBuildingPermit.com) The permit type selections are:

Jurisdiction: *King County*

Application Type: *Fire*

Project Type: *(Choose one)*

Activity Type: *(Choose one)*

Scope of Work: *Other Systems and Equipment*

**Apply On-Line** at [MyBuildingPermit.com](http://MyBuildingPermit.com)

**Select:** King County | Fire | (Project Type) Non-Residential | (Activity Type) | Other Systems and Equipment



If you have questions or would like to inquire about alternatives, please email [DPERWebInquiries@kingcounty.gov](mailto:DPERWebInquiries@kingcounty.gov).

## Submittal Requirements

A Fire, Other System and Equipment application permit submittal package must include:

- 1) Plan set cover sheet and two sets of plans (one digital set when submitting on MyBuildingPermit.com.) Plan sheets should include the following information:
  - a. All plans and calculations shall be prepared by a licensed WA electrical engineer or, at the discretion of the King County Radio shop, also known as Puget Sound Emergency Radio Network (PCERN), by the licensed WA electrical contractor who shall construct the system or by the manufacturer of the proposed system.
  - b. Plans shall be 8.5 inches x 11 inches or greater, scaled or dimensioned, with dimensions or scale clearly noted. North shall be indicated on plan views and elevations named in elevation views.
  - c. Include the site name, address and elevation name or floor number on each plan sheet.
  - d. Include a view of the subject building and surrounding property. The plan view shall clearly indicate the location and orientation of any outdoor antennas associated with the proposed systems.
  - e. Protect the cable against physical damage. Show or state how the cable will be protected

## Fire Systems – Emergency Responder Radio Coverage, continued

- f. against damage if located in vertical risers or low areas in the building. The preferred method is to install them in conduit. Show the location of the wire risers in the building and note where the cable is located to keep it from being damaged.
  - g. Include a minimum of one building elevation depicting the location of any outdoor antennas associated with the proposed system. Include the height of the antenna centerline above the building, and orientation and location of all external grounding connections. The outdoor antenna shall be directional and show which site it is pointed to.
  - h. Clearly indicate on the plans where the control amplifiers are to be located and protected.
  - i. Include a plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coax routes and the locations of any other system components, including splitters, couplers, filter, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating a –95 dBm down link (base to mobile) signal strength around each proposed indoor coverage antenna. Include the results of any previous coverage testing per grid, if available.
  - j. Specify antenna grounding and surge protection in accordance with the 2008 National Electrical Code.
  - k. Specify the backup power source. Include calculations to ensure that the backup power requirements are met.
  - l. Provide plans showing each floor divided into 40 equal squares for testing or a minimum of 20x 20 squares, except for isolated areas.
- 2) Applicants shall also submit a [Fire, King County Frequency Use Agreement form](#). The information required on this form requires the applicant have contact with the King County Radio shop (PCERN).

### Additional Resources

King County [Department of Local Services, Permitting Division](#)

[Permit Fees](#)

[Fire, King County Frequency Use Agreement \(PCERN\)](#)

[On-line Permit Status, Invoice Payment and Inspection Scheduling](#)

[IVR Inspection Scheduling, phone number and codes](#)

Continued

# Fire Systems – Emergency Responder Radio Coverage, continued

## Appendix A - Technical Requirements

**Ambient Signal Level Measurements.** For all proposed systems utilizing broadband amplification schemes, including bidirectional amplifiers (BDAs), ambient signal level measurements for nearby cellular bands must be provided. This will ensure the amplifier will not be overdriven and create harmful interface as defined in 47 CFR, Parts 22 and 90.

The following measurements shall be gathered with a calibrated spectrum analyzer utilizing an omnidirectional antenna with minimal gain.

1. A maximum amplitude plot (“Max Hold”) of signal strength (dBm) vs. frequency (MHz), between 863 Mhz and 880 MHz. Perform measurement for at least 10 minutes during the hours of 7 a.m. to 7 p.m., Monday through Friday.
2. Resolution Bandwidth shall be 10 KHz.
3. Place markers on any carrier measured over –55 dBm to readily identify signal strength and frequency. No more than three markers are required.
4. Plots should be submitted on 8.5-inch x 11-inch paper.

