AFC

APCO's Spectrum Management Division

Signal Boosters: Solving for Poor In-building Public Safety Wireless Coverage While Protecting Outdoor PS Networks

Sponsored by

Anritsu

Advancing beyond

Presenter:

John Foley

Managing Director

Safer Buildings Coalition

www.saferbuildings.org

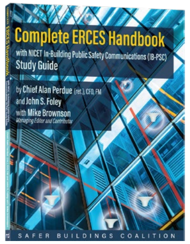
SAFER BUILDINGS COALITION™

Feel Safe Inside®

Managing Director, Safer Buildings Coalition (SBC)

- Coalition day to day operations management
- Develops and deploys SBC's mission-driven thought leadership, public policy, and lobbying efforts
- Extensive experience in analyzing and developing positions for telecommunications regulatory and legislative issues involving federal and state agencies and legislative bodies.

John is co-author of The Complete ERCES Handbook, the definitive resource for learning and reference material pertaining to Emergency Responder Communications Enhancement Systems (ERCES).



John currently serves on the following industry committees:

- TIA TSB-88 sub-group for TR-8.18 Wireless Systems Compatibility – Interference and Coverage
- TIA Smart Buildings Working Group and Public Safety Subgroup
- CTIA Smart Cities Steering Committee
- Informa's International Wireless Communications Expo (IWCE) Advisory Board
- Center for Campus Fire Safety (CCFS) Advisory Board
- NATE DAS and Small Cell Working Group
- John is also a certified ERCES instructor for the Florida State Fire College.

Career: 49th year in Telecommunications

- 7th year leading the Safer Buildings Coalition as Managing Director
- Bell of PA, Level 3 Communications, MFS, and MCI, co-founder of XO Communications.
- Led dark fiber provider City Signal Communications in the position of President and CEO.
- Served for five years in the role of Capture Director and engineering team lead for a leading DAS Integrator.

Presenter:
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Safer Buildings Coalition

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Who Am I?

APCO International
Leaders in Public Safety Communications®

SAFER BUILDINGS COALITION™
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Themes we will explore today:

- In-Building Wireless Coverage is essential to protect First Responders and the Communities they protect
- The Wireless "Dead Zone" Problem
- Fire and Building Codes Mandate Code-Compliant Coverage
- Technology Solutions: Emergency Responder Communication Enhancement Systems (ERCES) How they work, essential components
- FCC Rules / Frequency License Holder = Top of the ERCES Command Chain
- Noise & Interference: A Serious Problem
- Testing Best Practices
- Competency and Certification
- Where to get help?
- The path forward: What do we do next?
- Q&A

Safer Building Coalition is the only advocacy group and resource for everything related to solving for In-Building Wireless "Dead Zones".

Our Scope includes all In-Building Technologies:

Commercial Cellular (LTE / 5G) • LMR (Land Mobile Radio) • Emergency Responder Communications Enhancement Systems (ERCES) • Private LTE • Future Technologies.

SCAN ME

saferbuildings.org

Membership is always free for Gov't / Public Safety Staff

The **Safer Buildings Coalition** is an independent, 501(c)4 not for profit organization.

Not Just Fire Department, Not just radios…

“Instead of looking at things from the sense that we’re going to transport a patient to the hospital…now we have another tool with telehealth to arrive on scene and do a telehealth visit with a physician and navigate that patient appropriately,” *Source: Federal Interagency Committee on Emergency Medical Services (FICEMS) report: “Telemedicine Framework for EMS and 911 Organizations.”*

"Upon entering the building, the officers tried but were unable to communicate on their radios.“
Source: Interim report of the Investigative Committee on the Robb Elementary Shooting of the Texas House of Representatives

Radio signals failed firefighters scaling Charlotte high-rise

First responders couldn't communicate while rescuing people stranded in elevators

NIOSH LODD Reports

The National Institute for Occupational Safety and Health top 5 casual factors of firefighter deaths and injuries on the fireground:

1. Improper Risk Assessment
2. Lack of Incident Command
3. Lack of Accountability
4. Inadequate Communications
5. Lack of SOPs or failure to follow established SOPs

Key Recommendations Included:

- ***Provide all fire fighters with radios and train them on their proper use***

Define the Problem

- There are approximately 6+ million commercial buildings in the U.S
- People need to be able call 911 from inside those buildings
- First Responders need to be able communicate with each other inside and outside buildings
- **SBC survey shows that in a large percentage of buildings critical communication can't happen**

Materials	Attenuation @ 860 MHz
Free Space (Air) 10 feet	40.8 dB
Free Space (Air) 100 feet	60.8 dB
Free Space (Air) 1 mile	95.3 dB
Glass 0.25" (6 mm)	0.8 dB
Glass 0.5" (12 mm)	2.0 dB
Low-E / Green Glass (Double Pane)	23-38 dB
Lumber 3" (76 mm)	2.8 dB
Brick 3.5" (89 mm)	3.5 dB
Brick 7" (178 mm)	5.0 dB
Brick 10.5" (267 mm)	7.0 dB
Masonry Block 8" (203 mm)	12.0 dB
Masonry Block 16" (406 mm)	7.0 dB
Masonry Block 24" (610 mm)	28.0 dB
Concrete 4" (102 mm)	12.0 dB
Brick Faced Concrete 7.5" (192 mm)	14.0 dB
Concrete 8" (203 mm)	23.0 dB
Reinforced Concrete 3.5" (203 mm)	27.0 dB
Concrete 12" (305 mm)	35.0 dB

Construction materials that make up the obstructions are the largest attenuators.

-3.0 dB = ½ Power
-6.0 dB = ¼ Power
-10.0 dB = 1/10 Power

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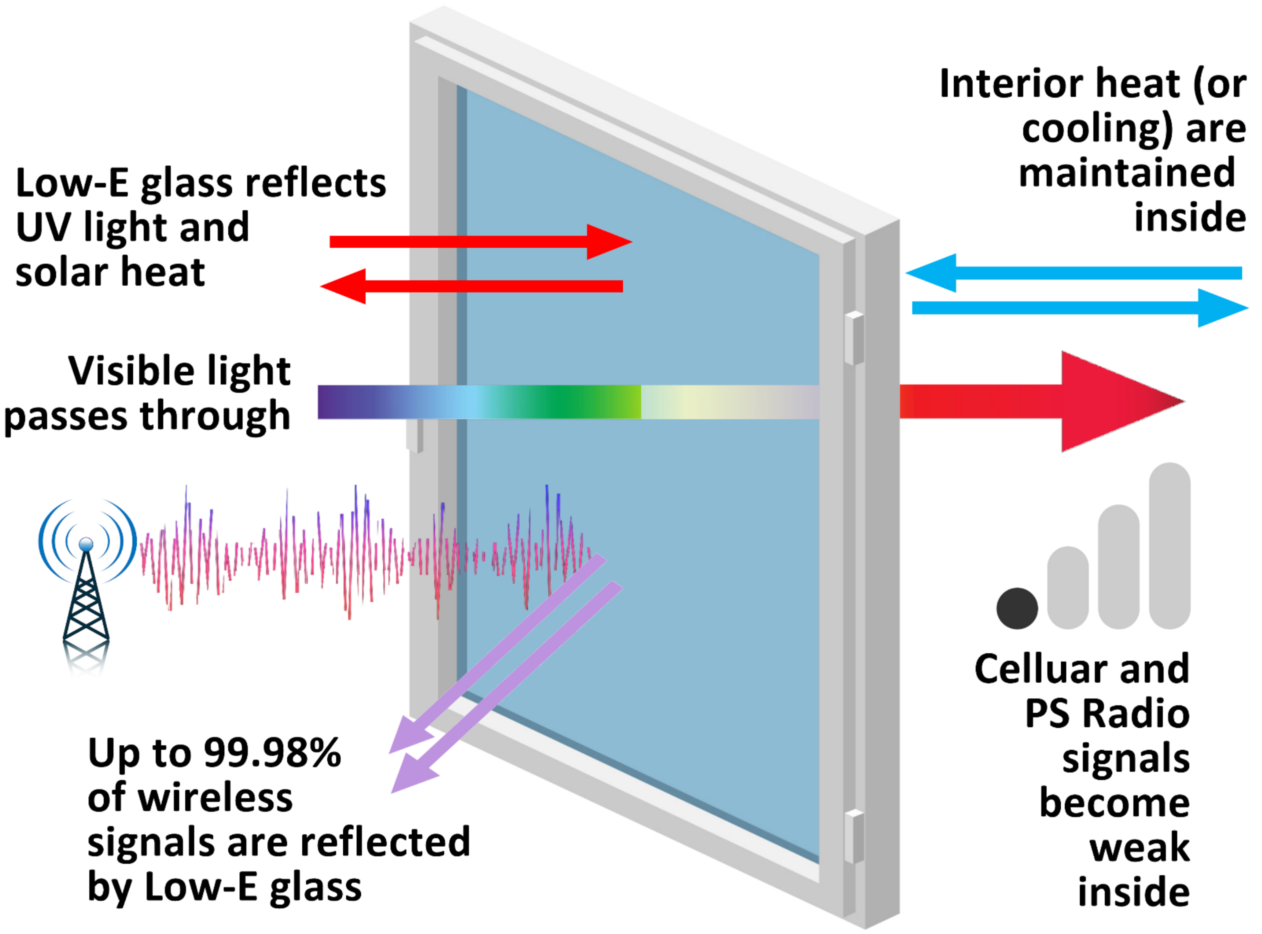
The Effect of Energy Efficient Glass on Wireless Signals



6 mm Glass Pane =
-0.8 dB @ 900 MHz = -17%

Double Glazing w/ 2 coated Glass Pane =
-23 dB @ 900 MHz = -99.5%

Double Glazing Low-E
= -30.6 dB @ 900 MHz = -99.9%


okta


LEED
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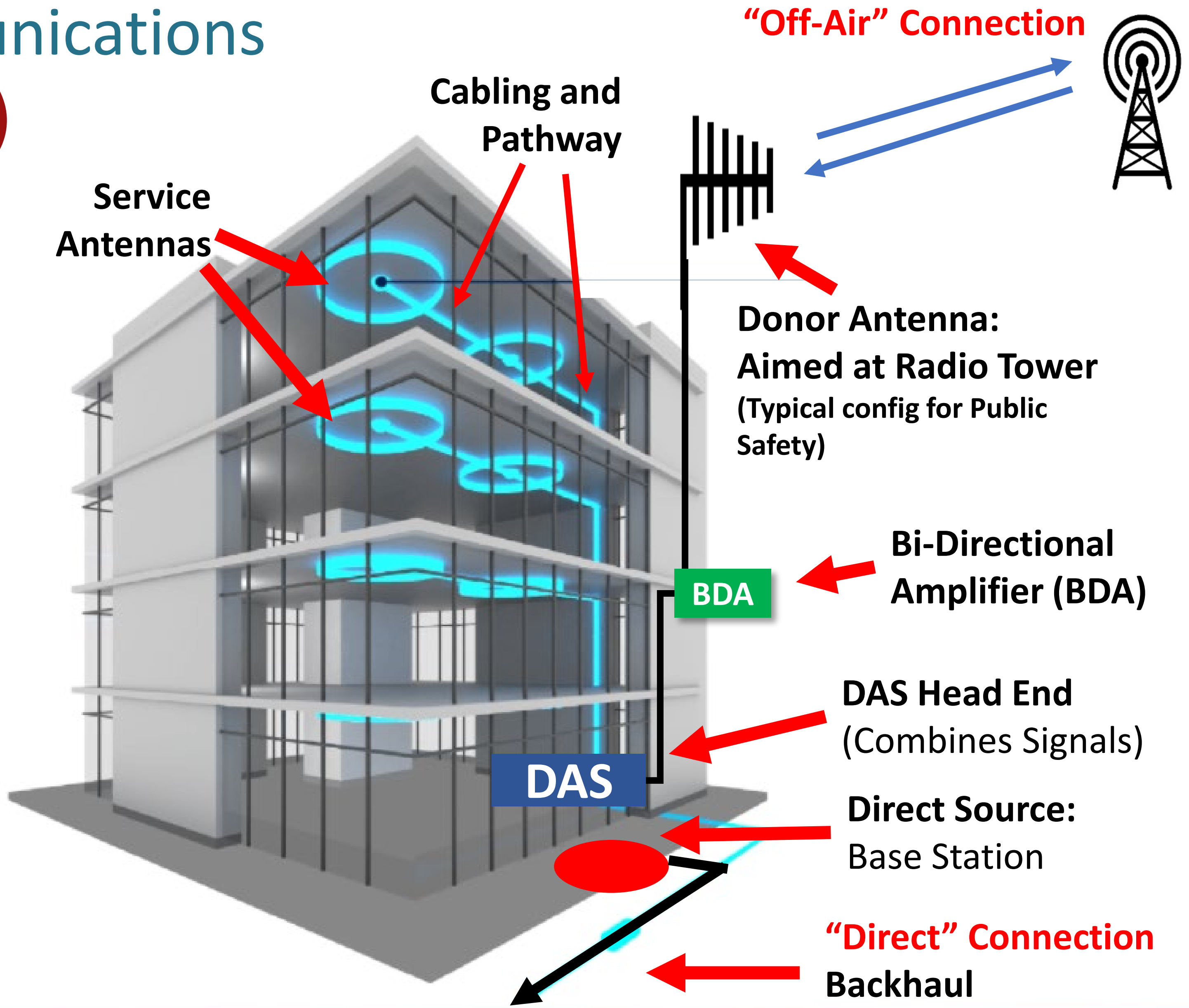
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN
SALESFORCE TOWER
San Francisco, California
HAS FULFILLED THE REQUIREMENTS OF THE LEED GREEN BUILDING RATING SYSTEM CERTIFICATION ESTABLISHED BY THE U.S. GREEN BUILDING COUNCIL AND VERIFIED BY GREEN BUSINESS CERTIFICATION INC.
LEED 2009
CORE AND SHELL DEVELOPMENT
PLATINUM
August 2018
MAHESH RAMANUJAM, PRESIDENT & CEO, U.S. GREEN BUILDING COUNCIL,
PRESIDENT & CEO, GREEN BUSINESS CERTIFICATION INC.

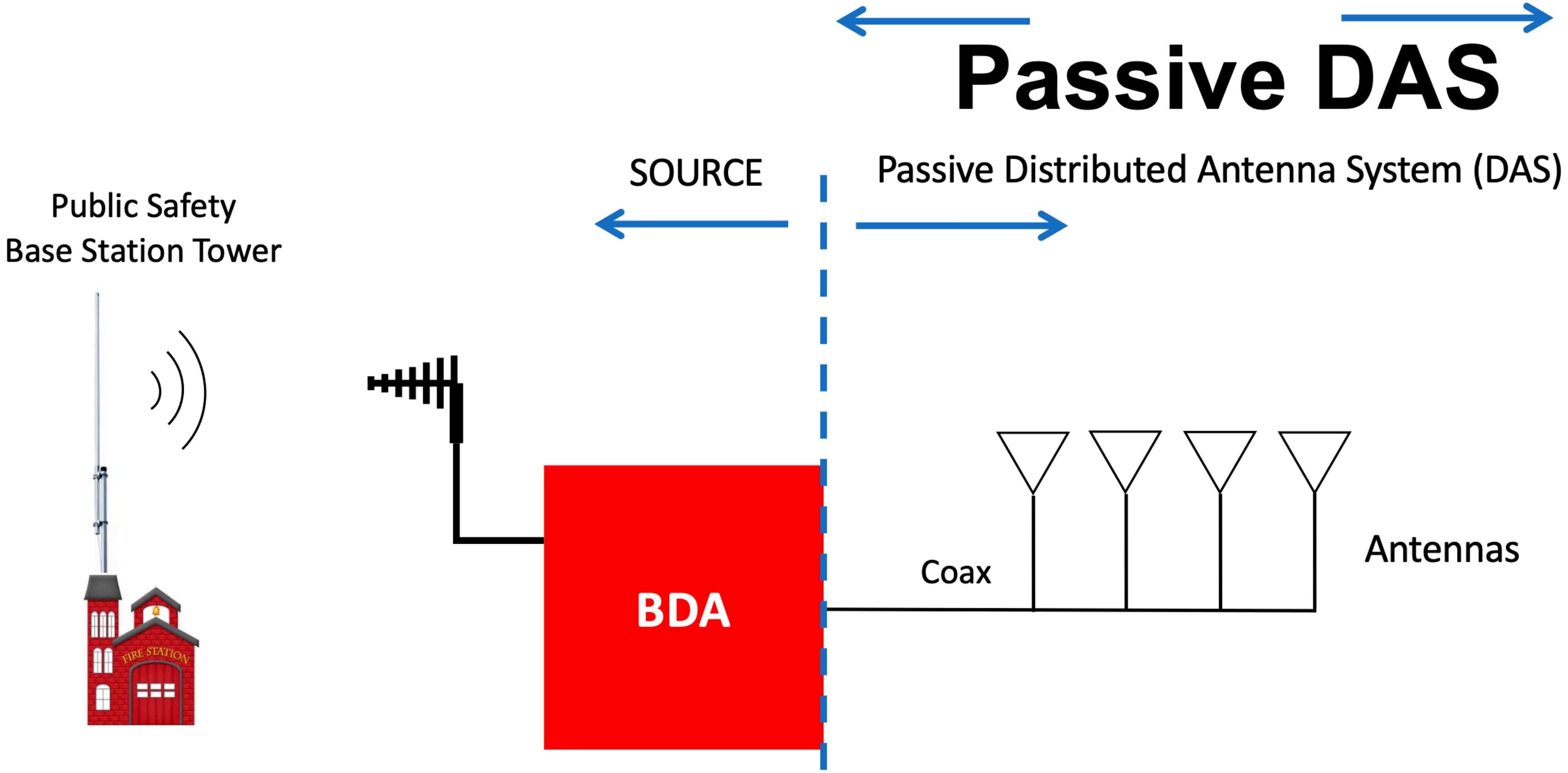
Emergency Responder Communications Enhancement Systems **(ERCES)**

