Interference from BDA and DAS

August 2023

Who am I?

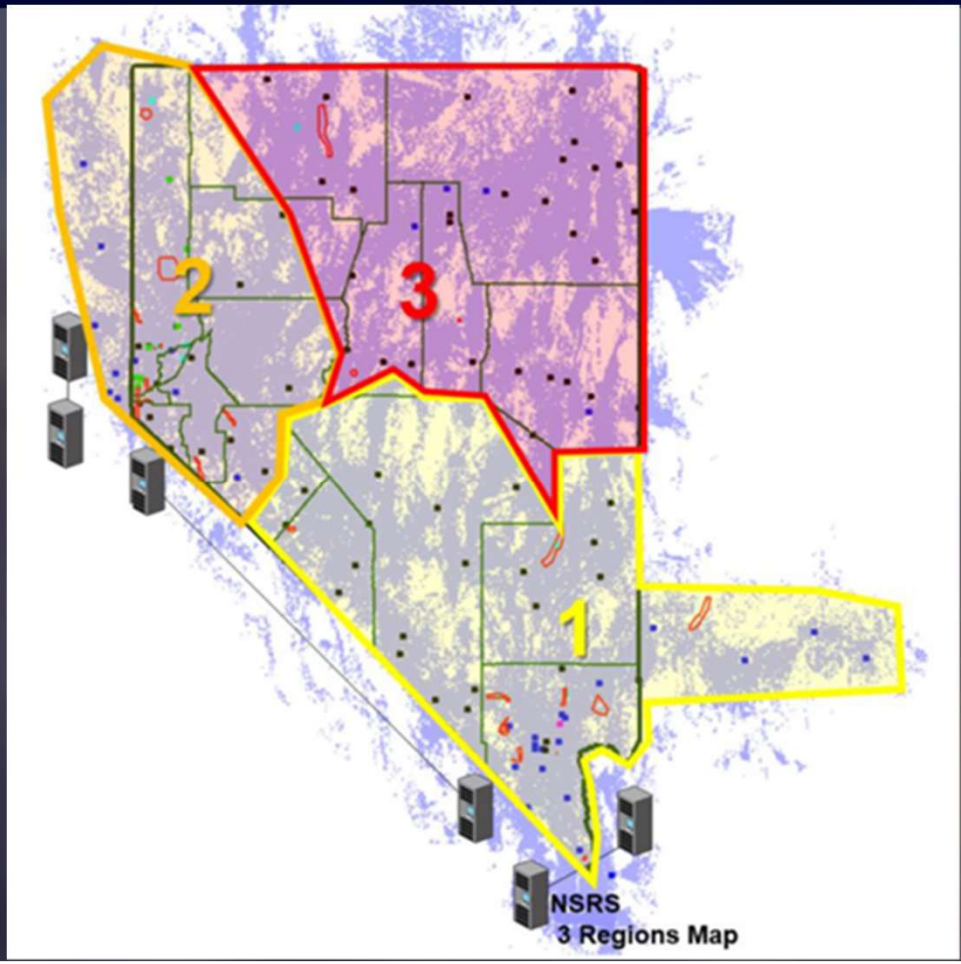
- Melissa Lawney
- Career:
  - 19 years in Telecommunications Industry, 25 Years in Technology
  - Washoe County Regional Communications Coordinator
  - Telecommunications System Engineering Manager at NV Energy
  - Field Engineer at the Nevada Test and Tactical Range (NTTR)
  - Telecommunications Specialist for ACEP
- Memberships:
  - Region 27 Chair for 700MHz and 800MHz Committees
  - Change Advisory Board Member of the Nevada Shared Radio System, as well as Technical Lead
  - Sierra Nevada Amateur Radio Operator & ARRL
  - APCO Member
  - AISES- American Indian Science and Engineering Society
  - Electronic Technician Association (ETA)
- ABET Accredited Computer Engineering Degree from Embry-Riddle Aeronautical University with Minor in Aerospace Engineering

Introduction- Region 27

- Region 27 is the entire state of Nevada.
- Washoe county is located in the Northwest Corner of the State of Nevada.
- Washoe county is the second most populated County within the State of Nevada (Second to Clark County located in Southern Nevada), with a population of ~500,000.
- The Washoe County Regional Communications System (WCRCS) is a regional radio system that consists of 12 Public Safety Agencies, and more than 4,000 radios.
- WCRCS is part of a bigger Statewide radio system called the Nevada Shared Radio System, NSRS.

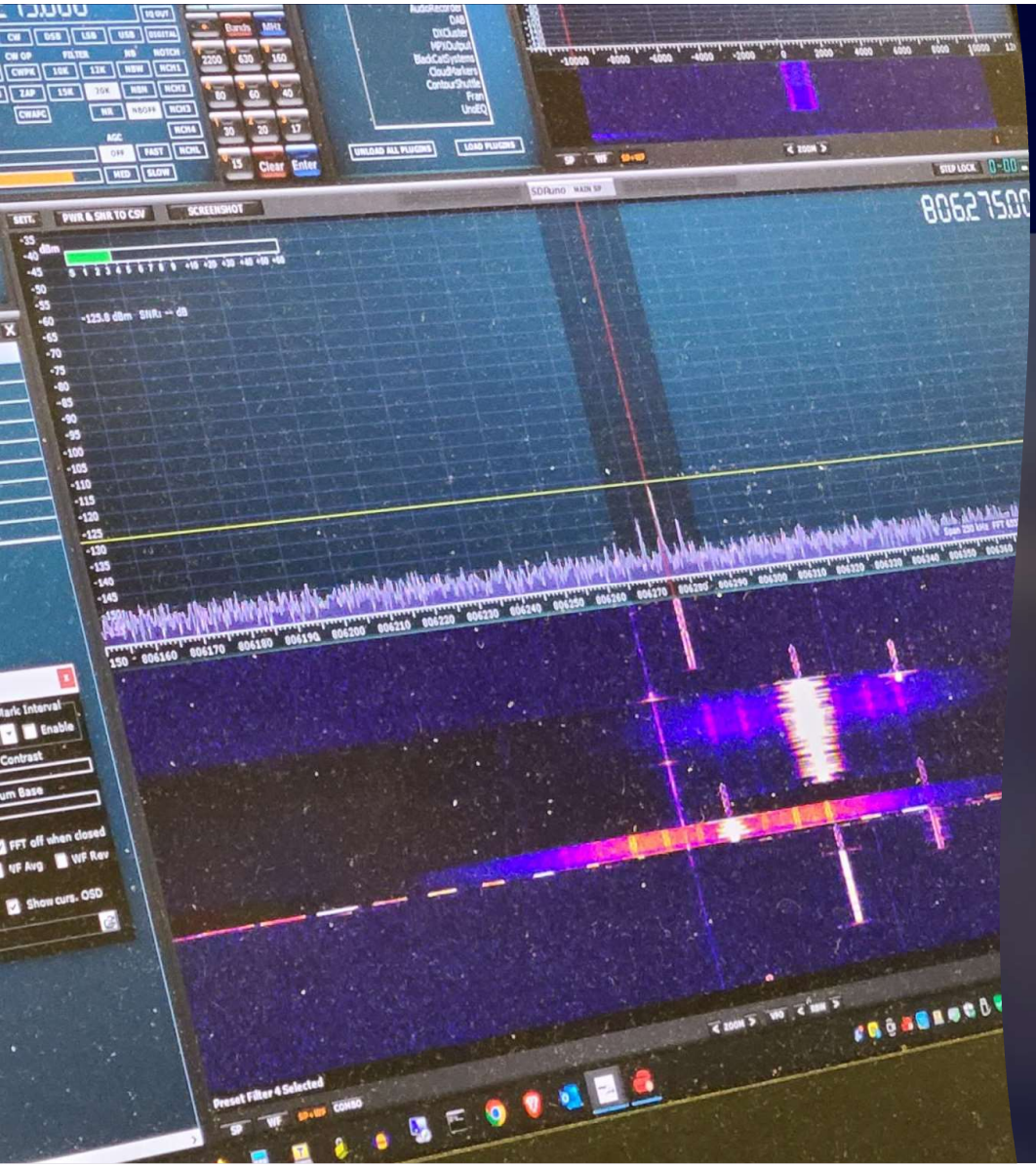
Welcome to the NSRS P25 Upgrade

- NSRS- Nevada Shared Radio System consists of 3 members:
  - Washoe County (WCRCS)
  - NV Energy (NVE)
  - Nevada Department of Transportation (NDOT)
- NSRS is a statewide system that seeks to cover 93% of roads and By-ways for the entire state of Nevada.
- The NSRS P25 Upgrade started in 2018 and is ongoing. This program will continue on until 2026.
- Frequency Licenses are shared between the members. So we are adopting one In-Building Enhancement policy for the Entire Nevada Shared Radio System



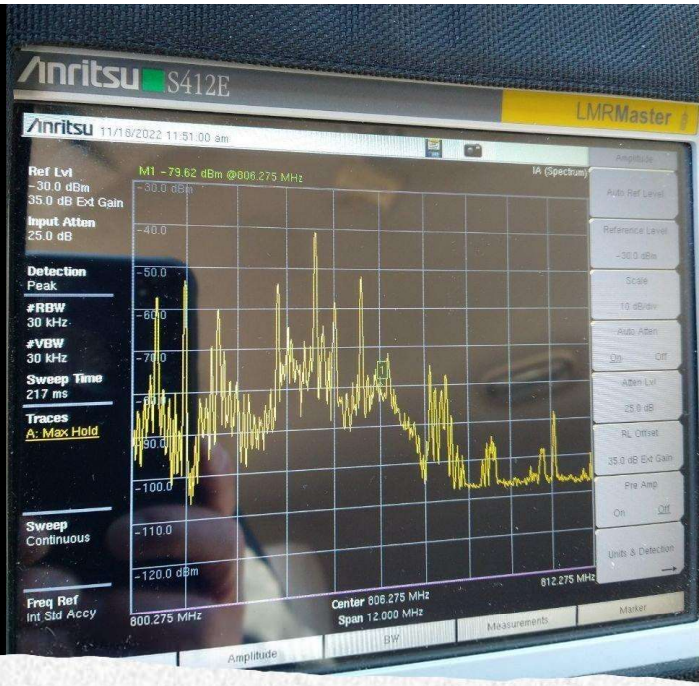
The Washoe County experience with BDA & DAS interference