### RF Power Budget Calculations

Provide the following data for the downlink bank (866-869 MHz)

1. Ambient EPSCA downlink signal strength @ donor antenna =	(dBm)
2. Donor antenna gain +	(dB)
3. Donor antenna cable system loss -	(dB)
4. Total donor antenna system gain =	(dB)
5. Downlink signal level at input to amplifier =	(dBm)
6. Amplifier gain +	(dB)
7. Amplifier multi-carrier derating, if any -	(dB)
8. Amplifier output per channel at amplifier output =	(dBm)
9. Amplifier maximum composite output power =	(dBm)
10. Maximum power available per channel (assume 8 channels active) =	(dBm)
11. Indicate amplifier derating if #8 is greater than #10	(dB)

# Fire Systems – Emergency Responder Radio Coverage, continued

Provide the following data for all indoor coverage antennas

Antenna #	Cable Length (ft)	Cable Loss per ft (dB)	Total Cable Loss (dB)	Splitter, Coupler and Combiner Losses (dB)	Antenna Make and Model	Antenna Gain (dB)	System Gain (dB)	Antenna Input Power (dBm)	Effective Radiated Power (dBm)
1									
2									
3									

Provide the following uplink (821-824 MHz) calculation for the antenna with the smallest system gain (i.e., worst case amplification)

Antenna #	Distance to -95 dBm contour (ft)	Coupling Loss (db) Constant	Free Space + Clutter Loss (dB)	Total Uplink Path Loss (db)	Average Portable ERP Constant (dBm)	Rx Power @ Antenna (dBm)	Donor Antenna System Gain (from above)	Uplink Effective Radiated Power, Worst Case (dBm)
		-10			35			

Estimated isolation between donor antenna and indoor antenna system must be 15dB plus the total amplifier gain or greater. All information submitted will be reviewed for conformance with the Bellevue Fire Code, the 2008 National Electrical Code, the FCC Rules and other applicable codes.

**Signal Booster Best Practices** The following list is a summary of some of the Best Practices from the National Public Safety Telecommunications Council (NPSTC) that must be followed in compliance with Ordinance 5675. This is not intended to be a complete list but to provide guidelines and a reference to an authoritative source of information.

- No public safety amplifiers, signal boosters, etc., may be installed without county approval.
- No specific technology is favored or endorsed; however, certain specifications restrict the use of consumer grade signal boosters for public safety applications.
- All amplifiers must be Type Accepted and carry an FCC Compliance label in accordance with 47CFR sections 90.7 and 90.219.

## Fire Systems – Emergency Responder Radio Coverage, continued

- Wiring shall be installed in conduit unless otherwise approved in areas not subject to physical damage.
- All amplifiers must be mounted inside NEMA-rated cabinets.
- 24-hour battery backup must be provided.
- Class “A” signal boosters may be used.
- Class “B” signal boosters may be used, provided uplink filters are incorporated to limit coverage to public safety frequency bands. November 9, 2018 City of Bellevue | Development Services 5
- Isolation testing between donor and service antennas must be measured to ensure a minimum isolation of 15db plus amplifier gain is achieved to avoid oscillation.
- There may be no outdoor service antennas incorporated in the design.
- The system must be designed to minimize “leakage” of signals outside of the building.
- Donor antenna must be directional and aimed at the an approved donor site.
- Prior to startup, signal levels to the donor site must be measured for compliance by a county approved vendor.
- A coverage study must be performed after construction to ensure ordinance compliance.
- No interference to or from other radio service is allowed. Any complaints must be mitigated by the party causing the interference. This especially applies to shared commercial /public safety RF distribution systems.
- Building owners are to be informed that frequency changes may be dictated by FCC rule changes or by acquisition of additional bands or channels.
- Any revisions or changes made to a system must be pre-approved and the system retested for compliance.
- Annual inspection is required to ensure that the signal booster system remains in compliance.

For a more complete description of these and additional best practices, to go to the [National Public Safety Telecommunications Council](#) website.

**Radio Signal Strength.** The building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95% of all areas of the building and 99% in elevators (measured at the primary recall floor), stair shafts and Fire Command Centers meet the signal strength requirements.