There are a variety of solutions, but the *most reliable* solutions are:

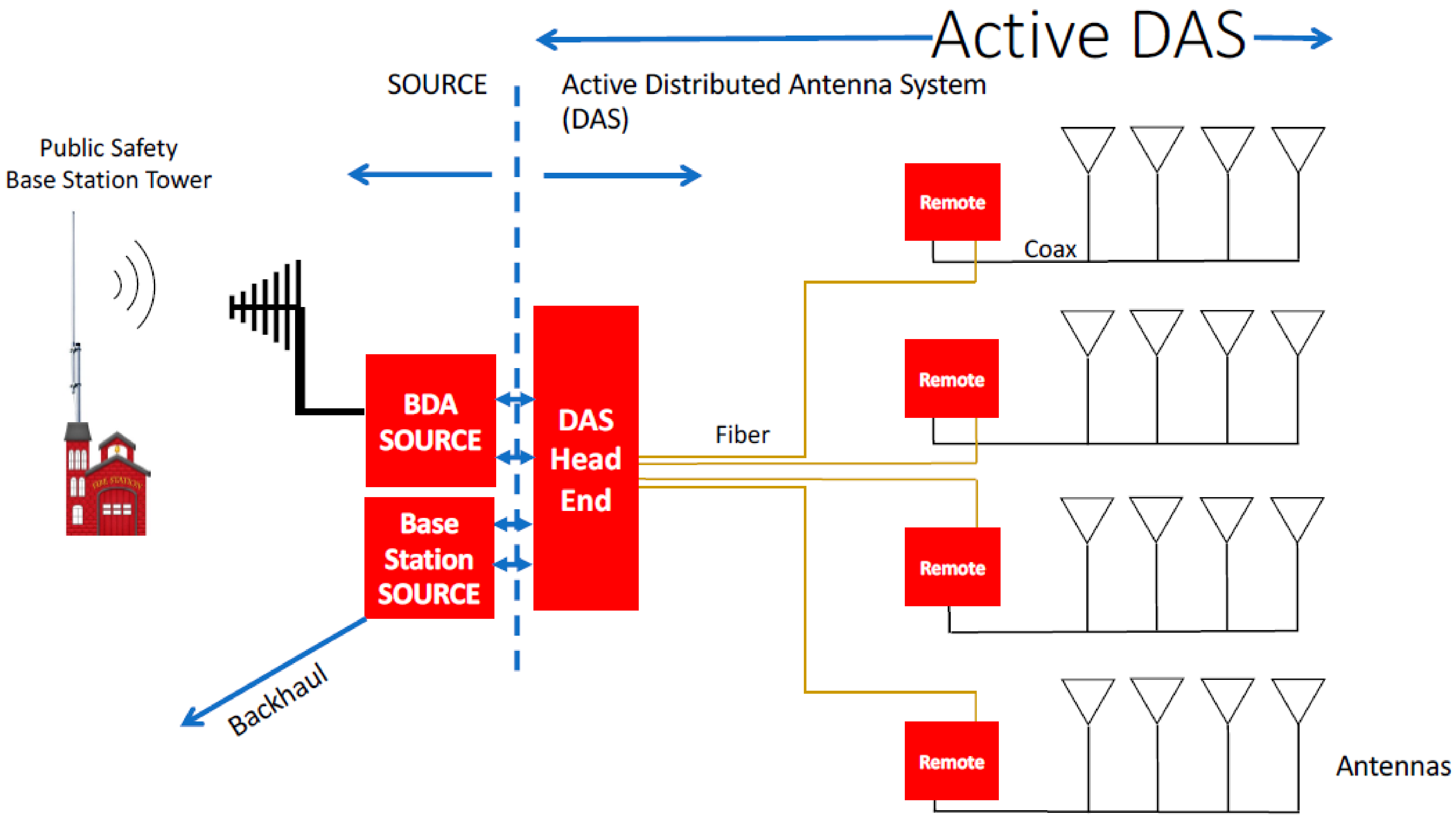
- Dedicated / Fixed rather than portable
- Resilient and Dependable
- Tailored to the building or structure
- Professionally engineered and installed by competent professionals in coordination with the AHJ and the Radio System Admin
- Properly Tested
- Fully Documented
- Monitored and Maintained



Basic Passive DAS Configuration



Basic Active DAS Configuration



Class B vs Class A Signal Boosters

Class A signal booster. A signal booster designed to retransmit signals on one or more specific channels. A signal booster is deemed to be a Class A signal booster if none of its passbands exceed 75 kHz.

Class B signal booster. A signal booster designed to retransmit any signals within a wide frequency band. A signal booster is deemed to be a Class B signal booster if it has a passband that exceeds 75 kHz.

(5) Class B signal booster installations must be registered in the FCC signal booster database that can be accessed at the following URL: www.fcc.gov/signal-boosters/registration

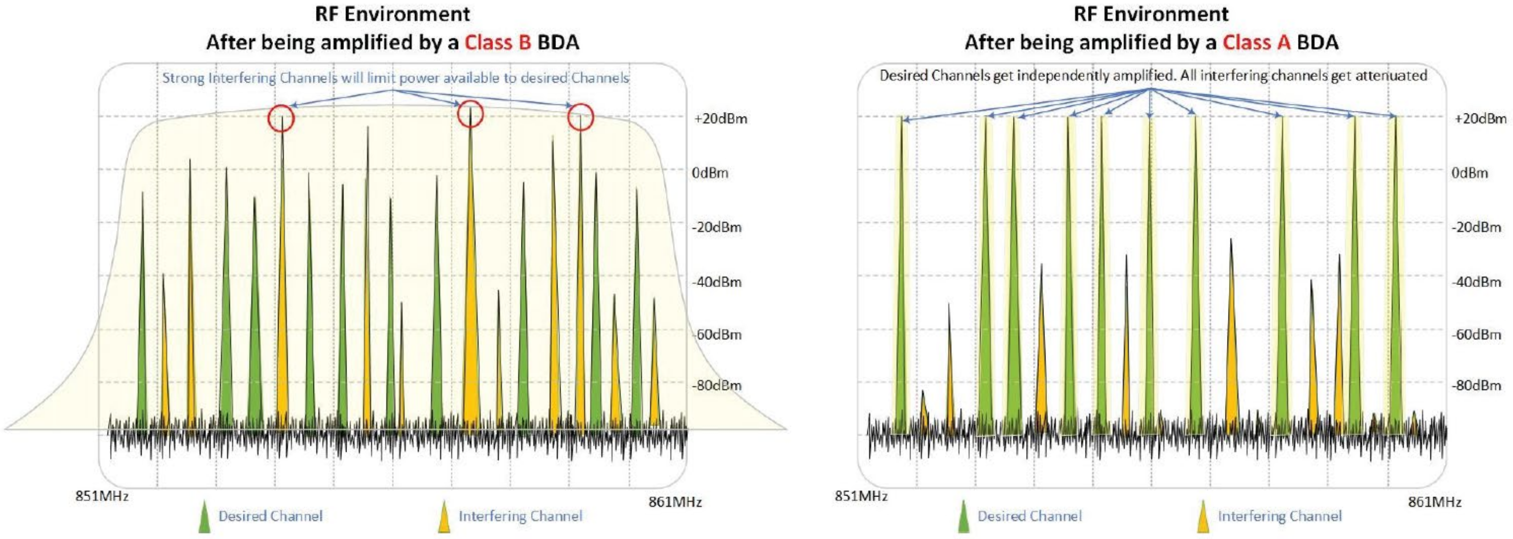
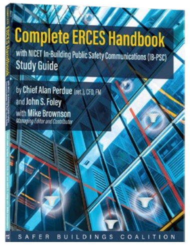


Figure 11.3.3 **Class B vs. Class A Amplifier Passband**



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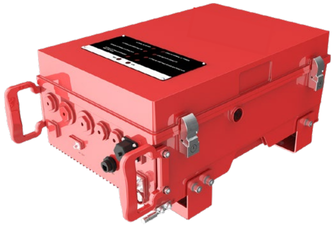
Common ERCES / DAS Components

Donor Antenna

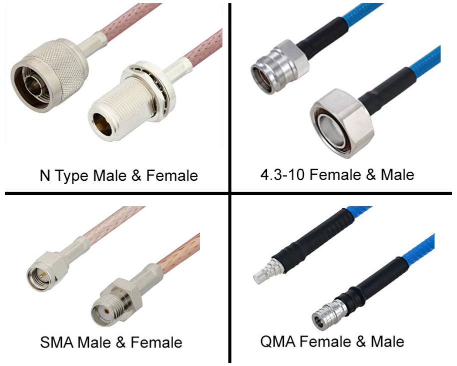
Distribution Antenna

Bi- Directional Amplifier (BDA) – Signal Source

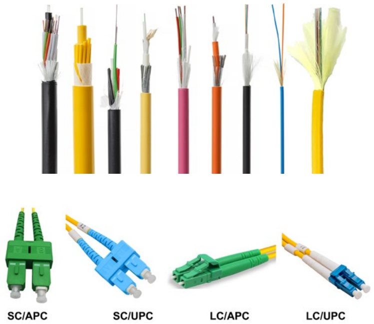


Fiber DAS Head End/ Master (Active DAS)

Optical Remote Units (Active DAS)



Coax Cable and Connectors



Fiber Optic Cable and Connectors (Active DAS)

Splitters and Couplers

Battery Backup Unit (BBU) and Alarm Annunciator

Backbone and Distribution

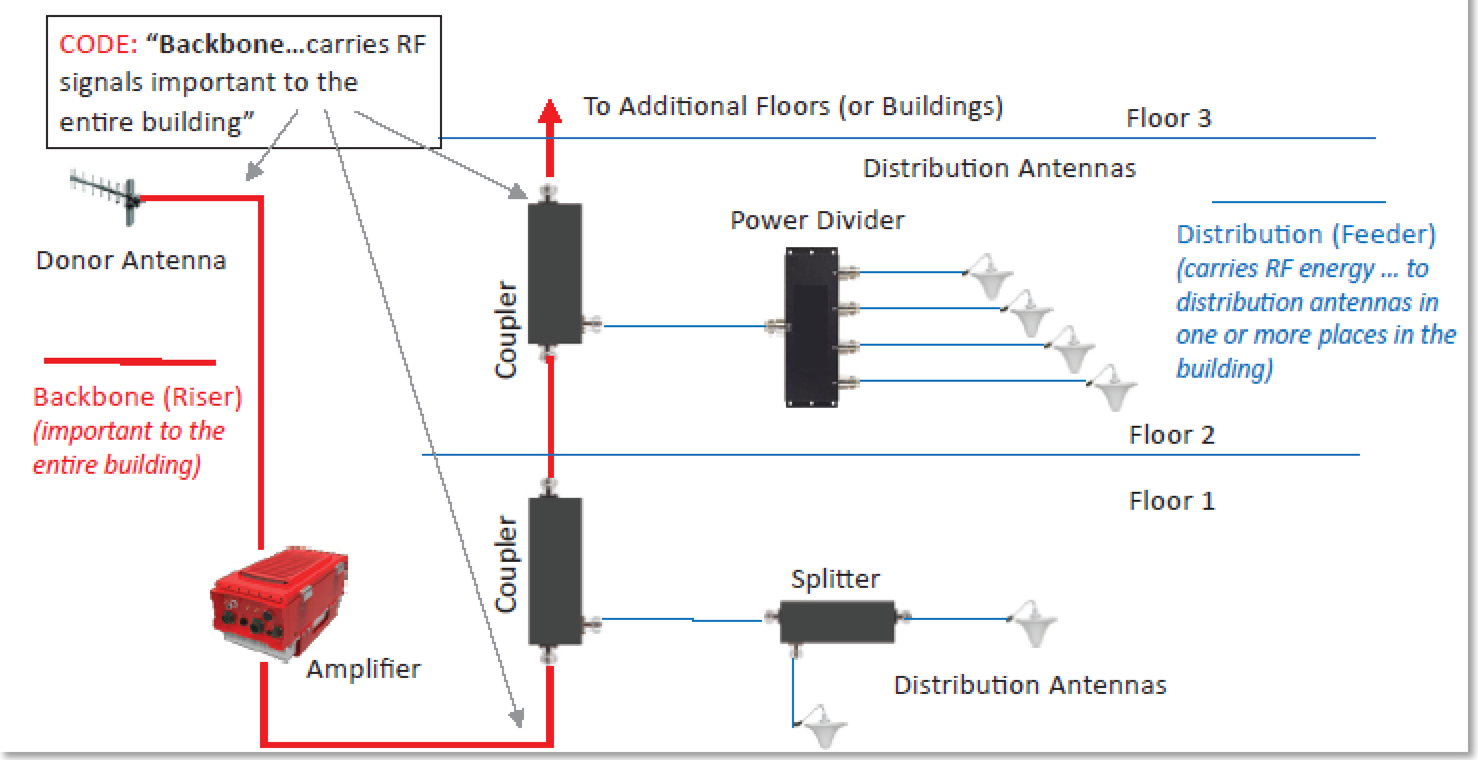
NFPA 1221 **2019 Edition**

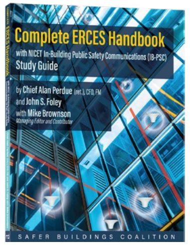
3.3.10* **Backbone.** A communications cable in an in-building radio enhancement system that carries wideband signals important to the entire building, from the donor antenna, through the amplifiers, and to distribution antenna lines.

3.3.49* **Distribution Antenna Cable**.
A communications cable that carries RF energy in both directions along its length to distribution antennas in one or more places in a building.

9.6.2.2 The backbone cables shall be connected to the antenna distribution, radiating, or copper cables **using** hybrid* **coupler devices** of a value determined by the overall design.

5.8.8.3 Backbone and Distribution Illustrations





*"hybrid" is removed in newer versions

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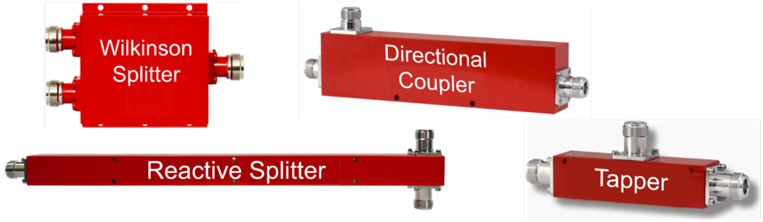
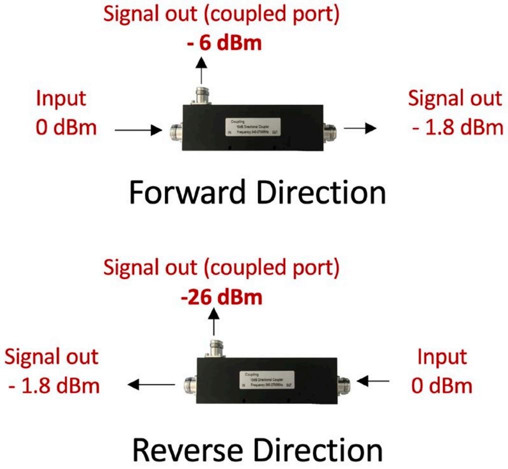
Does ERCES / DAS Need Splitters, Couplers, Filters and Combiners? ABSOLUTELY!