Interference in Region 27- Washoe County: Our experience in 2022 with Interference that we couldn't find on a Spectrum Analyzer

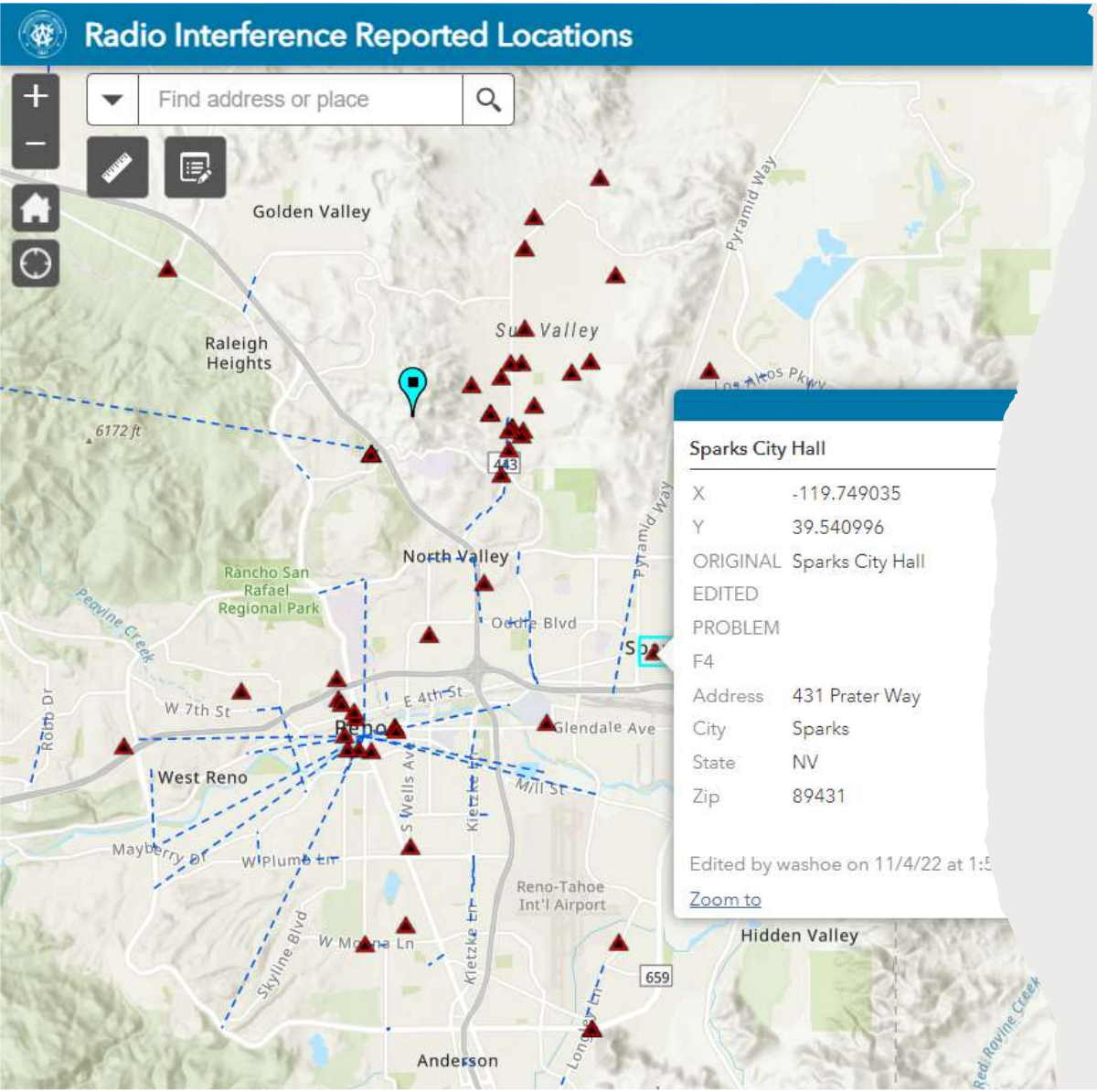


Introduction

- In Summer of 2022, Washoe County Regional Communication System (WCRCS) began experiencing Interference on the Washoe County Simulcast System (WC Metro: Red Peak and Peavine Peak).
- WCRCS had two major interferences issues:
  - General and constant “noise” or static in certain parts of the service area
    - This interference degrades the quality of communications. This noise can be heard in 10-20% of all communications.
  - Intermittent bursts of interference in certain parts of the service area
    - This interference is not always present but when it occurs, it completely blocks communication.
    - This primarily occurs in the area of downtown Reno, north to Parr Blvd.



- In July, WCRCS updated the L3Harris Vida Core to SR10.7A. Within a week Emergency alert (with unknown talk group) began appearing on our system. It was determined that Channel 3 on Red Peak couldn't be on the control channel. Issue was never formally resolved, Control Channel just moved for convenience of radio manufacturer.
- In August, Microwave Deployment started, and first reports of Interference began to trickle in. South Reno DMV was the first BDA that was turned off, as it was found to be adding considerably to the noise floor. (Red Peak was the Donor Site)



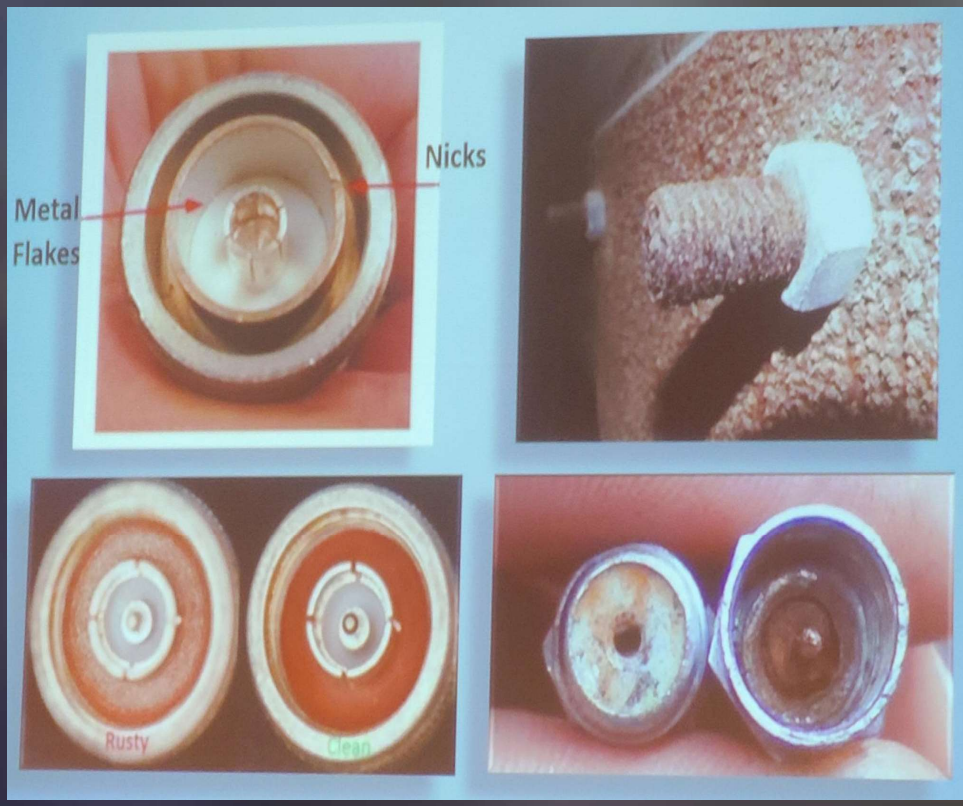
- By September, we hired a consultant to start investigating interference. The State (NDOT) turned off a BDA on Mustang Lane, and various Washoe County School BDA's had been investigated, and turned off.
- In October, throughout the microwave deployment, teams listened on radio to gather information and began drive testing to look for interference. WCRCS created the Interference Committee with dispatch supervisors (City of Reno, City of Sparks, along with Washoe County Sheriff's Office).
- We decided we needed more help.

Needing Additional Help…

- Reached out to National Regional Planning Committee for 700MHz & 800MHz to discuss interference experienced throughout the United States
  - Found various states experienced major issues with Comba BDAs
  - Found that some states are refusing any BDA that isn't a Class A Amplifier, Due to "oscillation" issues that occur 1 year after install.
  - Received testing policies and guides to add to our own system documents and RFP documentation
- Some members had the opportunity to listen to the sounds recordings and suggested we look for PIM.
- Finally it was suggested to reach out to FCC field teams for assistance.