**Minimum Signal Strength into Buildings.** A minimum signal strength of -95 dBm shall be receivable within the building

**Minimum Signal Strength out of the Building.** A minimum signal strength of -95 dBm shall be received by the agency’s radio system when transmitted from within the building.



## Fire Systems – Emergency Responder Radio Coverage, continued

**System Design and Installation.** The emergency responder radio coverage system shall be designed and installed in accordance with the applicable sections of the IFC and NFPA 72.

**Amplification Systems Allowed.** Buildings and structures which cannot support the required level of radio coverage shall be equipped:

1. A radiating cable system and/or
2. An internal multiple antenna system with FCC certificated bi-directional 800 MHz amplifiers, or
3. Systems otherwise approved by the County radio system manager in order to achieve the required adequate radio coverage.

**Frequency Range** The frequency range which must be supported shall be 806 MHz to 824 MHz and 851 MHz to 869 MHz and such other frequencies as determined by the Regional Radio System operator in all areas of the building.

**Power Supply.** Power supplies shall conform to NFPA 72, (Power Supplies). If any part of the installed system or systems contains an electrically powered component, the installed system or systems shall be provided with an independent battery system or an emergency generator capable of operating for a period of at least twenty four (24) hours without external power input. The battery system shall automatically charge in the presence of external power input.

**Signal Booster Requirements.** If used, signal boosters shall meet the following requirements:

1. All signal booster components shall be contained in a NEMA4-type waterproof cabinet.
2. The battery system shall be contained in a NEMA4-type waterproof cabinet.
3. The system shall include automatic alarming of malfunctions of the signal booster and battery system. Any resulting trouble alarm shall be automatically transmitted to an approved central station or proprietary supervising station as defined in NFPA 72 or, when approved by the fire code official, shall sound an audible signal at a constantly attended location.
4. Equipment shall have FCC certification prior to installation.
5. Signal boosters must be equipped with filters that reject adjacent frequencies in addition to the multi-band pass filters.

**Additional Frequencies and Change of Frequencies.** The building owner shall modify or expand the frequency range at his or her expense in the event frequency changes are required by the FCC or additional frequencies are made available by the FCC. Prior approval of a public safety radio coverage system on previous frequencies does not exempt this requirement.

**Approval Prior to Installation** No amplification system capable of operating on frequencies used by the Regional 800 MHz Radio System shall be installed without prior coordination and approval of the radio system licensee King County Radio shop – 206-263-8111) or (The Eastside Public Safety Communications Agency – [www.epsca.com](http://www.epsca.com) – (425) 556-2515) and any such system must comply with any standards adopted by the King County Regional Communications Board.

## Fire Systems – Emergency Responder Radio Coverage, continued

**Minimum Qualifications of Personnel** The system designer, lead installation personnel and personnel conducting radio system tests shall be qualified to perform the work. Design documents and all tests shall be documented and signed by a person in possession of a current FCC General Radio Telephone Operator License and a certificate or certification issued by the:

1. Associated Public Safety Communications Officials International (APCO), or
2. National Association of Business and Education Radio (NABER) or
3. Personal Communications Industry Association (PCIA), or
4. Manufacturer of the equipment being installed.

**Acceptance Testing Procedure** Acceptance testing for Emergency responder radio amplification system is required upon completion of installation. It is the building owner's responsibility to have the radio system tested by qualified personnel to ensure a minimum of 95% two-way coverage on each floor of the building.