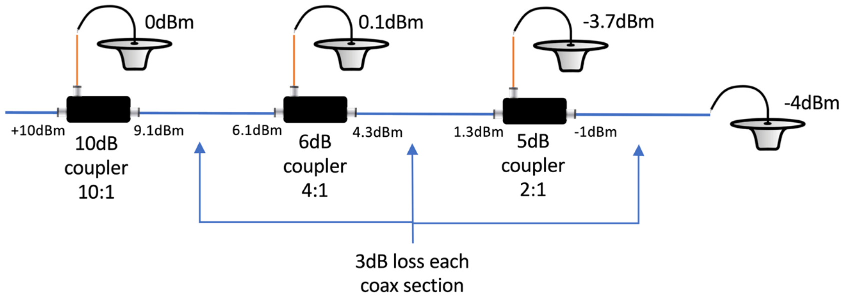
Splitters (couplers, dividers) divide power, either equally or unequally. These are needed to correctly balance the power across the distribution antennas

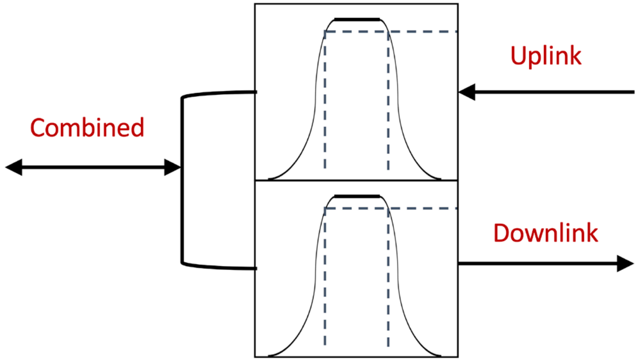




Directional Coupler

Filters (couplers, dividers) divide power, either equally or unequally. These are needed to correctly balance the power across the distribution antennas





Duplexer (Filter)

Splitters, Couplers, Tappers, Dividers

12.2.1 Equal Power Dividers

Power dividers evenly split power between 2, 3 or 4 output ports. They are available in two different flavors, Wilkinson style or reactive style. The two styles use different methods to maintain a constant 50 ohm impedance on all connectors but are otherwise interchangeable.

The Wilkinson splitter form-factor is more square-shaped while reactive splitters are long and thin. The physical differences make Wilkinson splitters easier to fit into metal junction boxes. Wilkinson splitters tend to have slightly higher insertion loss than reactive designs, however Wilkinson splitters may also be used as low power combiners whereas reactive splitters should never be used to combine multiple power sources.

With a 2-way power divider half the power is delivered to each output port in addition to a small amount of passive loss within the splitter. For example, a 2-way Wilkinson splitter will exhibit about 3.5 dB of loss between the input and each output port. The loss is the same in the reverse direction. A 4-way splitter will show about 6.5 dB of through loss.

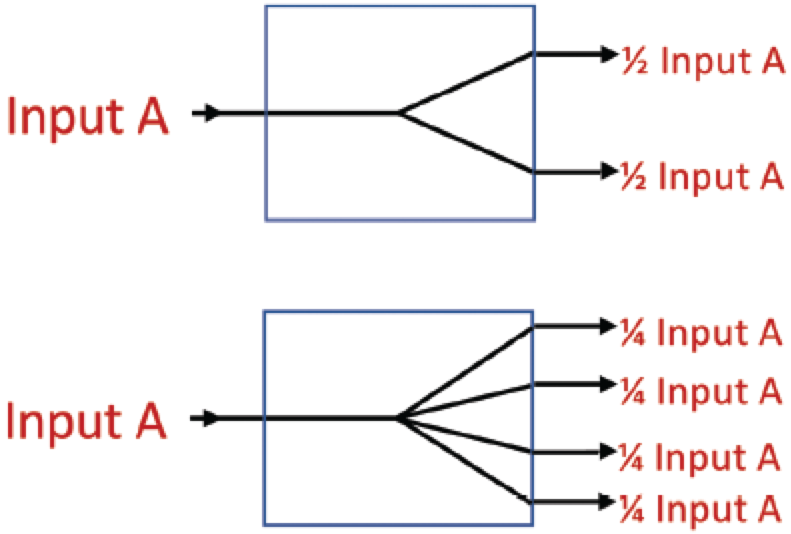
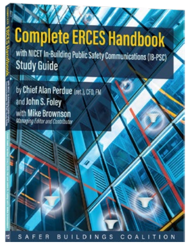


Figure 12.2.1 **2-Way Splitter and 4-Way Splitter**



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Splitters, Couplers, Tappers, Dividers

12.2.2 Directional Couplers

The directional coupler is one of the forms for an unequal splitter. Most of the power passes through the device with a smaller fraction sent to the coupled port. They are typically available in values from 5 dB to 30 dB, meaning the coupled port power is reduced by this value.

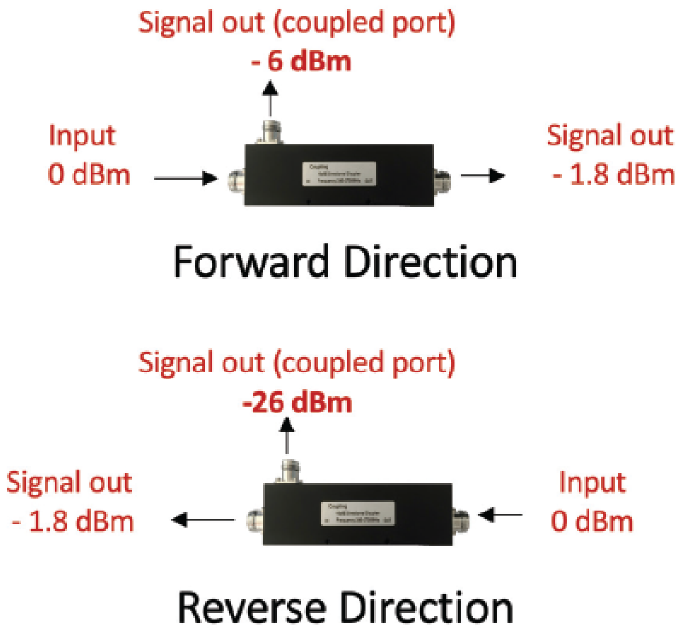
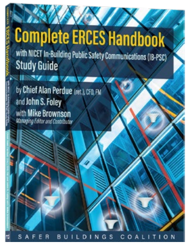


Figure 12.2.2 **Example of Forward and Reverse Coupled Power in a 6 dB Coupler**



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Directional Couplers used to Balance Power to Distribution Antennas

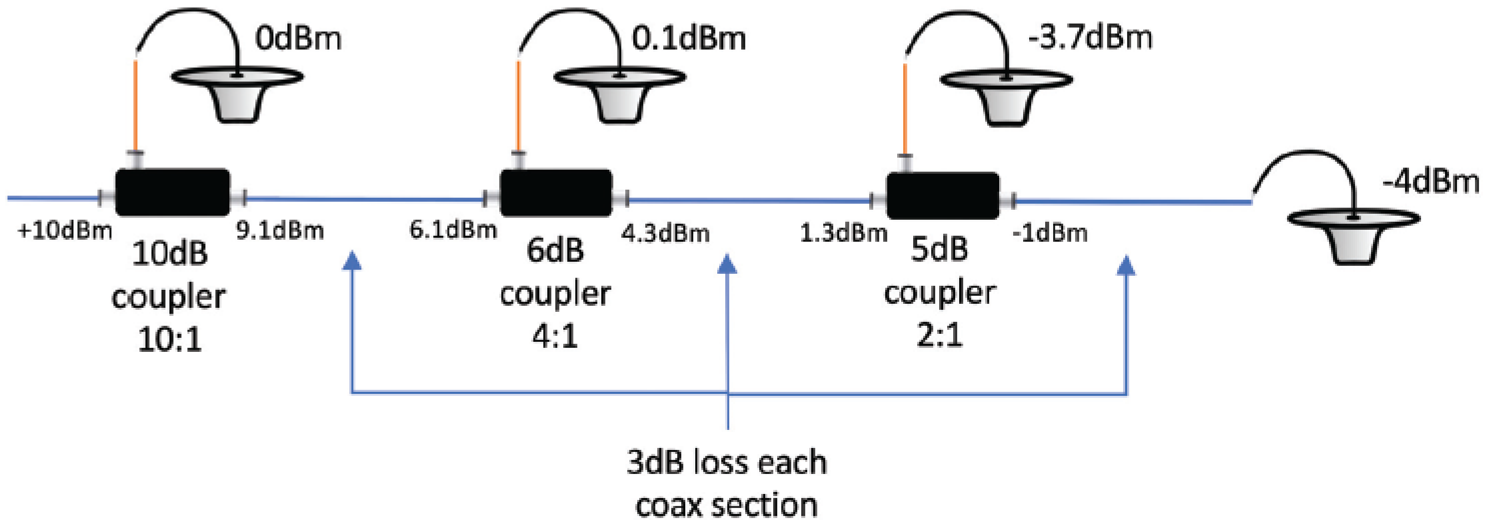
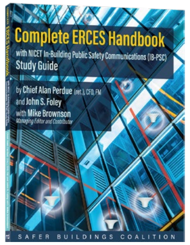


Figure 12.2.2b **Directional Couplers Used in Branch Line**

Directional couplers are only one choice for unequal splitters, the other being tappers. Directional couplers maintain a better VSWR/Return Loss (VSWR and Return Loss are two different methods to determine the transmission efficiency of a passive device) on all ports than a tapper will. They are also more effective at isolating damaged coax branches from the rest of the network. The higher the value of the coupled port, the lower the through insertion loss on the main line.



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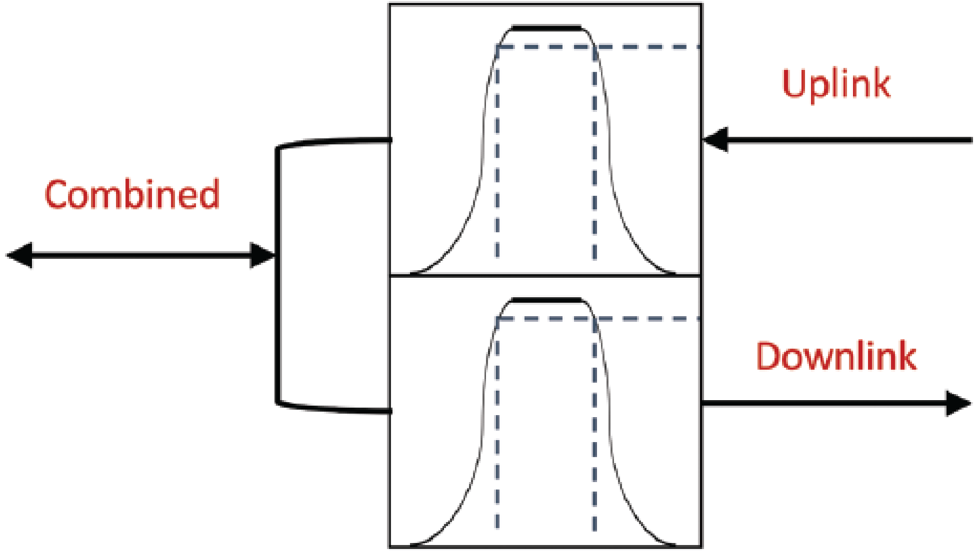
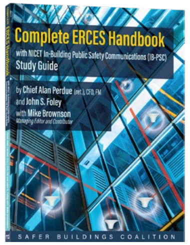
Filters

12.3.1 Duplexers

A Duplexer is a filter device used to separate two frequency groups within a single frequency band. For example, to separate the uplink band from the downlink frequency band. Almost all BDAs include a duplexer internally to separate the uplink from the downlink bands. Sometimes an external duplexer is needed when feeding a multi-carrier fiber DAS since active DAS may utilize simplex inputs or when the UL and DL bands are too close together and a large filter assembly is needed that won't fit inside the BDA's enclosure.





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Filters

12.3.2 Bandpass and Band Reject Filter

Bandpass filters (shown in Figure 12.3.2) pass a specific band of frequencies and rejects all others. A band reject filter passes the desired band while rejecting or filtering out a specific unwanted band or frequency. As mentioned in ERCES ACTIVE COMPONENTS chapter, all BDAs have a bandpass filter that is used to filter out unwanted RF signals that fall outside its intended passband. Class A channelized BDAs have a large number of very narrow passband filters that can be programmed through their computer interface.

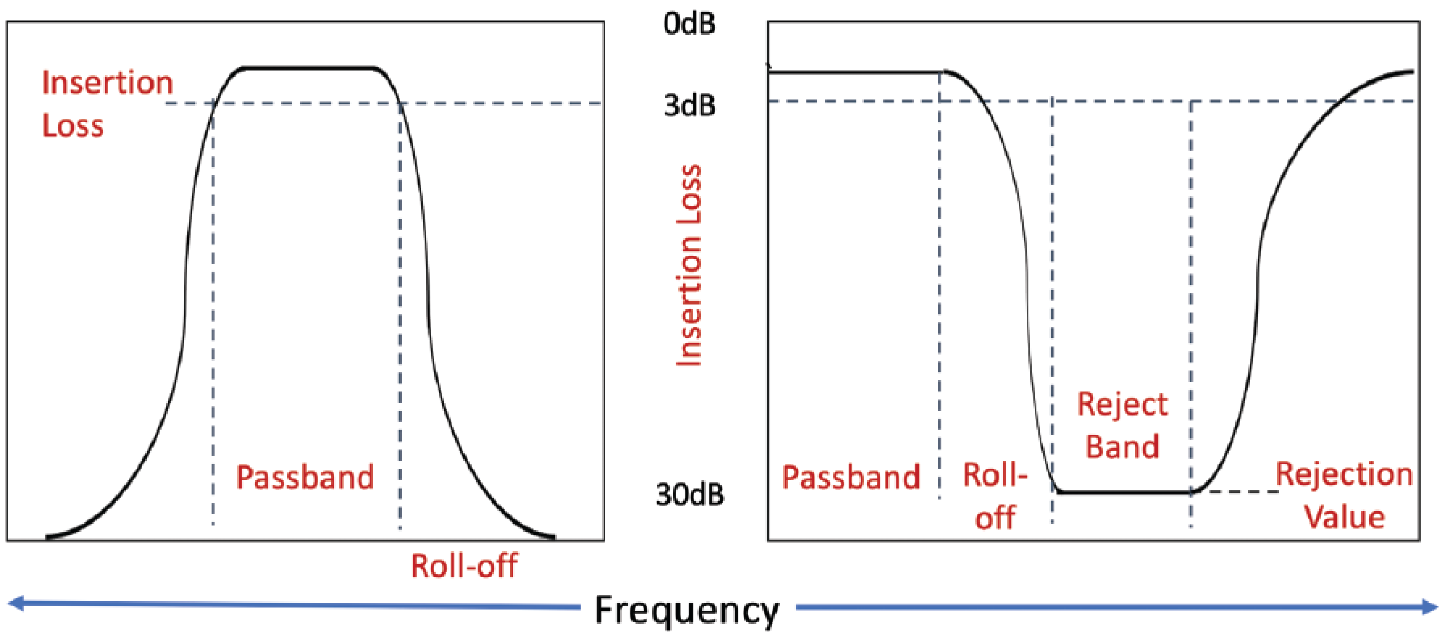
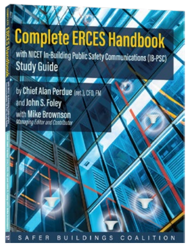


Figure 12.3.2 **Passband and Band-Reject/Notch Filter Profiles**



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Crossband Coupler/ Diplexer

12.4.2 Crossband Coupler/Diplexer

Crossband Couplers are essentially filter devices. They consist of 2 or more bandpass filters, or one high-pass and one-low pass, each tuned to a specific frequency band. They only work to combine, or to separate, RF signals on 2 different frequency bands. They offer clear advantages over a hybrid by providing both lower insertion loss, typically about 1 dB, and greater *port to port isolation*, typically 60 dB or more. However, they are also larger and more costly. The designer must weigh performance against cost and determine what is good enough for the project. Specifications may vary from the above example depending on the manufacturer, so be sure to check the data sheets.