PIM

- PIM: Passive Intermodulation
  - It occurs under the following conditions:
    - Poor connectors
    - Bad Antenna or splitters
    - Antennas located too close to metallic objects
    - POOR INSTALLATION PROCEDURES!
  - Passive Intermodulation is a form of IM that is usually internal to the RF Part of the System
  - PIM is usually caused by inferior components or poor workmanships



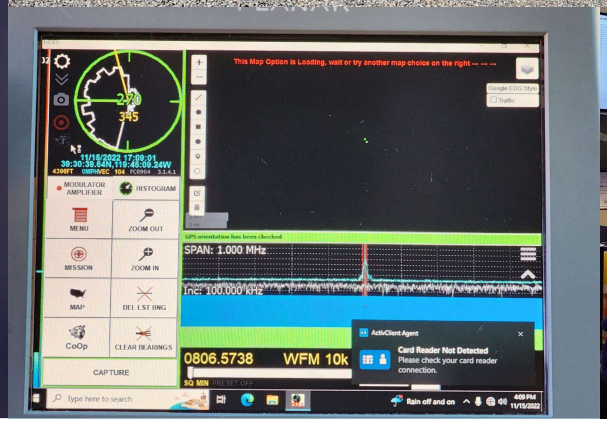
WCRCS Checklist

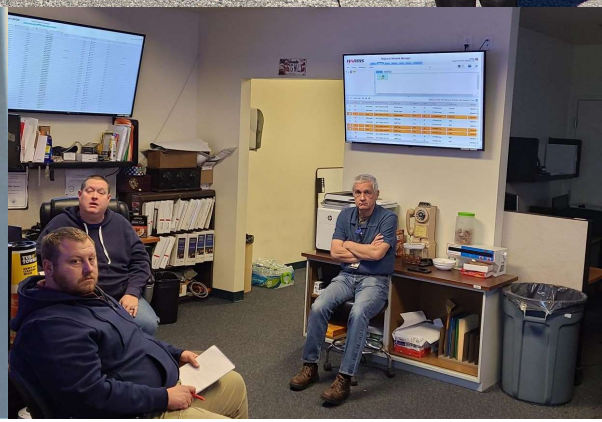
- Prior to FCC coming out in November the Washoe County Regional Communication Team did the following things:
  - Complete Channel by Channel Radio Assessment
  - Complete a Simulcast Re-alignment
  - Drive test looking for spurious signals with a spectrum analyzer, unable to locate interference signal
  - Hire RF Engineer to conduct a Simulcast Re-alignment
  - By-pass receiver multi-coupler
  - By-pass Tower Top Amplifier (TTA)
  - By-pass Power Amplifier (Inside PA)
  - Physically visit the Interference areas to conduct Channel by Channel Assessment
  - Created Public Safety Radio Interference Committee with PSAP's to try and solve Interference issues
  - Create Interference Map for drive testing and isolation of Interference
  - Continued investigating rogue BDA's

- Visit all “Known” BDA or in-building Amplifier systems.
  - Found 11 Sites requiring major adjustments.
  - Turned-off over 30 site BDA’s
  - Fixed or reconfigured sites with system’s we are familiar with
- Used Ultrasonic noise finder @ Red Peak to rule out the following:
  - Electrical Pole Leakage
  - Impulse sounds/ Intermodulation running along fences and within the building or building at Red Peak

FCC Engagement: A Community effort

- The week of November 15th, 2022, FCC sent a Field agent to assist us in our Interference Hunt.
- FCC downloaded a database a potential offenders.
- The Washoe County Regional System brought 7 Agencies from within the community, to the initial FCC Meet and Greet to discuss the Interference & Create a Route.
  - Washoe County Sheriff's Office
  - City of Reno
  - Local RF Engineers & Ham Radio Operators
  - Local Radio Broadcaster
  - Local Cellular providers

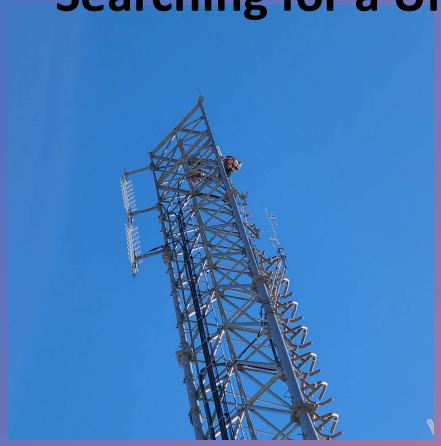


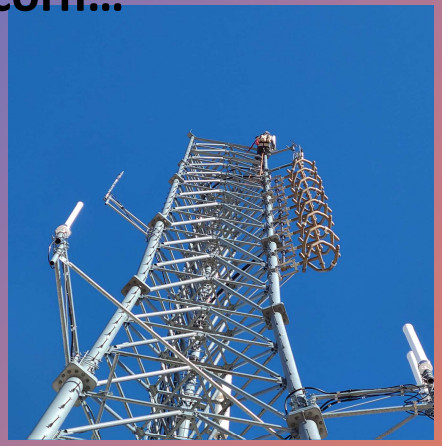


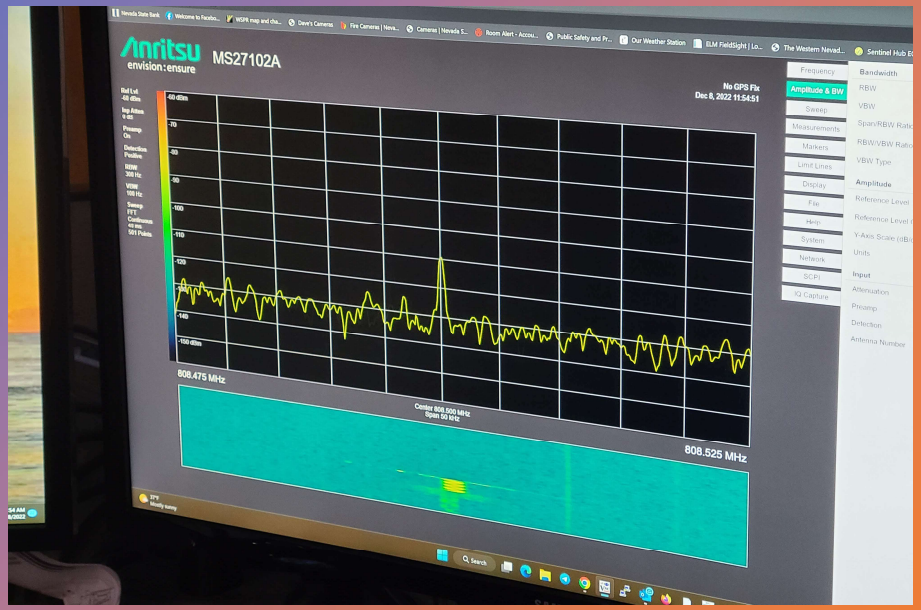
FCC Field Agent Investigation

- FCC Investigation included:
  - Turning off DMV BDA without citation
  - Turning off a Local TV Broadcaster
  - Checking all Solar Arrays
  - Checking all New buildings built within last 6 months
  - Checked Weather Tower & Radar systems
- Despite all efforts continued to experience the “transformer burst of Noise”
- FCC Recommended hiring an RF Engineering Firm to come assist the team in locating the source of interference. (Interference was deemed a Unicorn)

Searching for a Unicorn…



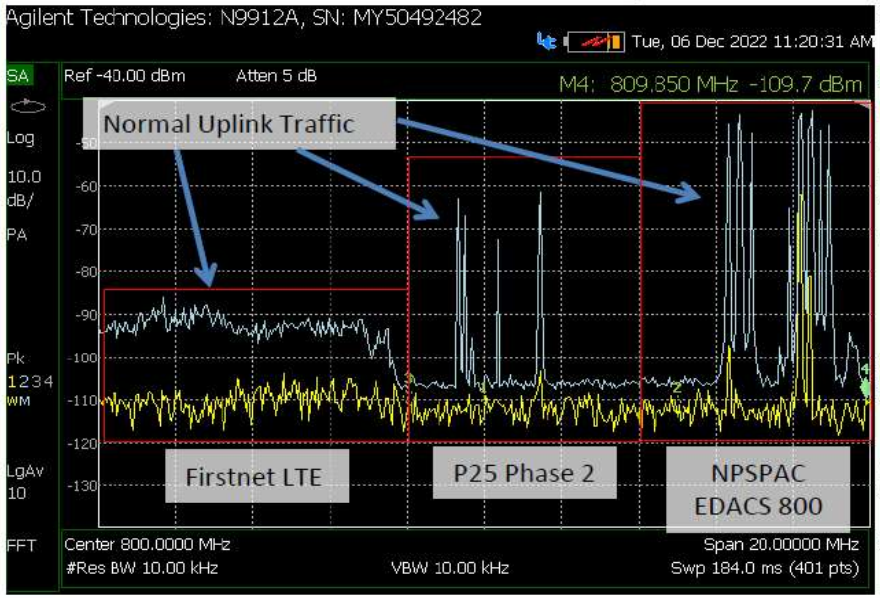




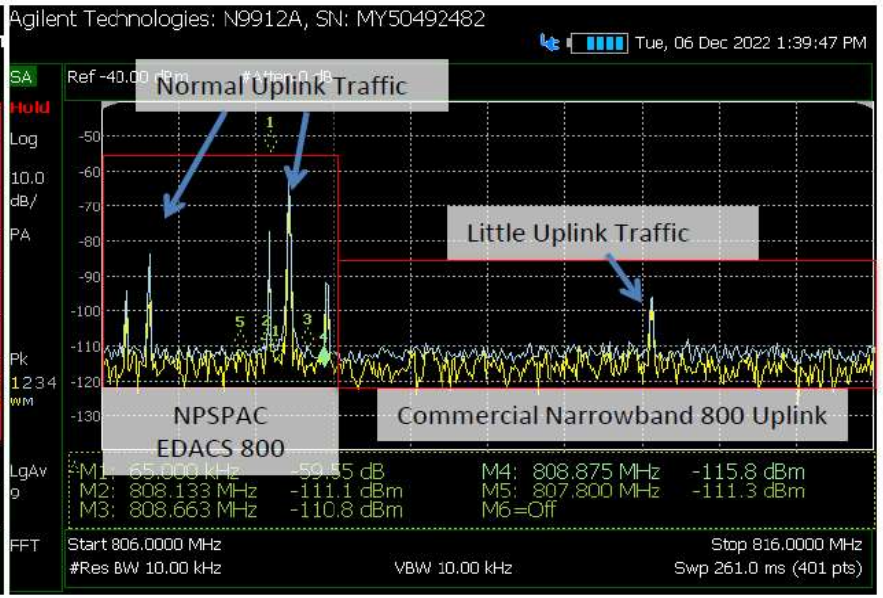
- Physically inspected all Antenna's connectors and feedlines for P25 System, and EDACS system at Red Peak and Peavine Peak looking for the possibility of PIM
- Hired RF Engineer to assist in all efforts
- Hired Tower Crew for Antenna Investigation
- Engaged FCC for assistance
- Finally Hired Pericle Communications to assist in finding the interference