A report shall be submitted to the Bellevue Fire Department at the conclusion of acceptance testing containing a floor plan and the signal strengths at each location tested and other relevant information. A Deputy Fire Marshal with the Department of Local Services, Permitting Division may oversee the acceptance test. Acceptance testing is also required whenever changes occur to the building that would materially change the original field performance test. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of approximately forty (40) equal areas.
2. Testing shall use a two (2) watt, portable transceiver with speaker/microphone and flexible antenna (or any calibrated device which will produce signal levels useable by the prescribed portable radio). Field strength testing instruments must have been calibrated within one (1) year of the date of the acceptance test. Field strength testing instruments must be of the frequency selective type incorporating a flexible antenna similar to the ones used on the handheld transceivers. City Radio System Manager may designate alternate methods of measuring the signal level, which satisfy appropriate levels of public safety coverage.
3. A maximum of two (2) nonadjacent areas will be allowed to fail the test.
4. In the event that three (3) of the areas fail the test, the floor may be divided into eighty (80) equal areas in order to be more statistically accurate. In such event, a maximum of four (4) nonadjacent areas will be allowed to fail the test. After the eighty (80) area tests, if the system continues to fail, the building owner shall have the system altered to meet the 95% coverage requirement.
5. A spot located approximately in the center of a grid area will be selected for the test, then the radio will be keyed to verify two-way communication to and from the outside of the building through the Regional 800 MHz Radio System. Once the spot has been selected, prospecting for a better spot within the grid area is not permitted. The gain values of all amplifiers shall be measured, and the results kept on file with the building owner so that the measurements can be verified each year during the annual tests. In the event that the measurement results become lost, the building owner will be required to rerun the acceptance test to reestablish the gain values.



## Fire Systems – Emergency Responder Radio Coverage, continued

6. The gain values of all amplifiers shall be measured, and the test measurement results shall be kept on file with the building owner so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building owner shall be required to rerun the acceptance test to reestablish the gain values.
7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at time of installation and subsequent annual inspections.

**FCC Compliance** The emergency responder radio coverage system installation and components shall also comply with all applicable federal regulations including, but not limited to, FCC 47 DFR Part 90.219.

**Maintenance** The emergency responder radio coverage system shall be maintained operational at all times.

**Testing and Proof of Compliance** The emergency responder radio coverage system shall be inspected and tested annually, or whenever structural changes occur to the building that would materially change the original field performance tests by a consultant approved by the Fire Code Official. The performance test shall include at minimum a floor plan and the signal strength in various locations of the building. Testing shall consist of the following:

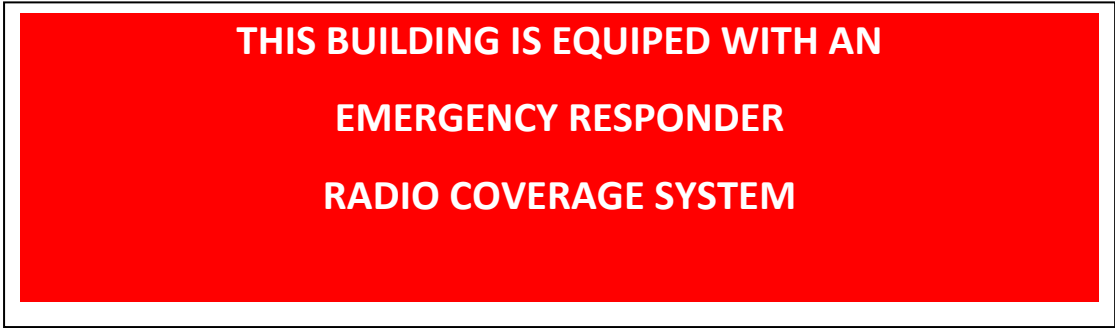
1. In-building coverage test as described in the Acceptance Test Procedure.
2. Signal boosters shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance.
3. Backup batteries and power supplies shall be tested under load of a period of one hour to verify that they will properly operate during an actual power outage. If within the 1-hour test period the battery exhibits symptoms of failure, the test shall be extended for additional 1-hour periods until the integrity of the battery can be determined.
4. All other active components shall be checked to verify operation within the manufacturer's specifications.
5. At the conclusion of the testing, a report, which shall verify compliance, shall be submitted to the fire code official not later than January 30th of each year.

**Identification** Buildings equipped with an Emergency Responder Radio Coverage system shall be identified by a sign located on or near the Fire Alarm Control Panel stating: "This building is equipped with an Emergency Responder Radio Coverage System." As a general rule, fire protection and related equipment are identified by a red sign with minimum one-inch white letters as shown below.

Continued

# Fire Systems – Emergency Responder Radio Coverage, continued

Example:



**Field Testing** Police and Fire Personnel shall at any time have the right to enter onto the property to conduct its own field-testing to be certain that the required level of radio coverage is present.