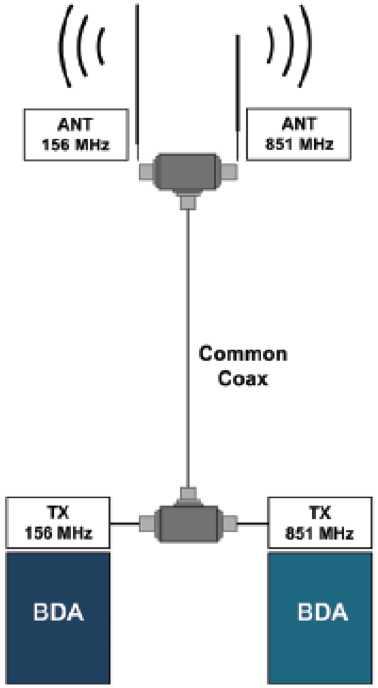
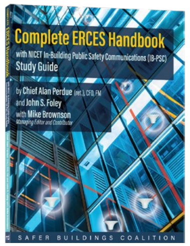


Figure 12.4.2 **Diplexer (Crossband Coupler) Operation**



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Typical Venues for Active DAS

- High capacity requirements
- Large areas

Hospitals - 6200

Casinos - 524

Malls - 1100

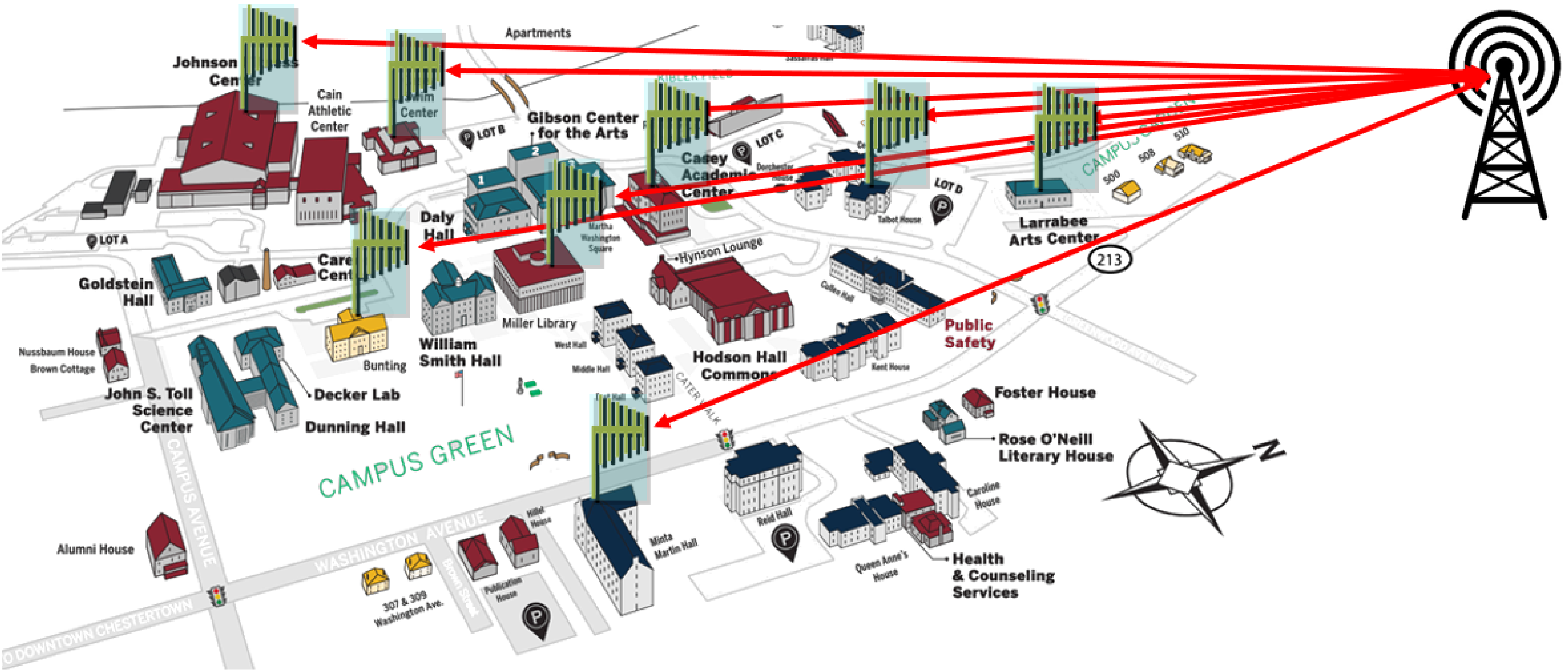
Convention Centers - 255

Large Buildings

Stadiums and Arenas - 140

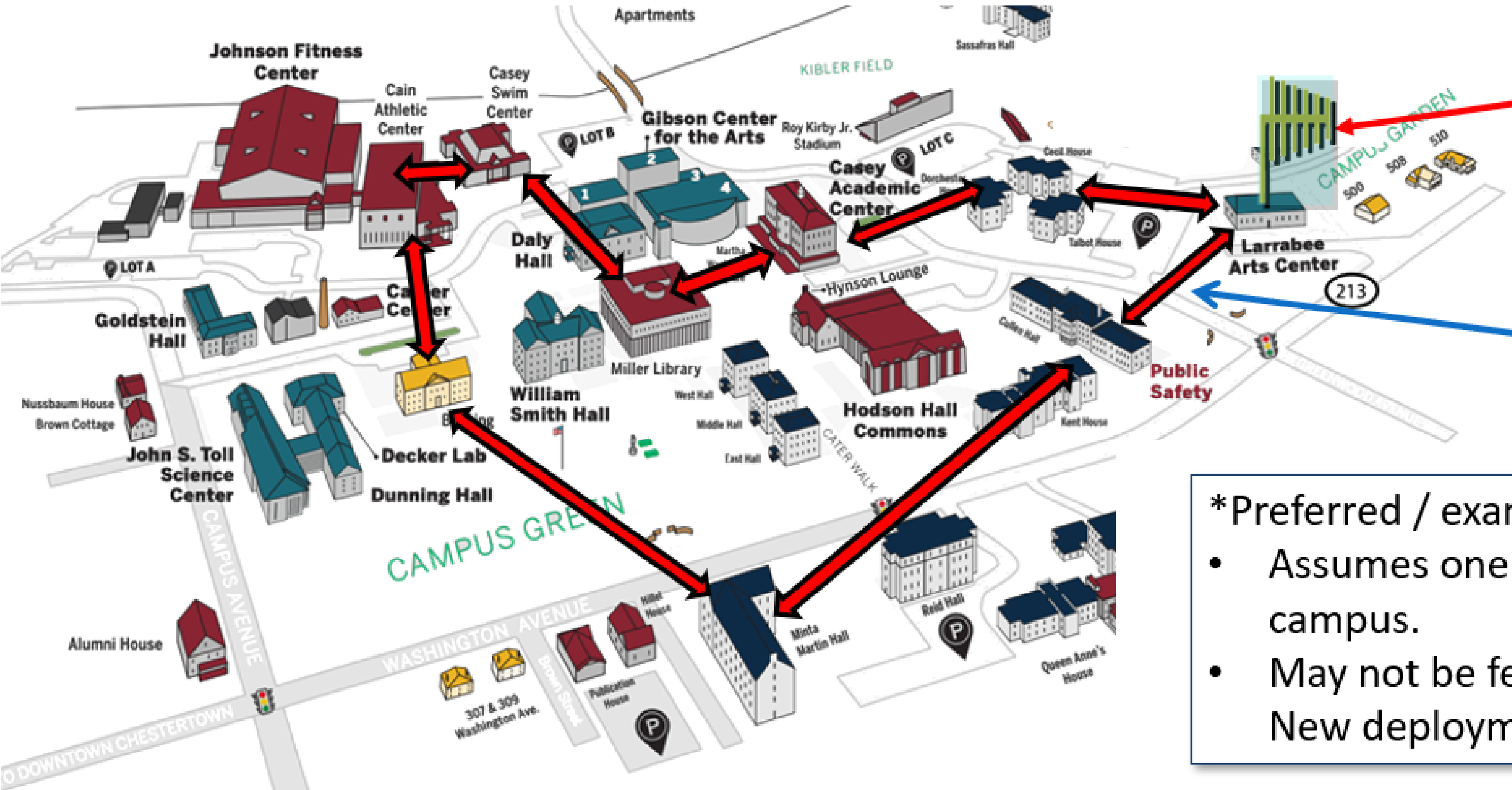
College Campuses - 4500

Campus & Multi-Building Site Considerations



Multiple Signal Boosters and Donor Antennas, with overlapping RF Paths?

Campus & Multi-Building Site Considerations



*Preferred / example topology.

- Assumes one owner for whole campus.
- May not be feasible in some cases, New deployments are more feasible

Or a Master Signal Booster and Donor Antenna Hubbed to other buildings using Fiber?

Codes, Standards and Regulations

Since 2009, the fire and building codes have required in-building public safety coverage

INTERNATIONAL CODE COUNCIL

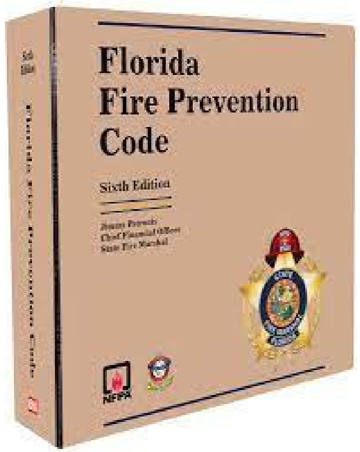
IFC 510

IBC 918

NFPA

- **1**
- **72**
- **101**
- **1221/1225**
- **70**

Federal Part 90 and Part 20 Rules



State and Local Amendments

UL TIA ANSI

Standards And Listings

SAFER BUILDINGS COALITION
Member Showcase

Return to Main Site

SBC Quick Code Reference - NFPA [2013 - 2022] and IFC [2015 - 2024]

- Click on Header Row to go to Codes Websites [Have you bought your code copies?]
- Updated July, 2022
- Members click here to download a customizable version
- Non Members click here for a copy of NFPA Codes or IFC Codes
- ©2009 Safer Buildings Coalition

NFPA TOPIC	NFPA 72-2013	NFPA 1221-2016	NFPA 1221 - 2019	NFPA 1225 - 2022
In-Building Solution Required	NFPA 1 Section 11.10	NFPA 1 Section 11.10	NFPA 1 Section 11.10	NFPA 1 Section 11.10
Permit Required	Yes, Section 24.5.2.1.2	Yes, Section 9.6.6	Yes, Section 9.6.6	Yes, Section 18.7
Pathway Survivability for Coaxial Cable Required	2 Hour for Riser Coaxial Cable - Sec. 24.3.6.8	2 Hour for Riser Coaxial Cable - Sec. 9.6.2.1.3	Backbone Cable Routed Through Enclosure Matching Bldgs. Fire Rating - Sec. 9.6.2.3	Yes, Sections 18.12.3.3, 18.12.3.4, 18.12.3.5, & 18.12.3.6
Plenum Rated Coaxial Cable Required	Yes, Riser & Feeder Coaxial Cable - Sec. 24.3.6.8	Yes, Riser & Feeder Coaxial Cable - Sec. 9.6.2.1.1	Yes, Backbone & Distribution Antenna Cables Sec. 9.6.2.1	Yes, Backbone & Distributi Antenna Cables Sec. 18.12.3.1
Lightning Protection Required	Not Addressed in Section 24.5.2	Yes, Sec. 9.6.3 - Installed per NFPA 780	Yes, Sec. 9.6.3 - Installed per NFPA 780	Yes, Sec. 18.4
Isolation of Donor Antenna Required	Yes, 15db - Sec. 24.5.2.3.3	Yes, 20db - Sec. 9.6.9	Yes, 20 db Above System Gain - Sec. 9.6.9	Yes, Sec. 18.3.3.2 & 18.10

SCAN ME

SBC Code Reference
Free / Online

Lessons Learned, technology advancements, etc. are being incorporated into newer editions of the codes & standards

Topics Covered in Fire Codes and Standards

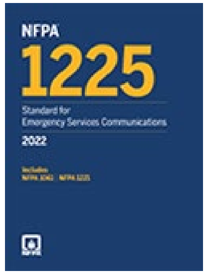
TOPIC
Approved Emergency Services Department Communications Required
Field testing - Building Signal Coverage Assessment Required
Permit Required
Listing of Equipment
Limitation of External References
Signal Strength and Quality & Area Coverage Required
IFC reference to NFPA 1221 or 1225 Standards
Backbone / Riser Cable Defined
Distribution / Feeder Cable Defined
Pathway Survivability: Fire Rating
Pathway Survivability: Mechanical Protection
Plenum Rated Coaxial Cable Required
Lightning Protection Required
Noise Floor Requirement
Technical Criteria to be Provided by AHJ(s)
Standby Power
Isolation of Donor Antenna Required
Cabinets for Equipment and Battery Backup Required

TOPIC
Frequency License Holder Approval Required
Oscillation Prevention
Monitoring By Fire Alarm Required
Monitor Signal Source Malfunction Required
Dedicated Annunciation Required
Additional Frequencies (May Include cellular and new technologies)
Design Documents
Communication Antenna Density/Near Far
Mounting of Donor Antenna
Approval prior to installation
Minimum qualifications of personnel
System Testing - Initial, Acceptance, Annual, 5-year
Compliance with FCC Part 90.219
Responsibility to Prevent or Correct Interference with Public Safety System
Nonpublic safety system - non-interference

Signal Strength and Quality & Area Coverage Required

IFC 2015	IFC 2018	IFC 2021	IFC 2024
−95 dBm Sec. 510.4.1 95% General - Sec. 510.4.1 99% Critical - Not Specifically Addressed in Sec. 510	DAQ 3.0 Sec. 510.4.1.1 95% General - Sec. 510.4.1 99% Critical - Sec. 510.4.2 Reference to NFPA 1221	DAQ 3.0 Sec. 510.4.1.1 95% General - Sec. 510.4.1 99% Critical - Sec. 510.4.2 Reference to NFPA 1221	DAQ 3.0 Sec. 510.4.1.1 95% General - Sec. 510.4.1 99% Critical - Sec. 510.4.2 Reference to NFPA 1225

NFPA 72-2013	NFPA 1221-2016	NFPA 1221 - 2019	NFPA 1225 - 2022
-−95 dBm Sec. 24.5.2.3 90% General - Sec. 24.5.2.2.2 99% Critical - Sec. 24.5.2.2.1	DAQ 3.0 Sec. 9.6.8 90% General - Sec. 9.6.7.5 99% Critical - Sec. 9.6.7.4	DAQ 3.0 9.6.8 90% General - Sec. 9.6.7.4 99% Critical - Sec. 9.6.7.3	DAQ 3.0 Sec. 18.9 95% General - Sec. 18.8.4 99% Critical - Sec. 18.8.3



Signal Strength/Quality – Per NFPA

NFPA 1225 - 2022 Edition

18.9 Signal Strength <u>and Quality</u>

18.9.1* Downlink**.**

A minimum <u>downlink</u> signal shall be sufficient to provide a minimum of DAQ 3.0 for voice communications using either narrowband, analog, or digital P25 signals or wideband LTE digital signals throughout the coverage area. (*See A.20.3.10.*)

A.18.9.1

<u>Downlink</u> refers to the signal from the base station to the portable. Although DAQ 3.0 is required as a minimum, it is recommended that systems be designed for DAQ 3.4 to provide a safety factor.

18.9.2* Uplink**.**

The <u>uplink</u> signal shall be sufficient to provide a minimum of DAQ 3.0 for voice communications using either narrowband, analog, or digital P25 signals or widespread LTE digital signals. (*See A.20.3.10.*)

A.18.9.2

<u>Uplink</u> refers to the signal from the portable to the base station.

Technical Criteria to Be Provided By AHJ(s)

IFC 2015	IFC 2018	IFC 2021	IFC 2024 DRAFT
510.4.2.2	510.4.2.2	510.4.2.2	510.4.2.2
NFPA 72-2013	**NFPA 1221-2016**	**NFPA 1221 - 2019**	**NFPA 1225 - 2022**
24.5.2.7	9.6.14	9.6.14	18.5, 18.11

NFPA 1225, 2022 Edition

18.15 The ***AHJ* and the Frequency License Holder(s) shall** maintain a document of Containing technical information specific to its requirements for the installation of emergency responder communications enhancement systems.

18.15.2 The document shall include relevant information from the frequency license holder(s).

18.15.3 The AHJ technical information documents shall be accessible to emergency responder communications enhancement system design personnel.

18.15.4 The AHJ technical information documents shall contain, but not be limited to, the following:
(1) Frequencies and other modulation technologies required for the in-building emergency responder communications enhancement system **and the point of contact for the frequency license holder(s)**
(2) Location and effective radiated power (ERP) of public safety radio sites used by the emergency responder communications enhancement system
(3) Maximum propagation delay — in microseconds
(4) Other supporting technical information necessary to direct system design

Every ERCES Project is a Shared Responsibility

Code Enforcement - AHJ

Building Owner and
Their Vendor:
The System Integrator

Frequency(s) License Holder

FCC 47 CFR § 90.219 - Use of Signal Boosters

The FCC recognizes the importance of in-building coverage for first responders, as they related in their 2013 comments on the record:

*"Signal booster systems play a crucial role in allowing public safety first-responders to communicate in buildings, tunnels and other areas where signals would normally be blocked." and, "We find that allowing third parties to operate signal boosters with express licensee consent serves the public interest by promoting reliable communications, particularly reliable public safety communications."**

*FCC's Report and Order, WT Docket No. 10-4. ¶ 151

47 CFR § 90.219 - Use of signal boosters.

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.

(b) ***Authority to operate.*** PLMRS licensees for stations operating on assigned channels higher than 150 MHz may operate signal boosters, limited to the service band for which they are authorized, as needed anywhere within the PLMRS stations' service contour, but may not extend the stations' service contour.