Red Peak Testing- Receiver Multicoupler

- **Initial Testing – Spectrum Analyzer**
  - Red Hill Receiver Multicoupler



Uplink Measurement 790-810 MHz

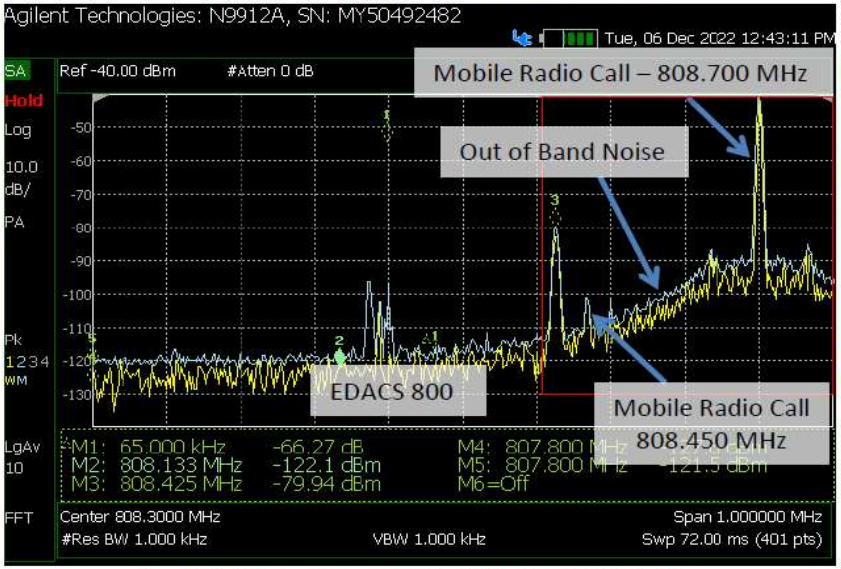


Uplink Measurement 806-816 MHz

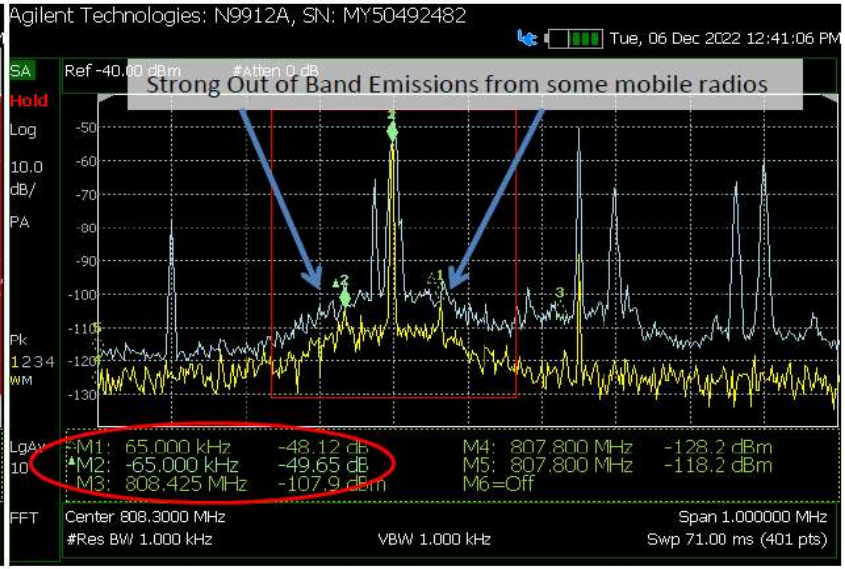
Yellow – Active Trace
Blue – Max Hold Trace

Red Peak Testing- Spectrum Analyzer

- **Spectrum Analyzer Results – Mobile Out of Band Emissions**
  - Red Hill Receiver Multicoupler



Uplink Measurement 807.8-808.8 MHz
Out of Band Noise (Phase Noise) in Adjacent Channel

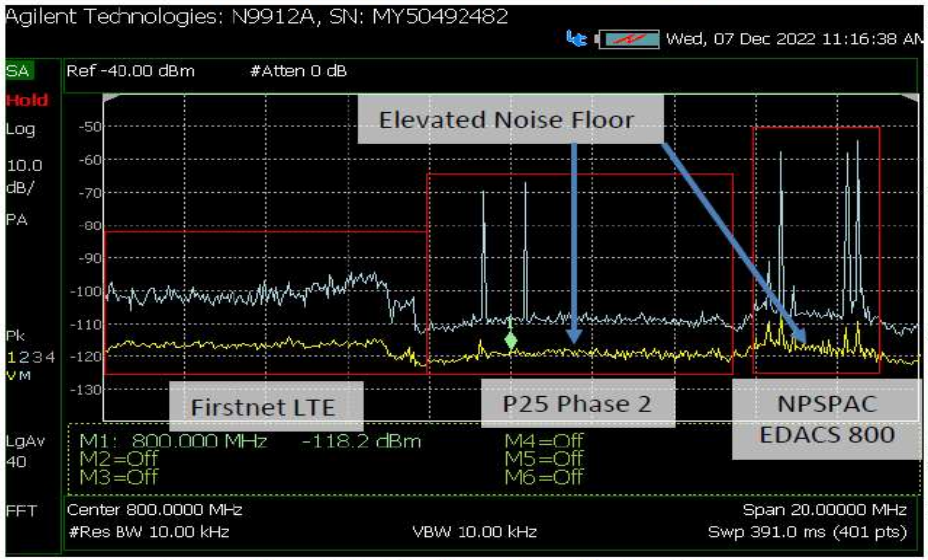


Spurious Emissions on adjacent channels – causing interference

Yellow – Active Trace
Blue – Max Hold Trace

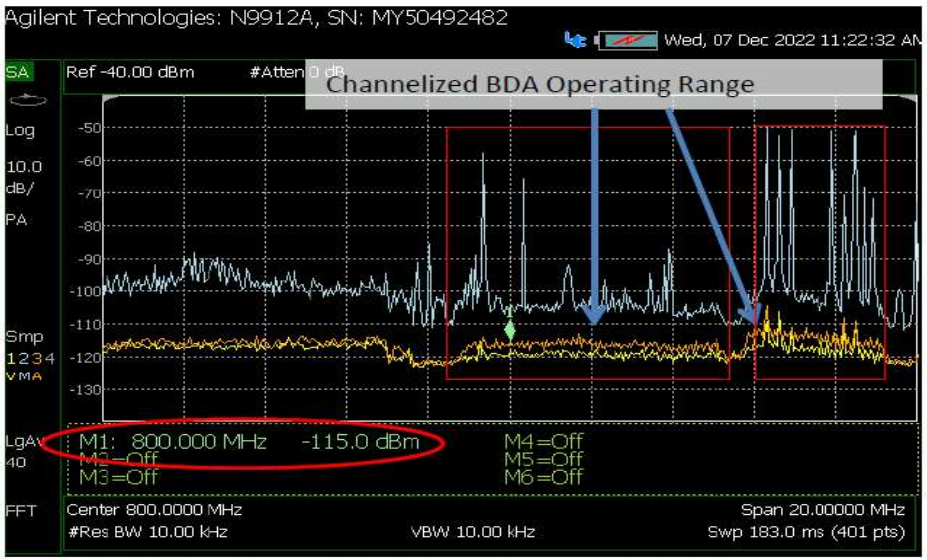
Nearby School BDA- Raised Noise Floor

- **Spectrum Analyzer Results – Nearby School BDA misadjusted**
  - Red Hill Receiver Multicoupler