> **(1)** PLMRS licensees may also consent to operation of signal boosters by non-licensees (such as a building owner or a signal booster installation contractor) within their service contour and across their applicable frequencies but must maintain a reasonable level of control over these operations in order to resolve interference problems.
>
> > **(i)** Non-licensees seeking to operate signal boosters must obtain the express consent of the licensee(s) of the frequencies for which the device or system is intended to amplify. The consent must be maintained in a recordable format that can be presented to an FCC representative or other relevant licensee investigating interference.

47 CFR § 90.219 - Use of signal boosters.

(c) *Licensee responsibility; interference.* PLMRS licensees that operate signal boosters are responsible for their proper operation and are responsible for correcting any harmful interference that signal booster operation may cause to other licensed communications services. Normal co-channel transmissions are not considered to be harmful interference. Licensees are required to resolve interference problems pursuant to § 90.173(b). Licensees shall act in good faith regarding the operation of signal boosters and in the resolution of interference due to signal booster operation. Licensees who are unable to determine the location or cause of signal booster interference may seek assistance from the FCC to resolve such problems.

(d) *Deployment rules.* Deployment of signal boosters must be carried out in accordance with the rules in this paragraph.

(1) Signal boosters may be used to improve coverage in weak signal areas only.
(2) Signal boosters must not be used to extend PLMRS stations' normal operating range.

Harmful interference. For the purposes of resolving conflicts between stations operating under this part, any emission, radiation, or induction which specifically degrades, obstructs, or interrupts the service provided by such stations.

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47 CFR § 90.219 - Use of signal boosters.

5) **Class B signal booster installations** must be registered in the FCC signal booster database that can be accessed at the following URL: *www.fcc.gov/signal-boosters/registration.*

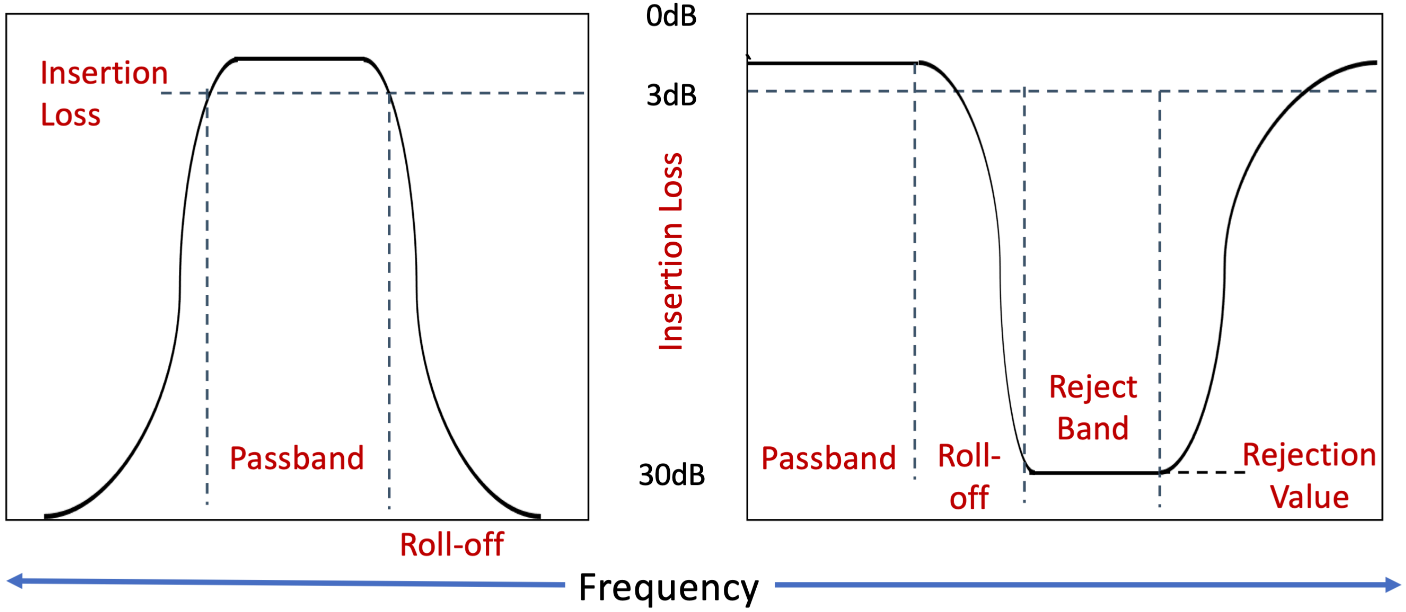
(6) **Good engineering practice** must be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of harmful interference caused by any given deployment, the FCC may require additional attenuation or filtering of the emissions and/or noise from signal boosters or signal booster systems, as necessary to eliminate the interference.

- **(i)** In general, the ERP of intermodulation products should not exceed −30 dBm in 10 kHz measurement bandwidth.
- **(ii)** In general, the ERP of noise within the passband should not exceed −43 dBm in 10 kHz measurement bandwidth.
- **(iii)** In general, the ERP of noise on spectrum more than 1 MHz outside of the passband should not exceed −70 dBm in a 10 kHz measurement bandwidth.

Effective radiated power (ERP). The power supplied to an antenna multiplied by the relative gain of the antenna in a given direction.

47 CFR § 90.219 - Use of signal boosters.

(7) Signal booster passbands are limited to the service band or bands for which the operator is authorized. In general, signal boosters should utilize the minimum passband that is sufficient to accomplish the purpose. Except for distributed antenna systems (DAS) installed in buildings, the passband of a Class B booster should not encompass both commercial services (such as ESMR and Cellular Radiotelephone) and part 90 Land Mobile and Public Safety Services.



Written Authorization from License Holder

Appendix C - Retransmission Application

Radio Communication Enhancement System
Retransmission Application

City of Tampa, Florida
Technology and Innovation

COMPLETE SEPARATE APPLICATIONS FOR EACH HEADEND IN SYSTEM DESIGN. SEE INSTRUCTIONS AND CHECKLIST ON SECOND PAGE.		
1. SITE INFORMATION		
Site Name:		
Site Address:		
Low Voltage Permit Number (Issued by City of Tampa Construction Services Division):		
Site Description (include type of construction, number of floors, total interior square footage):		
Site Latitude and Longitude:		
BDA Manufacturer and Model:		Class:
BDA Headend Location (room number, etc.):		
Number of Line Amplifiers:	Line Amplifier Manufacturer and Model:	
Type of System: Single carrier, County 800MHz only	Multiple carrier, neutral host	Other (describe below)
2. OWNER CONTACT INFORMATION		
Owner:		
Owner Address:		
Point of Contact:	Email:	

Appendix D - Provisional Retransmission Authorization

HILLSBOROUGH COUNTY SHERIFF'S OFFICE, FLORIDA
PROVISIONAL **700/800 MHz RETRANSMISSION AUTHORIZATION**

Hillsborough County Sheriff's Office, Florida (HCSO) hereby grants provisional authorization to ______________________ [*name of system operator*] (Opera... to operate a Two-Way Radio Communications Enhancement System (the System) on 700/800 MHz frequencie... licensed to HCSO by the Federal Communications Commission (FCC) under call signs WQNM806, WQPS818, WQVH304, WQRG242, WPCW643, WPDV262, WPHE897, WPMB935, WQBY646, WQLZ361, and WQPK525 at ... following location:

Site Name: ______________________
Site Address: ______________________
Latitude: __________ **Longitude:** __________
FCC Booster ID: ______________________
Site Contact: ______________________
Phone #: __________ **Email:** __________

This Authorization is subject to the following conditions:

1. This Provisional Retransmission Authorization is issued for the purposes of system installation... optimization, testing and commissioning and is valid for one year from date of issuance. Upon... completion of final inspection and testing, a Final Retransmission Authorization will be iss... is valid for fi...

Written Authorization from License Holder

Appendix E - Retransmission Authorization

HILLSBOROUGH COUNTY SHERIFF'S OFFICE, FLORIDA

700/800 MHz RETRANSMISSION AUTHORIZATION

Hillsborough County Sheriff's Office, Florida (HCSO) hereby grants authorization to ________________ [*name of system operator*] (Operator) to operate a Two-Way Radio Communications Enhancement System (the System) on 700/800 MHz frequencies licensed to HCSO by the Federal Communications Commission (FCC) under call signs WQNM806, WQPS818, WQVH304, WQRG242, WPCW643, WPDV262, WPHE897, WPMB935, WQBY646, WQLZ361, and WQPK525 at the following location:

Site Name: ________________

Site Address: ________________

Latitude: ________ Longitude: ________

FCC Booster ID: ________________

Site Contact: ________________

Phone #: ________ Email: ________

This Authorization is subject to the following conditions:

1. The Retransmission Authorization is valid for five years from date of issuance, and will be renewed up request, when an application for renewal and proof of successful NFPA72-2013 compliant annual test are provided. Renewal forms and instructions can be obtained by emailing smitchel@hcso.tampa.fl.u calling (813) 247-0080.

maintained and

MARIETTA FIRE DEPARTMENT
112 Haynes Street
Marietta, Georgia 30060-1973

Main – (770) 794-5450 Fax – (770) 794-5465 www.MariettaFire.com

IFC 510 Compliance Acknowledgment

Before a Certificate of Occupancy is issued, compliance with International Fire Code Section 510 is required by means of an Emergency Responder Radio Coverage System (ERRCS) installed, tested, and accepted OR through field-testing by a FCC licensed radio contractor to verify that an ERRCS is not required. A critical element to compliance with this standard is preliminary testing once the building is dried-in.

By signing below, I acknowledge that I have read the above statement on IFC 510:

Signature:
Printed Name:
Association with Project:
Date:
Project Name:
Project Address:

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47 CFR § 90.219 - Use of signal boosters.

Federal Communications Commission

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of

Oakmont of Concord LLC
Licensee of Station WQYK706

Concord, California

File No.: EB-FIELDWR-20-00031551

FRN: 0025824657

NOTICE OF VIOLATION

Released: February 19, 2021

By the Regional Director, Region Three, Enforcement Bureau:

1. This is a Notice of Violation (Notice) issued pursuant to section 1.89 of the Commission's rules[1] to Oakmont of Concord LLC (Oakmont), licensee of radio station WQYK706 in Concord, California. Pursuant to section 1.89(a) of the Commission's rules, issuance of this Notice does not preclude the Enforcement Bureau from further action if warranted, including issuing a Notice of Apparent Liability for Forfeiture for the violation(s) noted herein.[2]

2. On October 23, 2020, an agent of the Enforcement Bureau's San Francisco Office investigated an interference complaint in Concord, California, and observed the following violation(s):

a. 47 CFR § 90.219(b)(1)(i): "Non-licensees seeking to operate signal boosters must obtain the express consent of the licensee(s) of the frequencies for which the device or system is intended to amplify. The consent must be maintained in a recordable format that can be presented to an FCC representative or other relevant licensee investigating interference." Oakmont did not provide evidence that it had obtained express consent from the East Bay Regional Communications Systems Authority (EBRCSA) to amplify EBRCSA's licensed 800 MHz signals.

Federal Communications Commission

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of

Viega LLC
Licensee of Station WQYF702

Broomfield, Colorado

File No.: EB-FIELDWR-20-00031282

FRN: 0025868407

NOTICE OF VIOLATION

Released: May 13, 2021

By the Regional Director, Region Three, Enforcement Bureau:

1. This is a Notice of Violation (Notice) issued pursuant to section 1.89 of the Commission's rules[1] to Viega LLC (Viega), licensee of radio station WQYF702 in Wichita, Kansas. Pursuant to section 1.89(a) of the Commission's rules, issuance of this Notice does not preclude the Enforcement Bureau from further action if warranted, including issuing a Notice of Apparent Liability for Forfeiture for the violation noted herein.[2]

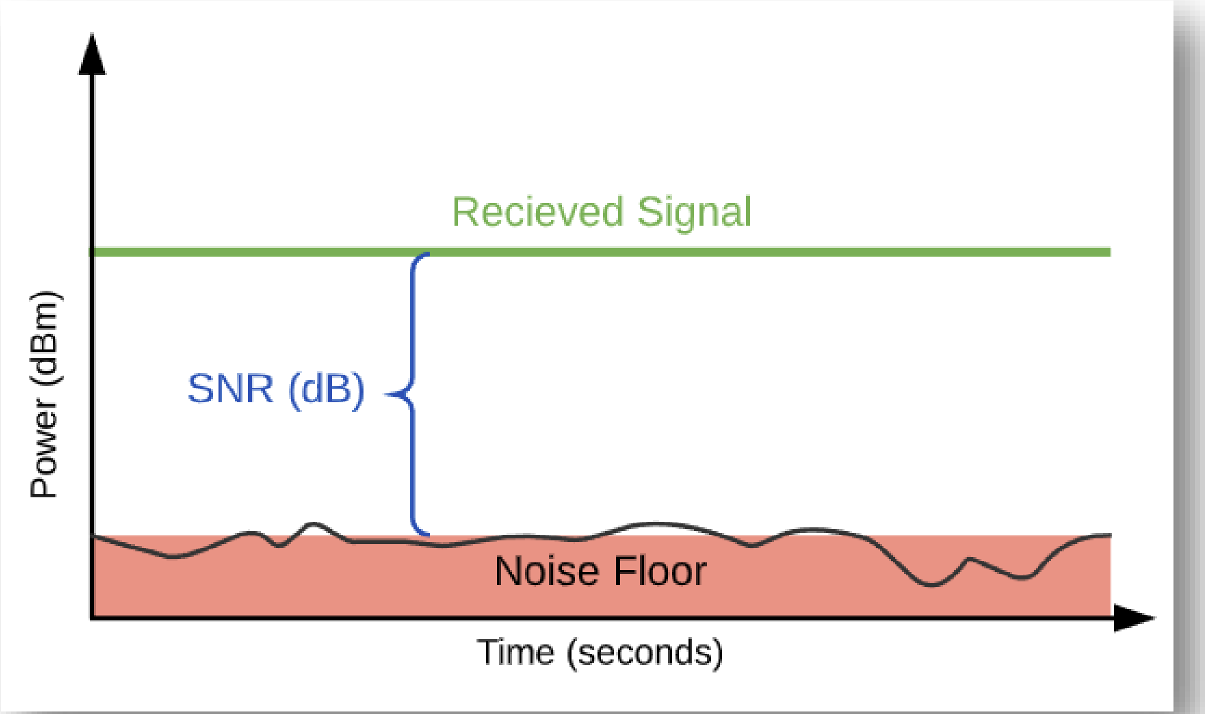
2. On October 5, 2020, agents of the Enforcement Bureau's Denver Office investigated an interference complaint in Broomfield, Colorado, and observed the following violation:

a. 47 CFR §90.219(c). "Licensee responsibility; interference. PLMRS licensees that operate signal boosters are responsible for their proper operation and are responsible for correcting any harmful interference that the signal booster operation may cause to other licensed communications services." On October 5, 2020, FCC Agents investigated interference to ADCOM911, Inc.'s (ADCOM911) licensed frequencies and by direction finding techniques, located radio emissions in the 800 MHz band emanating from a bi-directional amplifier (BDA) operating from Viega's office complex. An on/off test of Viega's BDA equipment confirmed that its transmissions were interfering with ADCOM911's licensed communication system. The interference ceased when Viega's BDA equipment was unplugged on October 6, 2020.

Signal to Noise Ratio

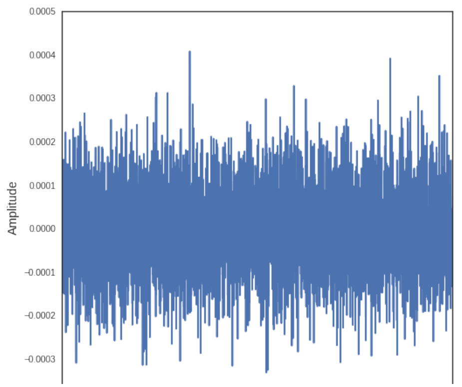
RF ***Noise*** can generally be regarded as any RF energy that is not the desired signal.

Signal-to-Noise Ratio is a measure that compares the level of a desired signal to the level of background noise. When the noise level is as high or nearly as high as the desired signal level, radio systems cannot function correctly.