Example of BDA Elevating Noise Floor

Yellow – Average Trace
Blue – Max Hold Trace

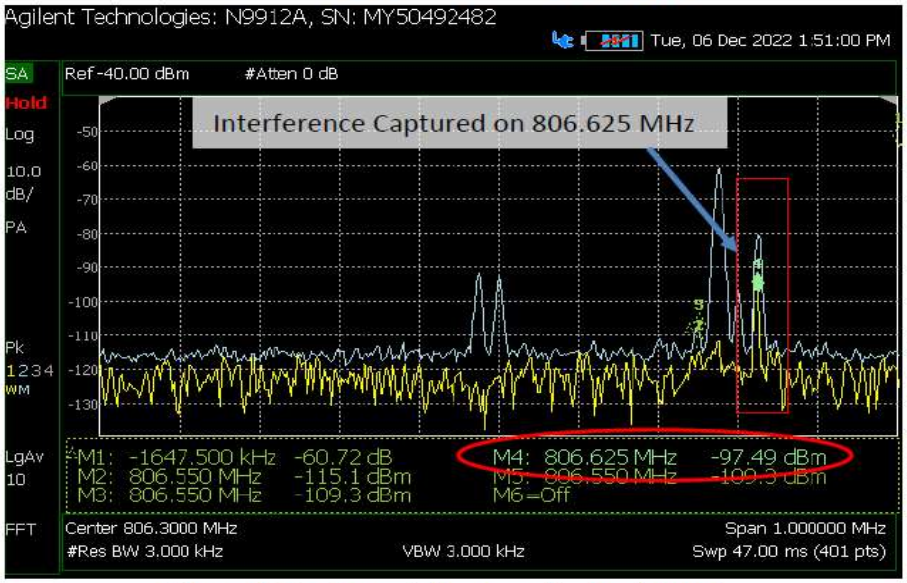


Nearby BDA Activated with Improperly Set Gain

Yellow – Average Trace
Orange – Reduced MCU Attenuation
Blue – Max Hold Trace

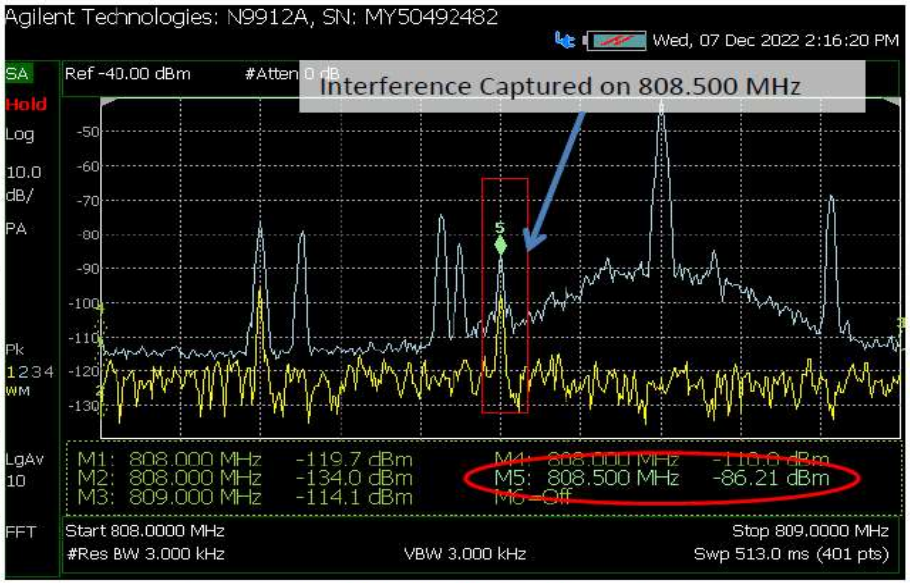
Interference Capture

- **Spectrum Analyzer Results**
  - Red Hill Receiver Multicoupler



Signal Captured During Noise Event

Yellow – Active Trace
Blue – Max Hold Trace

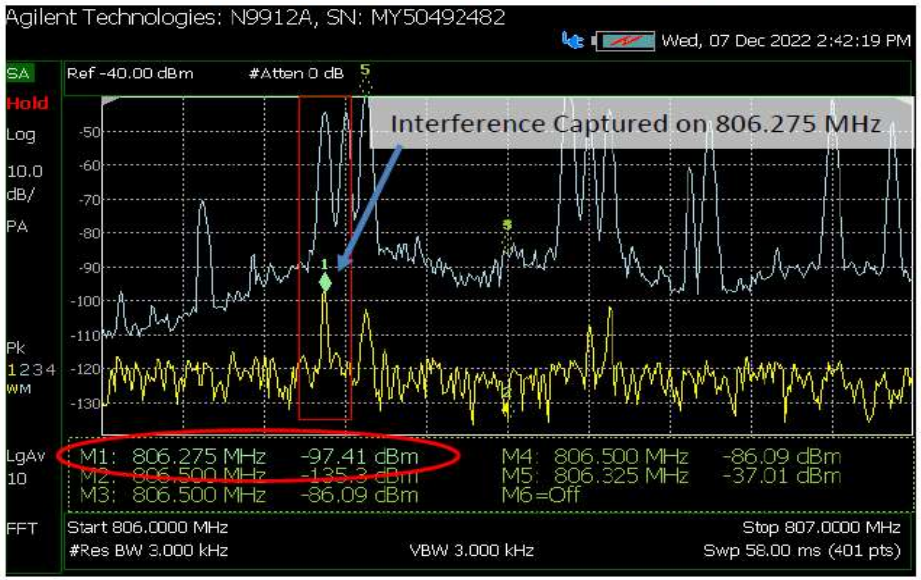


Signal Captured During Noise Event

Yellow – Active Trace
Blue – Max Hold Trace

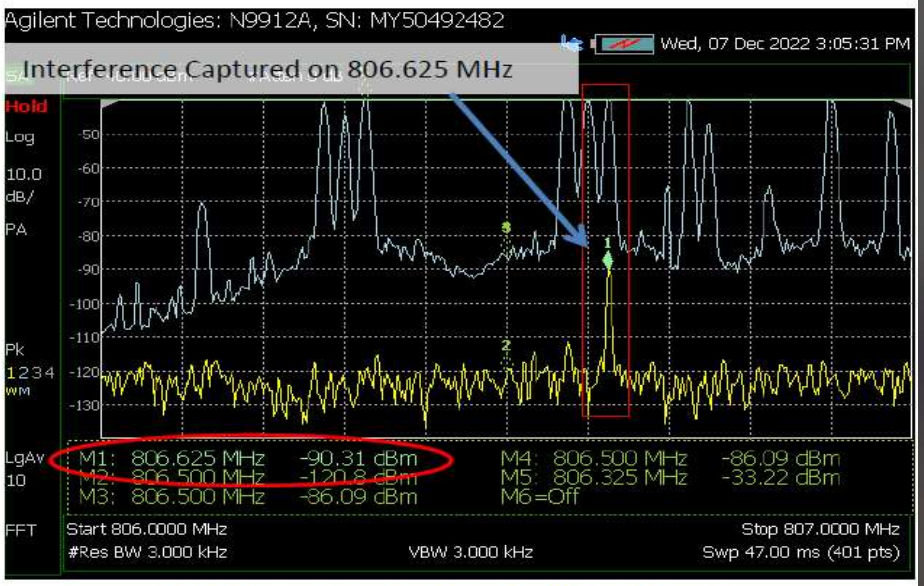
Another Interference Capture

- **Spectrum Analyzer Results**
  - Red Hill Receiver Multicoupler



Signal Captured During Noise Event

Yellow – Active Trace
Blue – Max Hold Trace



Signal Captured During Noise Event

Yellow – Active Trace
Blue – Max Hold Trace

Interference Characterized

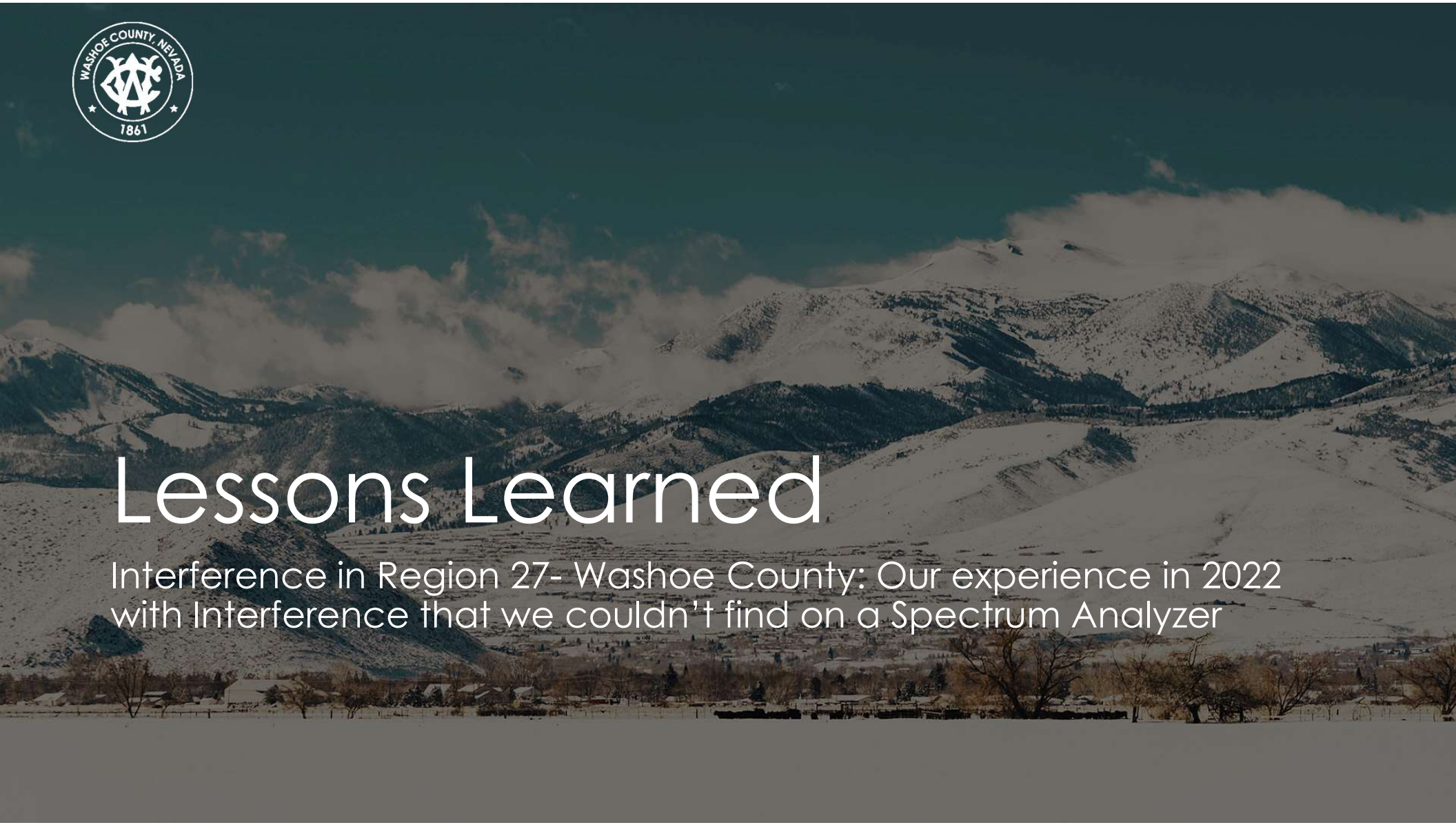
- **Interference Characterized**
  - Narrowband signal
    - Appeared during an uplink call
    - Stayed active for 2 seconds after mobile call ended
    - Appeared to include End of Call Signal only generated by the repeater output (GETC)
    - Appeared only on Washoe County Regional Communications System (WCRCS) channels
    - Had fixed magnitude between -95 to -98 dBm depending on the channel
      - Mobile calls could be -45 dBm and signal appeared at -95 to -98 dBm
      - Means the source was from a fixed location
    - "Transformer" noise only occurred when desired signal near the same level of the interfering signal
    - Occurred most often during busy traffic time of day (School bus voice activity)
    - Appeared within 25 kHz emission mask
    - Occurred all day after nearly every call
      - Could be tracked using drive test methods
        - » Go to a fixed location where signal is visible
        - » Use directional antenna to geolocate the source