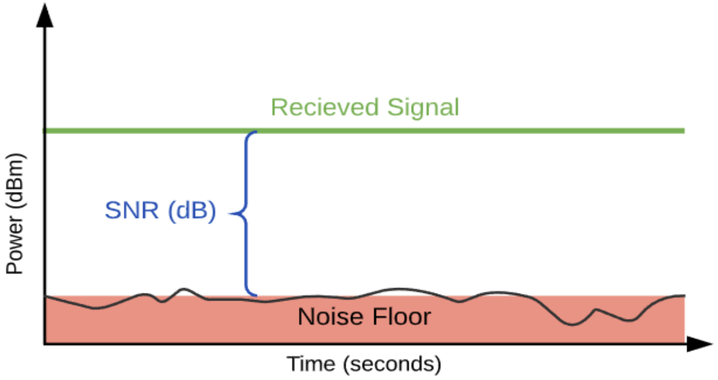


Some Key Terms:

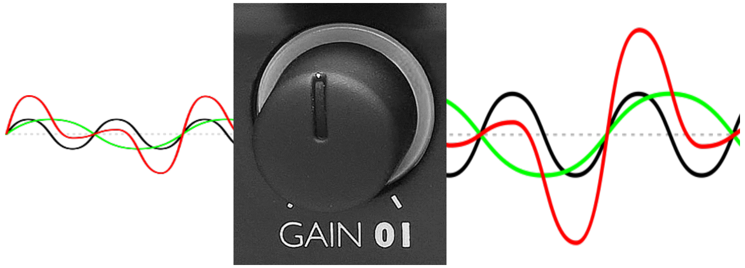
- **Thermal Noise** - Thermal noise is a noise that is a result of the thermal agitation of electrons. The thermal noise power depends on the bandwidth and temperature of the surroundings.



- **Noise Floor** - The Noise Floor is the signal created from adding up all the unwanted signals within a measurement system.

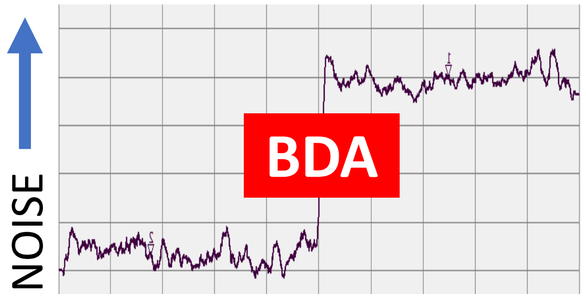


- **BDA Gain** - Gain is a measure of the ability of the Bi-Directional Amplifier (BDA) to increase the power of a signal from the input to the output

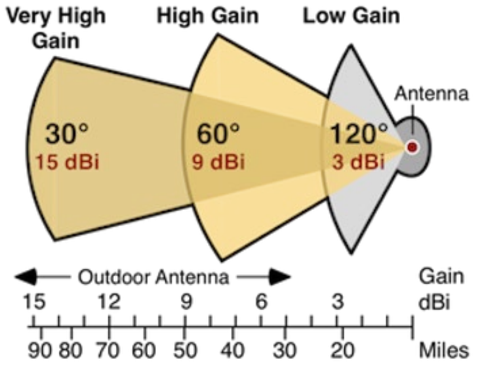


Some Key Terms:

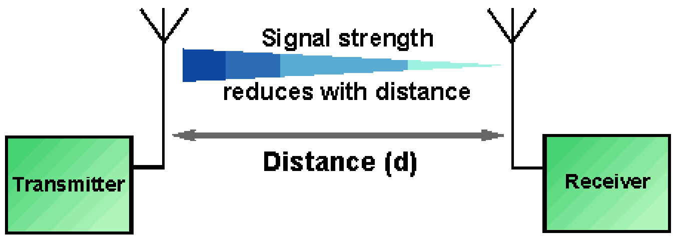
- **BDA Noise Figure** - The Noise Figure defines the amount of noise an element (like a BDA) adds to the overall system.



- **Antenna Gain** - Antennas don't create radio energy, they can only divert, direct, or concentrate it in some direction. This is called Antenna Gain.



- **Free Space Path Loss (FSPL)** - Free Space Path Loss is the attenuation (reduction) of signal strength between two antennas. Assumes the space between the antennas is an obstruction free, line-of-sight straight path through the air.

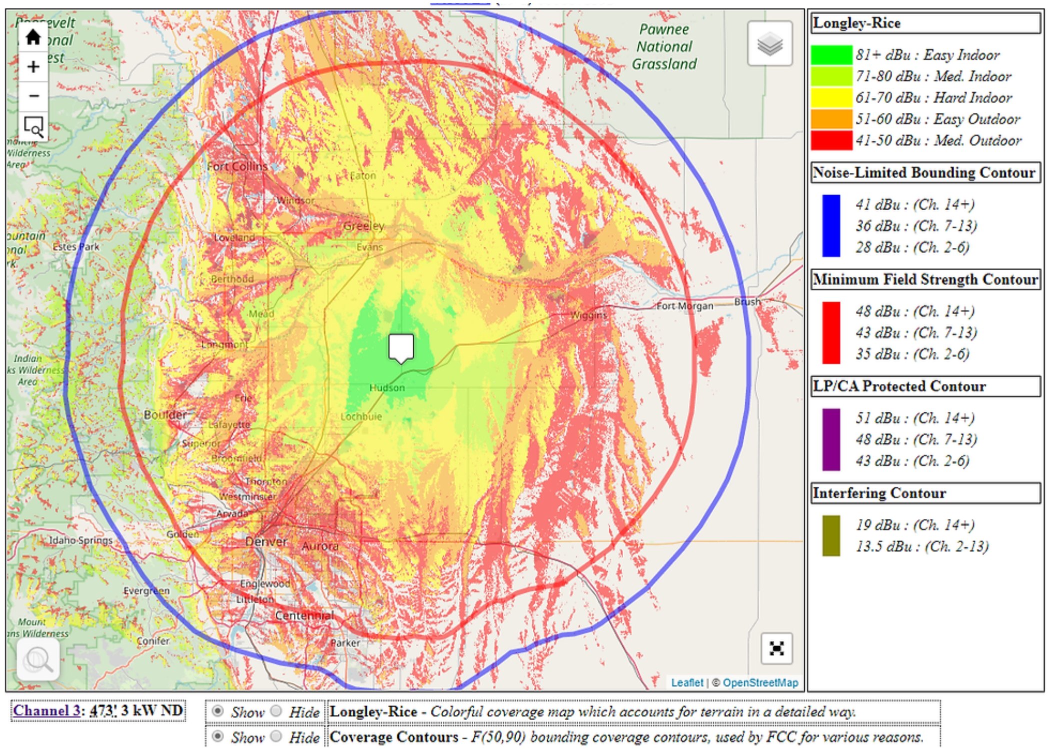


Impact of Noise and Interference

How does noise or interference affect public safety agencies and radio users?

1. **Coverage area shrinking.** Imagine a broadcast tower serving an area of 30 square miles, then being affected by noise. The users at the edges of that service area may now find themselves without emergency communications. The worse the noise, the more the coverage area shrinks.

2. **Reduction of call capacity for the radio system**. Contemporary radio systems support the ability to have numerous users talking concurrently. If the radio system detects noise it may disable some portion of itself, allowing for fewer users.

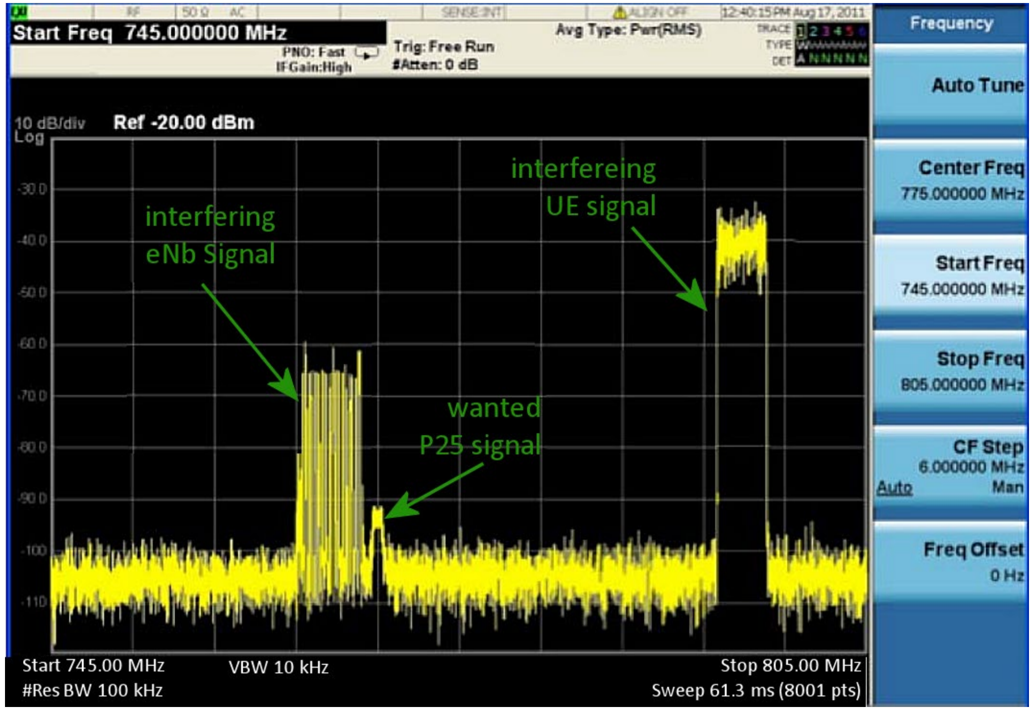


Impact of Noise and Interference

How does noise or interference affect public safety agencies and radio users?

3. Dead Channels – Or entire systems knocked out of service!

4. Diversion of public safety resources to identify and resolve the problems.

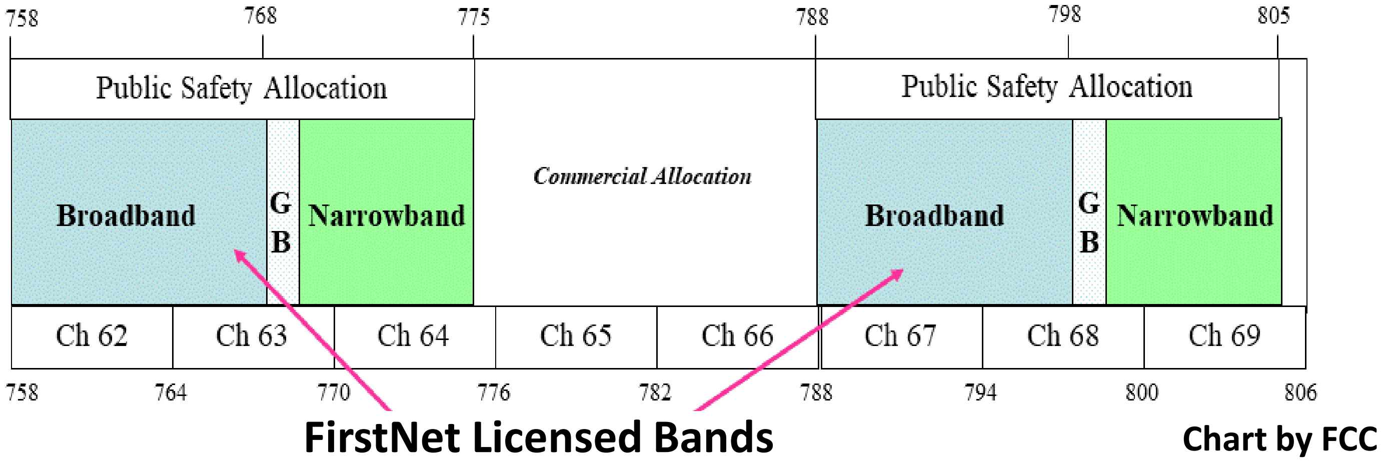


Thou Shalt Not Raise the Noise Floor….

18.9.3* Noise Floor.

If the design of the in-building emergency responder communications enhancement system (ERCES) requires the use of a signal booster, then the maximum uplink RF noise (noise crown) created by any signal booster or signal booster booster-based ERCES **shall not raise the noise floor at the public safety communications site closest to the ERCES or any receive site within the public safety communications network that the ERCES is intended to operate with.**

Interference Example: Band 14 and LMR Conflicts



- FirstNet Band 14 public safety LTE utilizes two 10-MHz-wide blocks of spectrum at 758 MHz to 768 MHz (downlink) and at 788 MHz to 798 MHz (uplink).
- These bands are adjacent to existing in-use public safety narrowband spectrum (769 MHz to 775 MHz and at 799 MHz to 805 MHz) *(only a 1 MHz Guard Band)*

Good Engineering and Notch Filters can help…

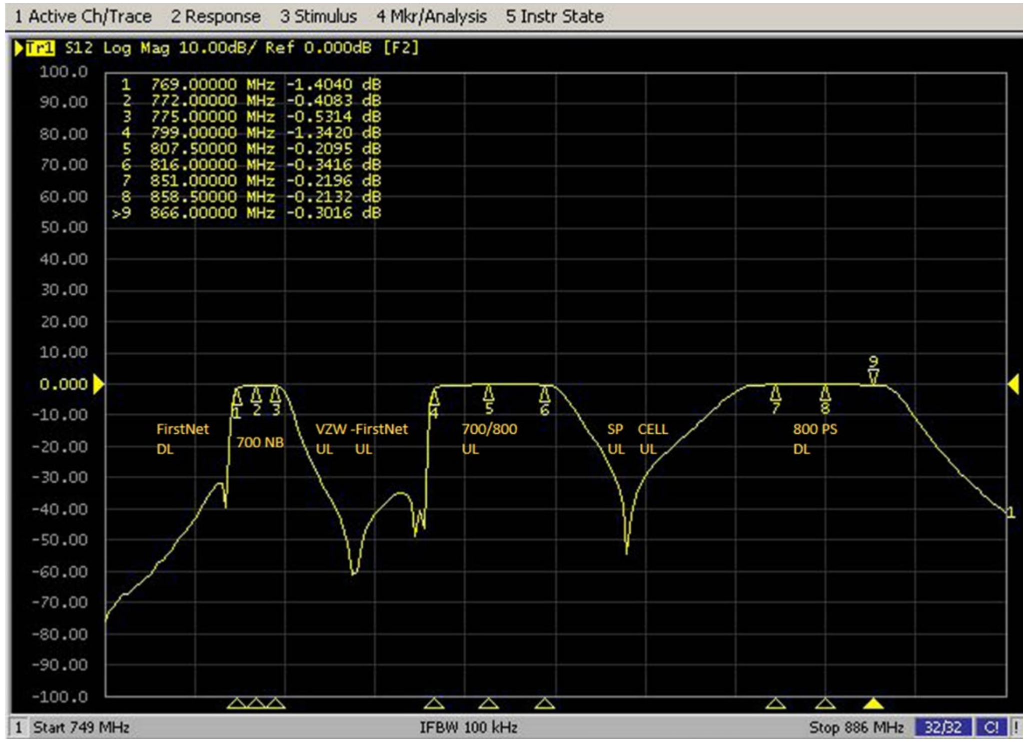
Example Notch Filters

Dimension Ranges: From about 9” x 9” to about 12” x 12” or 12” x 13”

- FirstNet has reported interference from existing ERCES / Signal Boosters that are improperly amplifying FirstNet licensed bands.
- This can be avoided with good engineering design practices and careful frequency planning. For example, *notch filters* may be added to ERCES / Signal Boosters to prevent such interference.

Notch Filter: Think about it like a graphic equalizer on your audio system

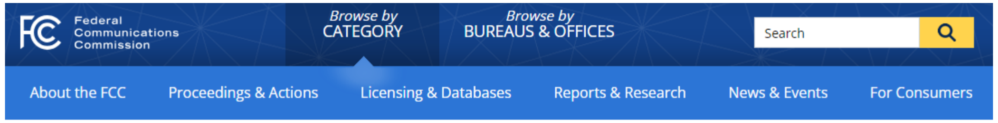
The graph of that looks like a Notch.



FCC Rules defines whose responsibility it is to fix any conflicts…

- Signal booster operation is on a non-interference basis and buildings using BDA's may be required to cease or alter the BDA's operating parameters due to a request from an FCC representative or a licensee's *[PS Radio Agency or FirstNet]* request to resolve interference.
- Therefore, it is the responsibility of building owners and their Systems Integrator contractors to resolve conflicts.
- Best practice is to engineer to avoid any conflicts to begin with.
- OEMs – Quality Products, proper labeling, documentation, training

Where to Get Help with Interference



Home / Reports & Research / Guides

Private Land Mobile Interference Complaints

The Enforcement Bureau's **Regional and Field Offices**, are responsible for responding to interference complaints involving private land mobile radio stations.

https://www.fcc.gov/enforcement/divisions-offices/ofd

•**Association of Public Safety Communications Officials, Inc.**
APCO AFC, Inc.
351 North Williamson Blvd.
Daytona Beach, FL 32114
Phone: (888) APCO-911
Fax: (386) 322-2502

- **News Release**
- **Memorandum of Understanding**
- **APCO Compliance Request Form**

•**Enterprise Wireless Alliance**
2121 Cooperative Way
Suite 225
Herndon, VA 22102
Phone: (703) 528-5115
Fax: (703) 524-1074

- **News Release**
- **Memorandum of Understanding**
- **EWA's Interference Resolution Support**

•

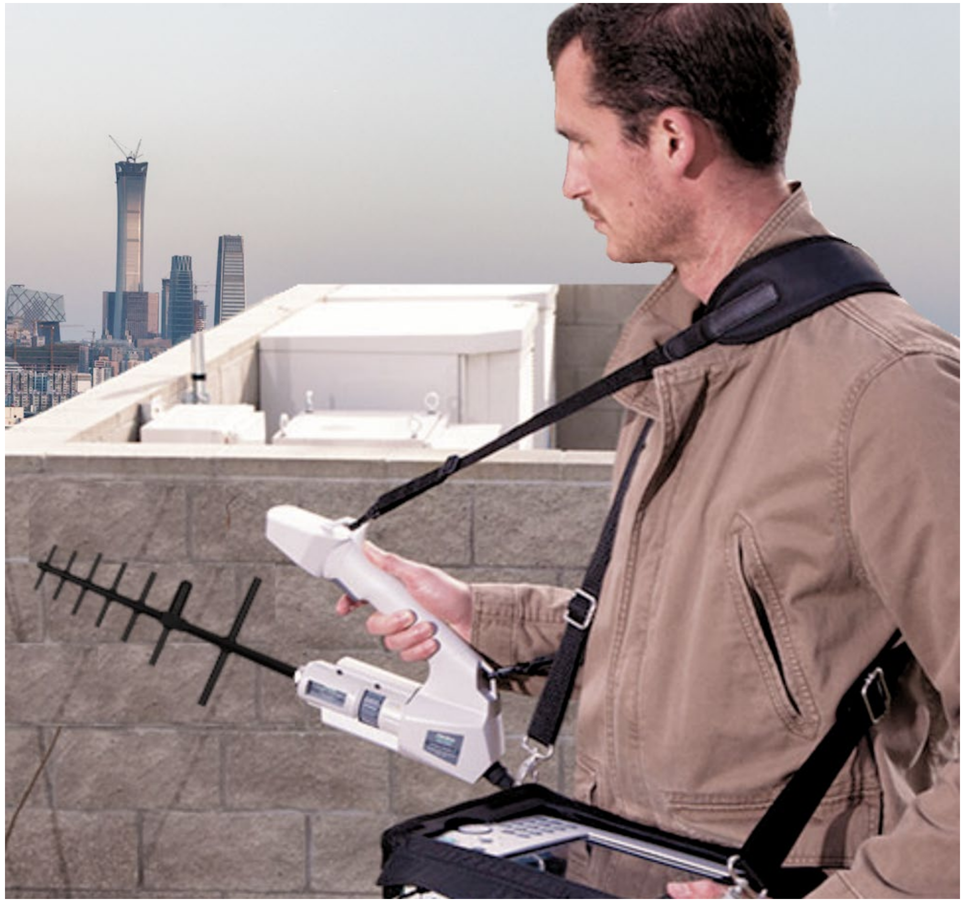
•**Association of American Railroads**
James Reimer
AAR Frequency Coordinator
Transportation and Technology Center, Inc.
P. O. Box 11130
55500 DOT Road
Pueblo, CO 81001
Phone: (719) 584-0578
Fax: (719) 584-7145

- **News Release**
- **Memorandum of Understanding**
- **AAR Compliance Request Form**

https://www.fcc.gov/reports-research/guides/private-land-mobile-interference-complaints

Proper ERCES Testing

1. Building Assessment
2. Pre-Installation
3. Commissioning
4. Optimization
5. Acceptance
6. Periodic Re-Testing



Evaluating The Need for an Enhancement Solution

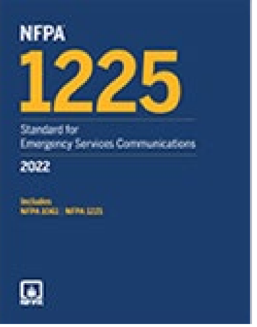
11.10.2 General.
In all new and existing buildings, minimum radio signal strength for emergency services department communications shall be maintained at a level determined by the AHJ.

Remember: Not all buildings or all portions of a building need an enhancement solution.

Examples:
- IFC 2024 exempts one-story buildings less than 12,000 square feet with no UG area
- Buildings that have natural RF penetration from the macro system

Current NFPA and IFC Both Require DAQ testing

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.
4.5	Speed easily understandable. Rare noise or distortion.
5	Perfect. No distortion or noise discernible.



How will vendors test DAQ in your jurisdiction? What is your process?

A.20.3.10

Methods of Determining DAQ. …… A third method of determining DAQ is to manually test the system using portable radios as specified by the AHJ.

- Loaner Radios?
- Purchase Radios?
- Joint Testing w/ Jurisdiction?

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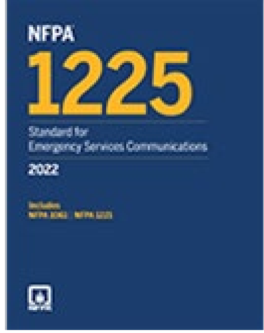
NFPA 1225: Standard for Emergency Services Communications, 2022 Edition
- Chapter 20 Testing (NFPA 1221)



20.3.10 * Test and Inspection of In-Building Emergency Responder Communications Enhancement Systems.
Where in-building emergency responder communications enhancement system are installed, a system test shall be conducted, documented, and signed by a person approved by the AHJ upon system acceptance and once every 12 months.

A.20.3.10
Test Procedures. The test plan should ensure testing throughout the building. Test procedures should be as directed by the AHJ or the frequency license holder(s). The following information is provided to guide the AHJ or the frequency license holder(s) on several types of testing methods that can be used when testing an in-building emergency responder communications enhancement system.

Grid Testing

Annex - A.20.3.10

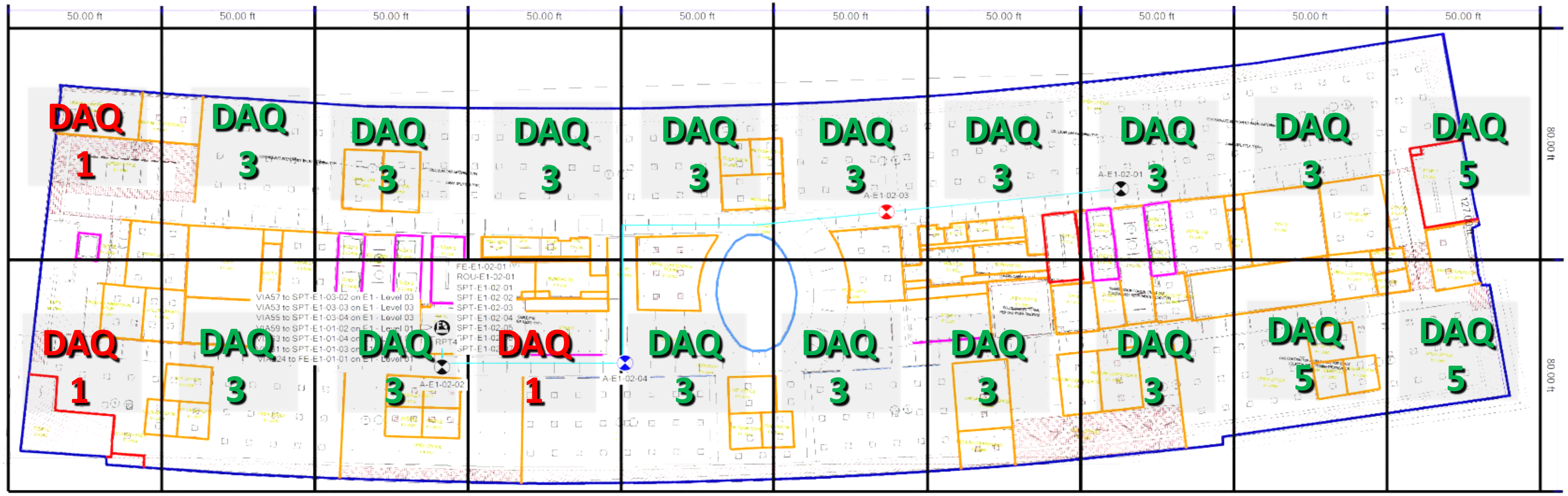
Testing procedures typically are performed on a grid system. A grid is overlaid onto a floor area to provide 20 grid cells. Grid cells are provided with definite minimum and maximum dimensions. For most buildings, using a minimum grid dimension of 20 ft (6.1 m) and a maximum grid dimension of 80 ft (24.4 m) will suffice to encompass the entire floor area. Where a floor exceeds 128,000 ft^2 (11,900 m^2), which is the floor area that can be covered by the maximum grid dimension of 80 ft (24.4 m), it is recommended that the floor be subdivided into sectors each having an area less than or equal to 128,000 ft^2 (11,900 m^2). It is also recommended that each sector be tested individually with 20 grid cells in each sector.

Signal strength measurements should be taken at the center of each grid, where required.

Evaluation and Acceptance Testing: Grid Method

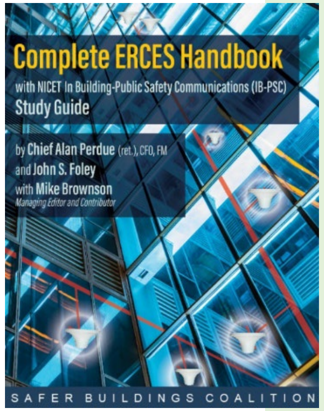
A grid is overlaid onto a floor area to provide 20 grid cells.

For most buildings, using a minimum grid dimension of 20 ft (6.1 m) and a maximum grid dimension of 80 ft (24.4 m) will suffice to encompass the entire floor area. Remember: BER and SINR can also be used for signal quality



Commissioning Tests: Equipment Performance

- Design and Installation Integrity
- This verifies the amplifier and antenna installation and configuration produces good performance



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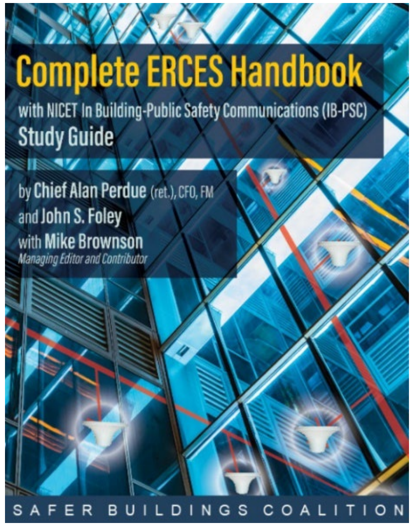
- Power received from the Donor Site on the roof [pg. 413]
- Antenna Verification "Test Signal" * [pg. 415]
- Isolation – multiple points to measure * [pg. 416]
- Verify BDA Filter configuration and gain (low and high levels) * [pg. 421 – 429]
- Optimization of Uplink Power and Gain [pg. 421 – 429]
- Optimization of Uplink Squelch * [pg. 432]
- Exterior Performance (Leakage and Dominance)* [pg. 420]
- Near / Far operation ("Two Radio")* [pg. 431]
- Noise out of the BDA [pg. 427]
- Antenna Verification "Live" (control channel quality) [pg. 419]

** Uses a Test Transmitter*

Example Commissioning Tests



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Isolation Test – Pg 416

22.8.2 Isolation Test

The isolation test ensures adequate electrical separation between the indoor antenna network and the donor antenna. On a Simplex (aka split DAS), isolation tests must also be performed between all antenna systems. This is to verify the overall system design and configuration and to ensure indoor antenna signals do not feedback through the donor antenna OR that outdoor signals do not feedback through the indoor antenna system. This information will be used during the BDA configuration (gain, etc.). Per the current model fire codes and standards, the isolation must be 20 dB greater than the gain of the BDA. However, many AHJs and license holders will mandate 20 dB above the **maximum gain of the BDA**, not just the BDA's actual gain.

This test can be run before the BDA installation. However, for an active DAS, the active elements will need to be installed and energized.

Figure 22.8.2 Isolation Test

Isolation Test Procedure

1. Select two test frequencies within the same frequency bands used in the network but are unused and sufficiently isolated from any existing channel (>50 kHz). Find one clear frequency at the top end of the band and another at the bottom end of the bands. Different frequencies respond differently to the environment, so it's best to check both the high and low end of the bands. For example, if the public safety network operates on the 700 and 800 bands, you'd want to test at both 860 MHz and 769 MHz. If the radio network is dual band on UHF and 800 MHz, test at 450 MHz and 860 MHz.
2. Connect the test CW transmitter to the indoor antenna network setting the signal level to the maximum. This should be at least 0 dBm, preferably 10 dBm or more. This makes it easier to distinguish your RF test signal from the noise floor.

Exterior Leakage Test – Pg 420

22.9.3 Exterior RF Leakage

This test measures the downlink radio signal leakage from the DAS and compares it to the outdoor macro signal level. Excessive RF leakage can cause interference to nearby public safety radio users or can interact with adjacent buildings that may have ERCES installed.

This method works by first measuring the donor signal level that would be entering the BDA and replacing it with a signal generator tuned to the same RF level on a nearby, but unused, frequency. By walking the perimeter of the building and observing both the test signal leakage from the building and the signal level from the public safety radio network the RF technician can evaluate how much RF energy from the DAS is escaping the building. The goal is to verify the direct outdoor signal is much stronger than the RF leaking from the building, and if not, to make required adjustment by reducing downlink gain or moving distribution antennas away from exterior walls.

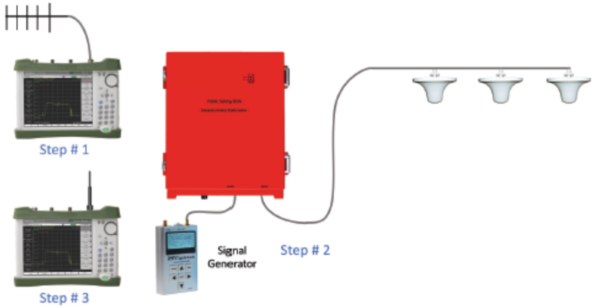

Figure 22.9.3 Exterior Leakage Test

Exterior Leakage Test Procedure

1. Identify the radio network test channel. This will be a trunking system's control channel or a busy voice channel if the system is a conventional repeater.
2. Connect a spectrum analyzer, or other measuring device, to the donor coax line that would normally be connected to the donor port of the BDA as shown in Step 1 of Figure 22.9.3. Measure the RF channel power of the incoming signal from the donor antenna.
3. Using the spectrum analyzer search for a clean test frequency close to the macro network's test channel but sufficiently isolated by at least 50 KHz. A clean DAS test frequency is one with no other RF traffic that might cause variations in the test readings. The goal is to be able to see both radio network signal and the DAS test frequency on a spectrum analyzer display.

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22.10.1 Establishing Maximum Uplink Gain Allowed By FCC Rules

In Chapter 4, THE RULES, we discussed the maximum noise power that can be radiated from a signal booster system. To calculate the noise power radiated we need to measure the noise power from the donor port of the BDA plus add in donor antenna system gain. This next procedure will show how to make the BDA noise measurement and adjustments to assure that the FCC rules are not violated.

Recall that the FCC limit for noise power is −43 dBm as measured in a 10 KHz bandwidth. The purpose is to minimize the potential for a signal booster system to interference with other nearby radio systems. While this may not totally eliminate the potential for interference it is a step in the right direction

Establish Maximum UL Gain Procedure

1. Connect a 50-ohm termination load to the BDA's mobile port and connect the spectrum analyzer to the BDA's donor port. Verify that squelch or other noise reduction feature of the BDA is turned off.
2. Turn on the UL HPA and adjust the uplink amplifier to full gain.
3. With the spectrum analyzer resolution bandwidth (RBW) set to 10 KHz, measure the noise power out of the BDA and record.
   a. Recommended spectrum analyzer setting for measuring noise, RBW = 10 KHz, Reference Level = −40 dBm, Detection mode = RMS or Average, Pre-amp = on, Input Attenuation = Automatic.
4. Calculate the gain of the donor antenna system by looking up the donor antenna specifications and subtract the coax loss. To find the coax loss use the manufacturer's specification for loss within the frequency band in use. It is usually specified as X number of dB loss per 100 ft. You'll need both the manufacturer's insertion loss spec as well as approximate donor cable length.
5. To determine noise power radiated (ERP) add donor antenna system gain to the noise power measure in step 2. [BDA Noise Power + Antenna system gain = Noise ERP]
   a. If this value is greater than −43 dBm the uplink gain must be reduced. **Note:** These are negative numbers, −43 dBm is a larger number than −48 dBm.
6. If Noise ERP is greater than −43 dBm, reduce the uplink gain of the BDA until the calculated Noise ERP is below −43 dBm.
7. This uplink gain value is now the highest gain allowed under FCC rules. **Never exceed this value while optimizing the BDA and verifying DAQ coverage throughout the building.**

22.12.1 Measuring Uplink Noise Power

The actual uplink noise value amplified toward the donor tower is needed to ensure the BDA is commissioned properly and will not exceed FCC noise power limits. If the BDA is equipped with a UL squelch feature this procedure will also verify correct squelch operation. If the noise power is significantly more than expected, troubleshooting will need to be done before enabling the UL amplifier.