- **Drive test plan**
  - Set up two drive test vehicles (MCRCS/Pericle Communications and Collins Communications)
  - Drive to various areas of the region searching for the signal
  - Collins Communications partitioned channel 5
    - Manually keyed channel 5
    - Interference stayed active
    - Made tracking the signal continuous on single channel instead of trying to follow calls on all channels
  - Tracked signal to 930 Evans Avenue, Reno (HERE Reno Student Housing Complex)

- **BDA Installation – 930 Evans Ave., Reno**

Poor BDA Installation

- **BDA Installation – 930 Evans Ave., Reno**



Lessons Learned

Interference in Region 27- Washoe County: Our experience in 2022 with Interference that we couldn't find on a Spectrum Analyzer

Lesson Learned

- Interference hunting is fun when you have a signal to trace, not fun when you can't find a signal to trace.
- RF Engineers are busy folks, it took some time to get one hired.
- Leveraging folks from the NRPC and APCO team really helped.
- Engaging the community really helped, our cellular vendors and Radio Broadcasters were very interested in helping us, and they also own tons of helpful equipment. Our PSAP's and Officers in the field were also ready and willing to go out with us on field visits, and hunt interference.
- We needed stricter County codes, and Testing procedures for our Emergency Responders Radio Communication systems, or In-building BDA's and DAS'.

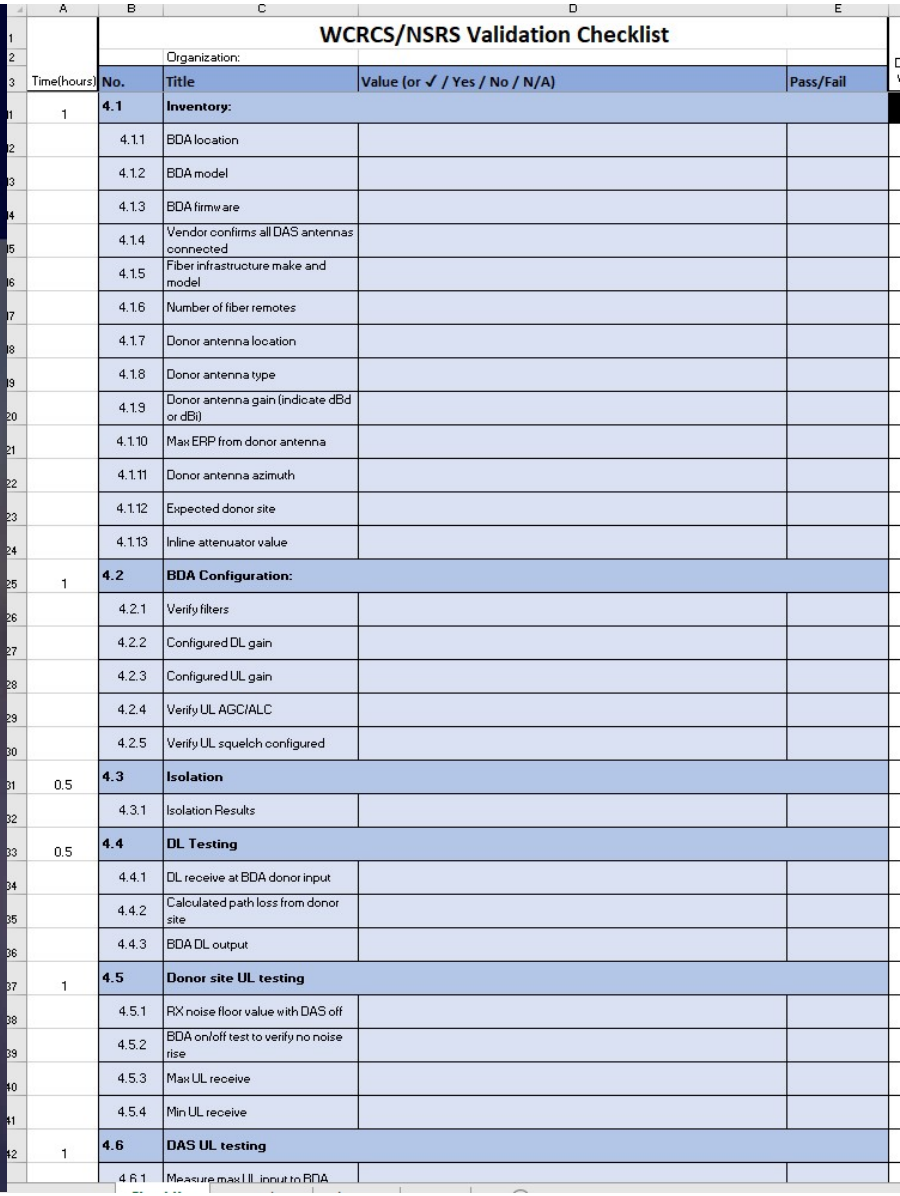
Lessons Learned Overview

- The BDA was eventually found and FCC took over the investigation.
  - BDA installer claims they followed a process, but it was determined that no process was officially followed. FCC issued a sanction against Business owner.
- Based off the information available to us.
  - It appears the BDA was configured incorrectly- it wasn't pointing at a single donor site, rather between two donor sites.
  - The box itself appears to have confused input configuration and output configurations, the Interference was on the carrier wave of the transmission.
  - On the spectrum analyzer it was found that our calls that had the interference held up a few second longer than a normal calls. The interference was within our own traffic- which is why we couldn't find a signal to trace. EDACS has a three pulse tear down- and that was being rebroadcast within the carrier signal.

- Washoe County Regional Communication System Has three distinct fire groups that were enforcing fire code, 3 different ways.
  - Truckee Meadows Fire Protection District
  - City of Reno Fire
  - City of Sparks Fire
- All Fire Teams had adopted the IFC 510 Codes for testing the BDA, DAS, and only when there were issues with the radios did they call Regional Services for assistance. Not all BDA's were being tested the same way twice.
- Communications team have been relying on the NFPA 1221 Standard for in building BDA/DAS systems (Now there is a new Standard NFPA 1225)

Checklist for testing

- Checklist has been created to have Vendors complete an informational form for our records,
- Within the Tabs is a Testing Tab that delineates how we plan on testing them, and what the expectations are for each individual test.