Measuring UL Noise Power Test Procedure (Excel Worksheet)

Use the Excel worksheet, *BDA Optimization, Measuring Uplink Noise Power* for this procedure.

1. Complete steps A-1 through A-3 of the worksheet to determine donor antenna system gain.
2. Place a 50 Ohm termination on the mobile port of the BDA. If an active DAS place terminations on mobile ports of all remotes. This ensures the only uplink noise power in the system is thermal noise.
3. Set the BDA-DAS system for maximum uplink gain. If the BDA is equipped with squelch function, turn squelch OFF along with any other noise reduction features. Record the BDA UL gain value in Step 3 of the worksheet.
4. Measure the uplink noise power with the spectrum analyzer set to 10 kHz resolution bandwidth and record the value in Step 6 of the worksheet.
   a. Any amount of noise power above the calculated value in Step 5 (it should measure more) is additional noise added by the BDA/DAS system.
5. If the BDA is equipped with UL squelch engage it now and verify that the uplink noise decreased by at least 20 dB. Enter noise power measure in step B-1.

Figure 22.12.1 Measuring UL Noise Power from BDA

22.13.2 Near-Far (Two Radio) Test

This test simulates the near radio's signal using a RF signal generator connected into the mobile port of the BDA through a directional coupler. A circulator is added to protect the signal generator from excessive power from the BDA.

Equipment required includes a signal generator, directional coupler, and circulator connected to the mobile port of the BDA and a few coaxial jumper cables. As an RF signal from the signal generator is injected, a manual DAQ voice test is done from a weak area. As mentioned in earlier chapters the jurisdiction may substitute a BER or SINR test as an alternate to DAQ testing.

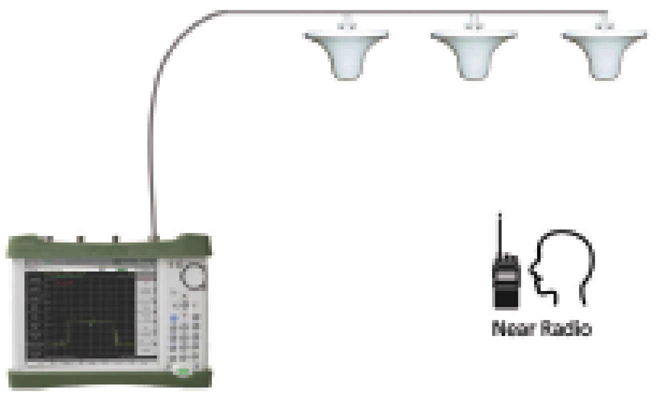


Figure 22.13.2a Step 1 of Near-Far Test

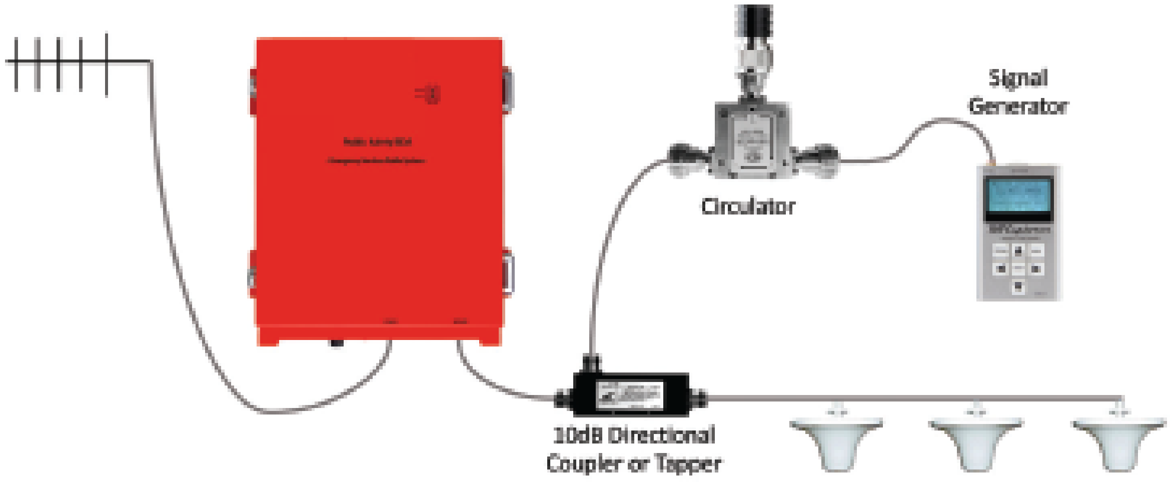


Illustration 22.13.2b Near-Far Test Configuration

22.11 The BDA Optimization Excel Worksheet

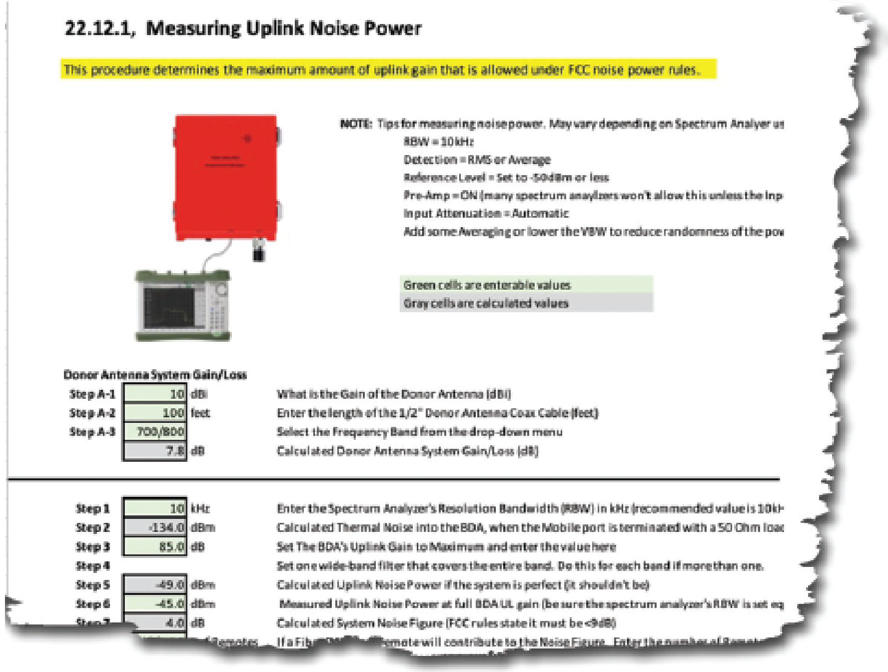
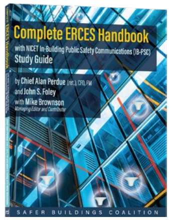


Figure 22.11 BDA Optimization Workbook

The UL optimization procedures in section 22.10 involve math functions with negative numbers which may be confusing to some installers. In the following sections within this chapter we introduce a new Excel worksheet to help with those calculations. Not all tests and optimizations use this worksheet, actually just a few. Most tests rely on basic dB math as we covered in Chapter 7. But for those that prefer a more exact solution we have the worksheet as a commissioning aid. It takes more variables into account and helps as a checklist to verify all tests were completed. It can also serve as a record of measurements and level settings as part of the close-out package.



Tools and Resources

ERCES Handbook Page 426

- RF Power Conversion Calculator
- RF Free Space Path Loss Measurement Calculator
- Free Space Loss Calculator for Distances in Feet
- Calculate Vertical Ant to Ant Isolation (Based on Dipoles)
- Calculate Horizontal Ant to Ant Isolation (Based on Dipoles)
- Calculate Return Loss and VSWR from Power out and Power Reflected
- BDA Optimization Excel Workbook

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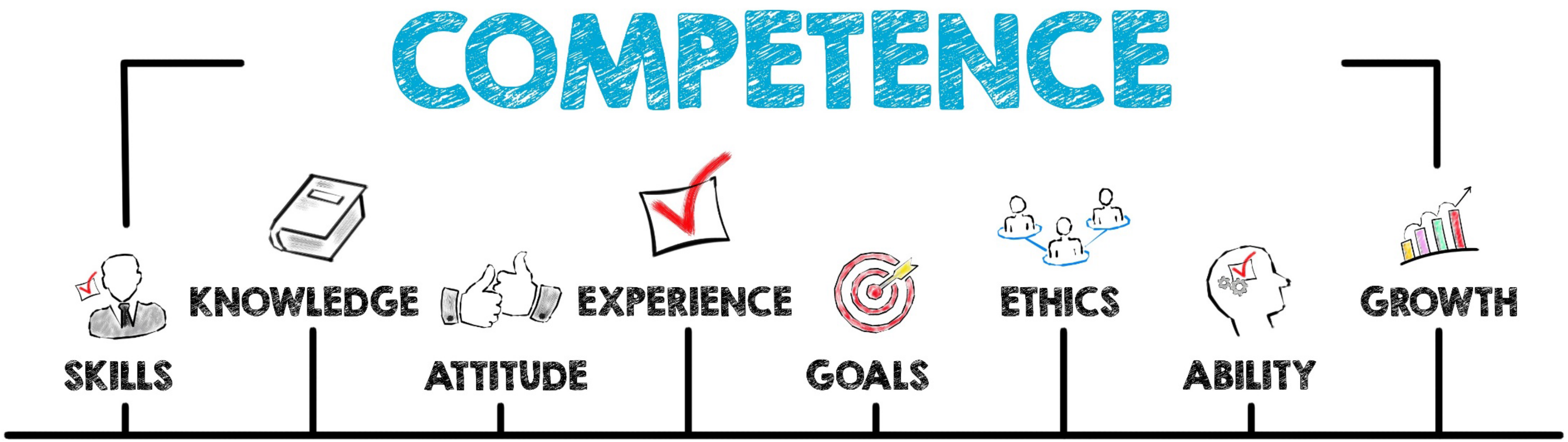
The Case for Competency

QUESTIONS TO CONSIDER

- Are Emergency Responder communications capabilities inside buildings important?
- Are ERCES considered part of the Life Safety eco system of a building?
- Does ERCES need to work when needed?
- Do the ERCES Stakeholders need to know what they are doing?

The Case for Competency

So, What is Competence?



Increasing the Competency of the Industry

IFC 510.5.3 Minimum Qualifications of Personnel.

The minimum qualifications of the system designer and lead installation personnel shall include both of the following:

1. A valid FCC-issued general radio operator's license.
2. Certification of in-building system training issued by an approved organization or approved school, or a certificate issued by the manufacturer of the equipment being installed.

These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the fire code official is provided.

SBC Qualifications of Personnel Principles:

1. Adopted codes require qualifications of personnel, which means individuals, not organizations.
2. ERCES are essential life-safety systems. The potential for these systems to cause disrupting interference to public safety communication networks demands that RF competency is paramount in determining qualifications of personnel.
3. Bodies certifying the qualifications of individuals must be competent to do so.
4. Competency of individuals must be evidence-based.
    a. Minimum acceptable principles for knowledge test development are detailed in the ISO/IEC 17024:2012 standard.
5. Credentials must be publicly accessible for inspection and verification, providing most current level(s), status, issued date, and expiration date.
6. Bodies certifying qualifications of individuals should require continuing education, ensuring continued competencies and accomplishments that align with affirming organization's requirements.
7. Bodies certifying qualifications of individuals must utilize a discipline process to enable performance feedback and corrective action.

Should We Certify Companies or Individuals for ERCES?

SBC issues position paper on ERCES Minimum Qualification of Personnel

Read in our January 2024 Newsletter

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SBC Seminars

saferbuildings.org/events

Date(s)	TZ	Market
31-Jan	E	Miami Area
5-Mar	C	Dallas
6-Mar	C	St Louis
14-Mar	E	Knoxville
23-Apr	E	Fairfax
25-Apr	E	Boston Area
7-May	M	Denver (Ft Coll.)
9-May	M	Phoenix
21-May	C	Chicago Area
22-May	C	Minneapolis
30-May	E	Charleston
13-Jun	E	Ottawa
25-Jun	E	Hempstead
27-Aug	E	Atlanta

Date(s)	TZ	Market
12-Sep	P	SeaTac
17-Sep	P	NO Cal
19-Sep	P	SO Cal
24-Sep	E	Northern NJ
26-Sep	E	Central FL
2-Oct	HA	Honolulu
7-Oct	P	Las Vegas
10-Oct	M	Salt Lake City
15-Oct	E	Toledo
17-Oct	E	Phila Metro
14-Nov	C	Birmingham
19-Nov	C	Houston
4-Dec	E	Fayetteville

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IWCE In-Building Track: March 26th, Orlando

SBC In-Building Public Safety Wireless Track Sessions:

Tuesday, March 26 | 9:10am - 10:10am
IN-BUILDING WIRELESS PART 1: THE CURRENT STATE
Moderator: Alan Perdue (Safer Buildings Coalition)

Tuesday, March 26 | 10:20am - 11:20am
IN-BUILDING WIRELESS PART 2: THE CASE FOR COMPETENCY
Moderator: Seth Buechley (Cathedral Consulting)

Tuesday, March 26 | 11:45am - 1:00pm
FLORIDA IN-BUILDING PUBLIC SAFETY COMMUNICATIONS – IMPROVE WHAT WORKS, FIX WHAT DOESN'T
Moderator: Charlie Fleetham (Project Innovations)

Tuesday, March 26 | 1:15pm - 2:15pm
IN-BUILDING WIRELESS PART 3: THE ROADMAP FOR A BETTER ECOSYSTEM
Moderator: John Foley (Safer Buildings Coalition)

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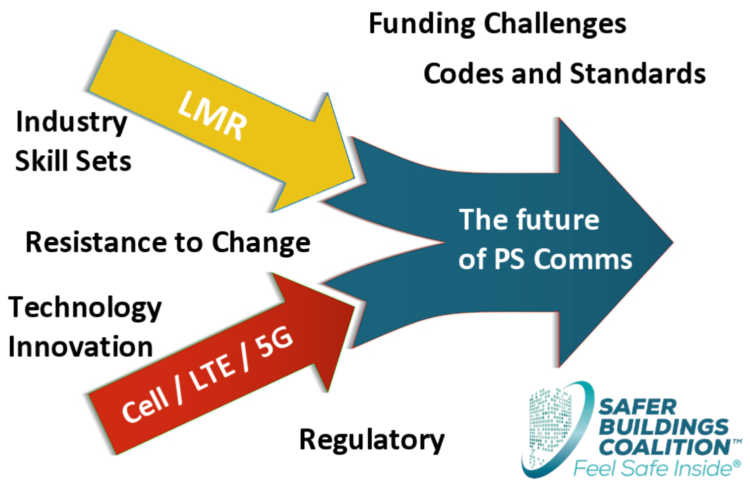
The Future – Best Path Forward?



- Broadband public safety comms is growing
  - FirstNet, HPUE
- New Technologies are coming
  - Mesh, 5G, Sat to Device
- FCC Rules need to be Updated
- Signal Boosters need to be tracked, monitored, and maintained
- Fire and Building Codes Need Updating
- Jurisdictions must document and share technical criteria and processes
- Industry Competency must improve
- Credentialing must expand

KEY TAKEAWAYS FROM TODAY'S PRESENTATION

- In-Building Wireless Dead Zones are a threat to life and safety
- ALL public safety agencies require in-building coverage
- The FCC finds that allowing signal boosters with express licensee consent serves the public interest.
- Building materials inhibit RF penetration into buildings.
- Fire and Building Codes require code-compliant in-building coverage for public safety.
- FCC rules dictate how and where signal boosters may be used.
- Use of signal boosters requires FCC License Holder Written Authorization.
- Building Owners and their Contractors are responsible for correcting harmful noise and interference.
- FCC License Holders must maintain reasonable operational control of signal
- Correct deployment of signal boosters relies on professional testing using quality, calibrated test equipment and radios tuned to the jurisdiction frequencies.
- Jurisdictions must supply necessary technical criteria and test procedures to contractors.
- COMPETENCY!

Q&A

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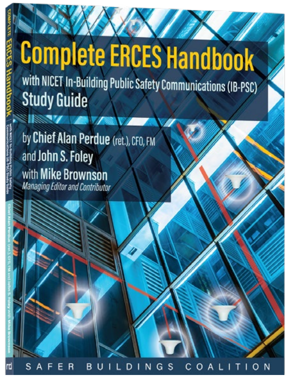
Advancing beyond



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There's so much more to learn!

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576-page ERCES reference

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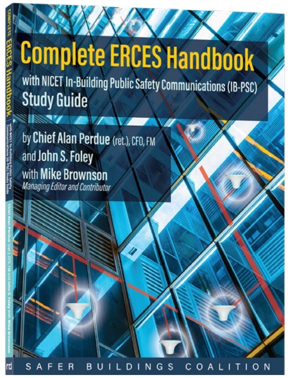

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