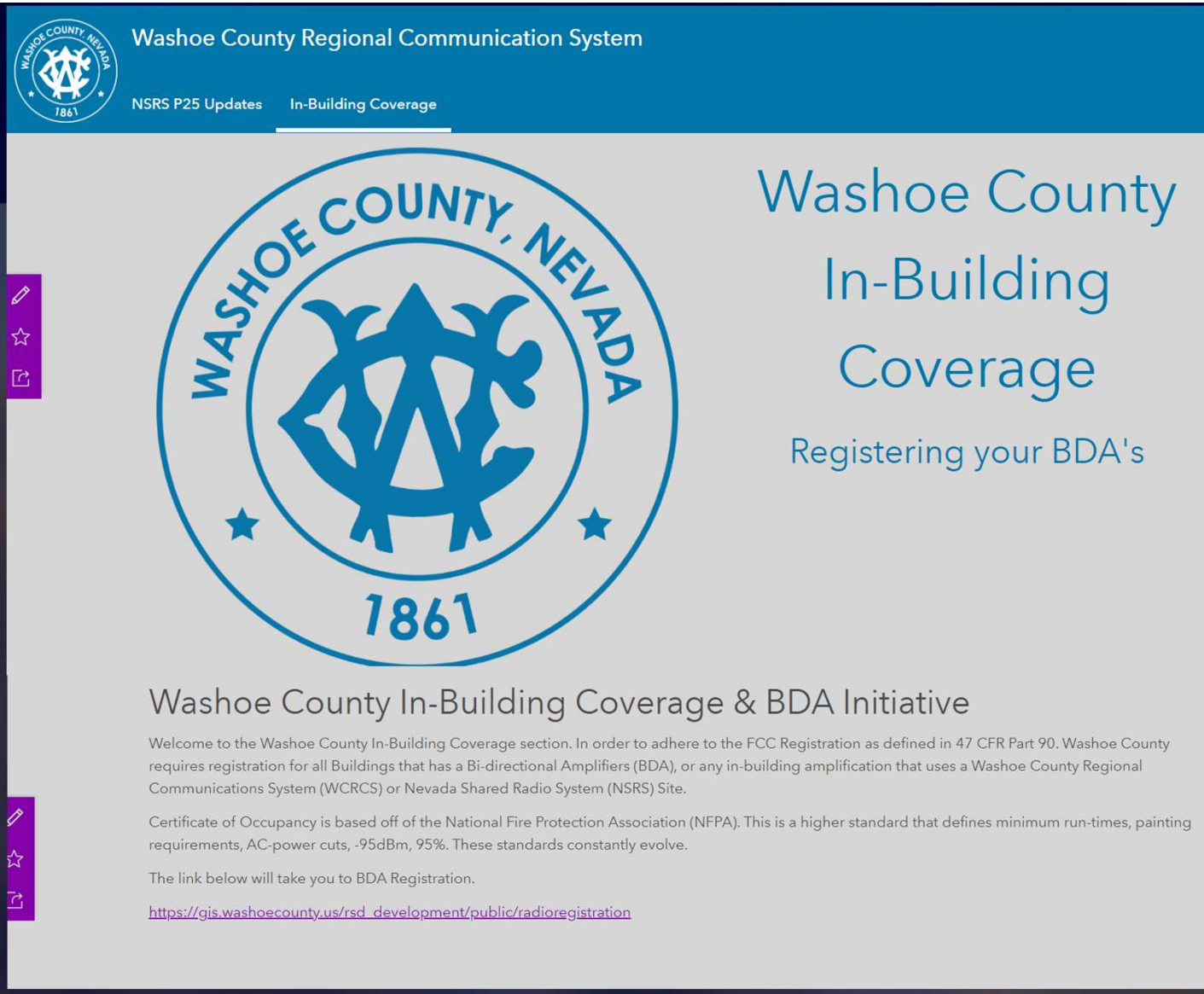


	A	B	C	D	E
1		WCRCS/NSRS Validation Checklist			
2			Organization:		
3	Time(hours)	No.	Title	Value (or ✓ / Yes / No / N/A)	Pass/Fail
31	1	**4.1**	**Inventory:**		
32		4.1.1	BDA location		
33		4.1.2	BDA model		
34		4.1.3	BDA firmware		
35		4.1.4	Vendor confirms all DAS antennas connected		
36		4.1.5	Fiber infrastructure make and model		
37		4.1.6	Number of fiber remotes		
38		4.1.7	Donor antenna location		
39		4.1.8	Donor antenna type		
20		4.1.9	Donor antenna gain (indicate dBd or dBi)		
21		4.1.10	Max ERP from donor antenna		
22		4.1.11	Donor antenna azimuth		
23		4.1.12	Expected donor site		
24		4.1.13	Inline attenuator value		
25	1	**4.2**	**BDA Configuration:**		
26		4.2.1	Verify filters		
27		4.2.2	Configured DL gain		
28		4.2.3	Configured UL gain		
29		4.2.4	Verify UL AGC/ALC		
30		4.2.5	Verify UL squelch configured		
31	0.5	**4.3**	**Isolation**		
32		4.3.1	Isolation Results		
33	0.5	**4.4**	**DL Testing**		
34		4.4.1	DL receive at BDA donor input		
35		4.4.2	Calculated path loss from donor site		
36		4.4.3	BDA DL output		
37	1	**4.5**	**Donor site UL testing**		
38		4.5.1	RX noise floor value with DAS off		
39		4.5.2	BDA on/off test to verify no noise rise		
40		4.5.3	Max UL receive		
41		4.5.4	Min UL receive		
42	1	**4.6**	**DAS UL testing**		
		4.6.1	Measure max UL input to BDA		

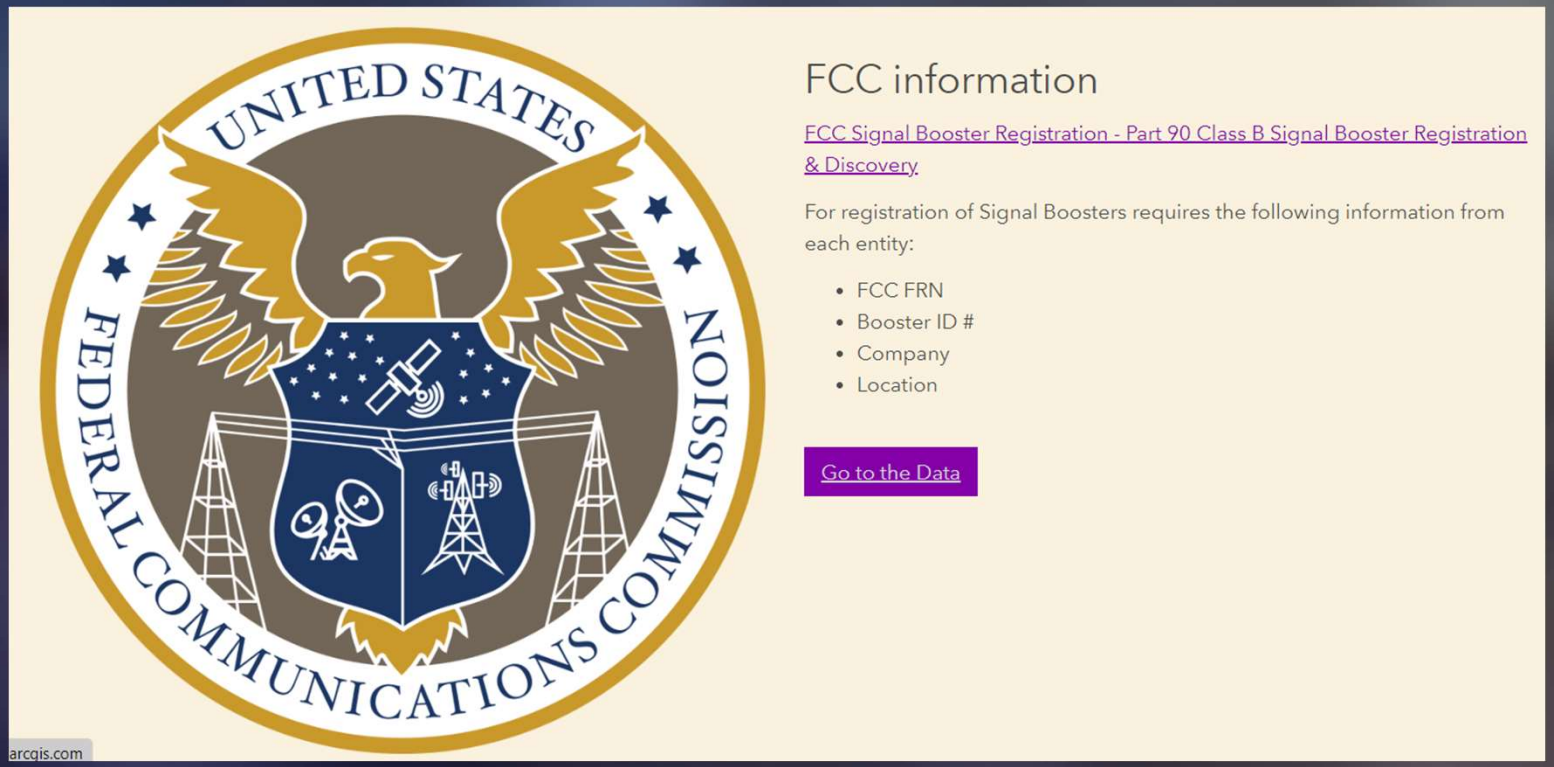
Website

- Part of the Permitting process within our County includes an Emergency Responder Communications section now where they are required to provide a heat Map, A design of the BDA system, along with Address/location, and Information requiring their GROL.

- This website was designed to begin having existing BDA's get mapped so that we have a record of their existence. This was to help us with Stating points for interference tracking.



In-Building Coverage Page



NSRS In-Building Coverage & BDA Initiative

Back to Washoe County In-Building Coverage & BDA Initiative

WCRCS Initial Assessment Request

Please complete all sections.

- Property Information
- Contact Information
- Acknowledge and Submit

Property Information

Project Name

Permit Application Number

Site Street Address

City

State

Zip Code

Project Information

Building Status

Select Building Status ...

Total Building SQ. FT.

0

Number of Floors

0

Escort Name

Escort Number

Washoe County Regional Services Department

NSRS In-Building Coverage & BDA Initiative

Back to Washoe County In-Building Coverage & BDA Initiative

WCRCS Initial Assessment Request

Please complete all sections.

- Property Information
- Contact Information
- Acknowledge and Submit

Contact Information

Contact Name

Contact Title

Contact Email

Contact Phone Number

Extension

Company Name

Street Address

City

State

Zip Code

Washoe County Regional Services Department
1001 E. 9th Street
Reno, NV 89512

WCRCS Initial Assessment Request

Please complete all sections.

- Property Information
- Contact Information
- Acknowledge and Submit

Building Owner Responsibilities

- Must comply with 47 CFR 90.219, FCC rules governing use of signal boosters
- Installer must have **FCC General Radiotelephone Operator License or Professional Engineering License with the State of Nevada**
- Must adhere to National Fire Prevention Code 2018 understanding the adopted requirements from NFPA 72 and NFPA 1221.
- The in-building radio system shall use a channelized BDA. The BDA shall be certified Class “A” FCC-type accepted and must operate in accordance with FCC rules. The system must also be compatible and fully operational with both P25 Phase 1 and P25 Phase 2 for all channels.
- Provide design plans that complies with the In-Building Radio Communications Enhancement System Technical requirements. Documentation should include:
  - Sealed floor plans showing radio coverage for critical and general areas using industry-standard radio frequency computer-generated propagation modeling.
  - System is upgradable for frequency band coverage changes, including at a minimum both 700/800 MHz.
  - Record of all appropriate signal levels after the system implementation, as previously detailed.
  - Provide a floor plans heat map that color-codes the received levels.

Evaluator Responsibilities

- Generate Testing documents that Satisfy TMFPD requirements for Public Safety in-building Coverage
- Generate Test documents that Satisfy WCRCS requirements for Public Safety Coverage
- Conduct Signal Testing Documentation
- Compile Testing Results and provide Recommendations to TMFPD

Acknowledgements

(Check Box to acknowledge reading.)

By submitting this form, the building owner acknowledges that if signal enhancements are required; no Certificate of Occupancy, Certificate of Completion, or Project Finals will be issued or approved until an TMFPD approved signal enhancement system is implemented and a Retransmission Authorization form is issued by Washoe County WCRCS

Acknowledgements

(Check Box to acknowledge reading.)

By submitting this form, the building owner acknowledges that if signal enhancements are required; no Certificate of Occupancy, Certificate of Completion, or Project Finals will be issued or approved until an TMFPD approved signal enhancement system is implemented and a Retransmission Authorization form is issued by Washoe County WCRCS Radio Division.

☐ All enhancement systems must meet the currently adopted NFPA standards for coverage and installation unless otherwise stated in writing by the AHJ.

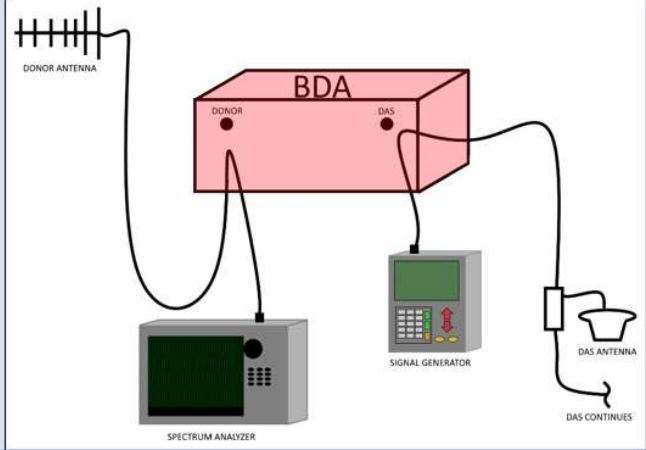
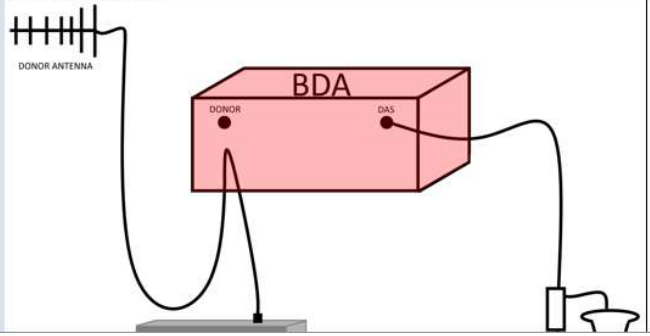
It is the sole responsibility of the building owner to fund the testing, equipment purchase, and system installation required to satisfy NFPA requirements

Submit

Cancel/Clear Form

Test Procedures

- WCRCS created a sheet for testing all BDA's, DAS, and ERRCS.
- The tests are writing into an excel sheet now, but is under development with our applications team, so we can build a Phone Ap for all our testers.

4.2.5	Verify UL AGC/ALC	If present as a feature. Required for new construction or new electronics.
4.2.6	Verify UL squelch configured	If present as a feature. Required for new construction or new electronics.
4.3	**Isolation**	
4.3.1	Isolation Results	If BDA supports self-reporting isolation, using that tool is acceptable. If not, • Connect Signal Generator to DAS cable infrastructure (cable disconnected from port on BDA labeled DAS/MOBILE/SVC) • Connect Spectrum Analyzer to Donor cable infrastructure (cable disconnected from port on BDA labeled DONOR/BTS) • If fiber infrastructure is present, confirm with DAS vendor input of +0dBm is acceptable for fiber point of interface • Generate test signal at XXX MHz at +0 dBm (or value confirmed with DAS vendor) • Identify receive of generated signal via donor antenna connected to spectrum analyzer • Document (Generated signal - measured value = isolation) e.g. (+0dBm - (-103dBm) = 103dB of isolation
4.3.1.1	Isolation Diagram	
4.4	**DL Testing**	
4.4.1	DL receive at BDA donor input	Connect spectrum analyzer to cable from BDA donor port. Record dBm of control channel with spectrum analyzer resolution bandwidth of at least 15kHz but no more than 50kHz
4.4.1.1	DL receive at BDA donor input diagram	

Educational Resources

- Safer Building Coalition:
  - Helps municipalities write building codes that help First responders as well as City and County government make better decisions
  - Join for FREE
  - https://sbc.memberclicks.net/

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Complete ERCES Handbook
with NICET In-Building Public Safety Communications (IB-PSC) Study Guide

Educational Resources

- ETA Electronic Technician Association
  - ETA International, Accredited Certification Provider
  - https://www.etai.org/
  - Education Forum - Technical Classes And Training Opportunities (etai.org)
-
  - IWCE Classes
    - Radio Frequency Interference Mitigation (RFIM)
      - Presenters: Tom Brinkoetter, LAS, Radio Site Test & Rob Rowlands, Gap
    - Wireless Distributed Antenna Systems (ERCES) - Code Compliance (DASC)
      - Presenter: Ira Wiesenfeld, PE, CETms(RF), IWA Technical Services, Inc.
      - Part of the committee that wrote the Standard for NFPA 1225

Contract Engineering Firms

Pericle Communications Company

- (719) 271-3633
- (720) 377-4094
- www.pericle.com
- 7222 Commerce Center Drive, Suite 180
  Colorado Springs, CO 80919

Mr. Joseph R. Kramer,
Senior Engineer
kramer@pericle.com

CSI Telecommunications, Inc.

- (415) 751-8845
- 6 Hamilton Landing, Suite 170
  Novato, CA 94949
- Contact Us - CSI Telecommunications, Inc.

Collins Telecom

- (775) 225-9191
- 21560 Dortort Dr;
  Reno, NV 89521
- info@collinstelecom.com
- sales@collinstelecom.com
- Customer support@collinstelecom.com

Pegasus Telecommunications Consulting Group

- (562) 370-7744

How to Contact the FCC

& Other Great resources for Interference Hunting

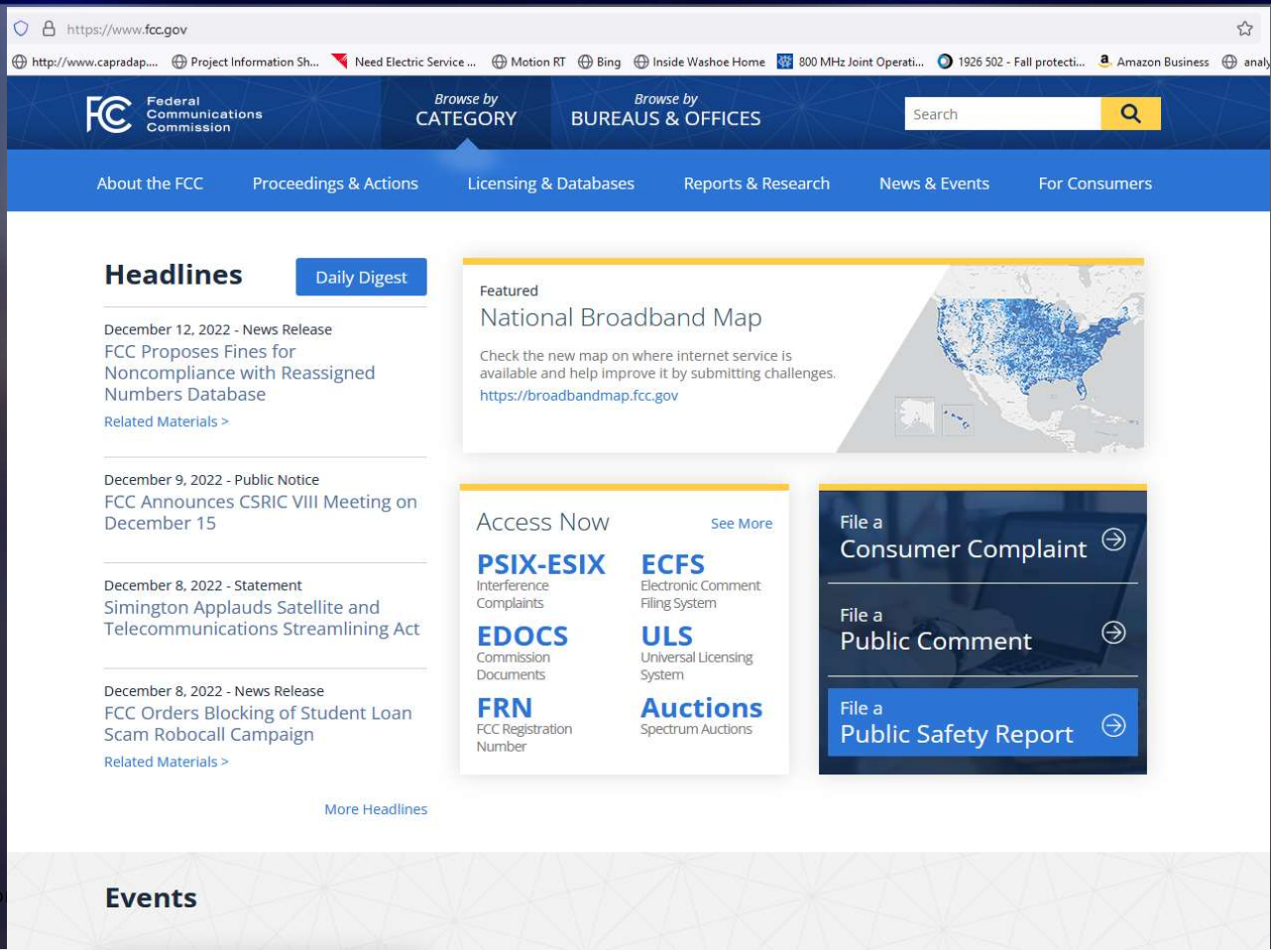
Interference Assistance

- ***APCO Website***
  - Training
  - Services
    - Standards
    - **RF Management**
    - Consulting
  - Technology
    - NG911
    - Cybersecurity
    - Interoperability
    - Spectrum
  - Advocacy
    - Public Filings

- ***FCC Interference Help***
  - Alert testing
  - Public Safety Reporting, requests & Inquiries
  - **Public Safety Interference Complaints**
  - Consumer reporting Complaints

FCC Interference Assistance

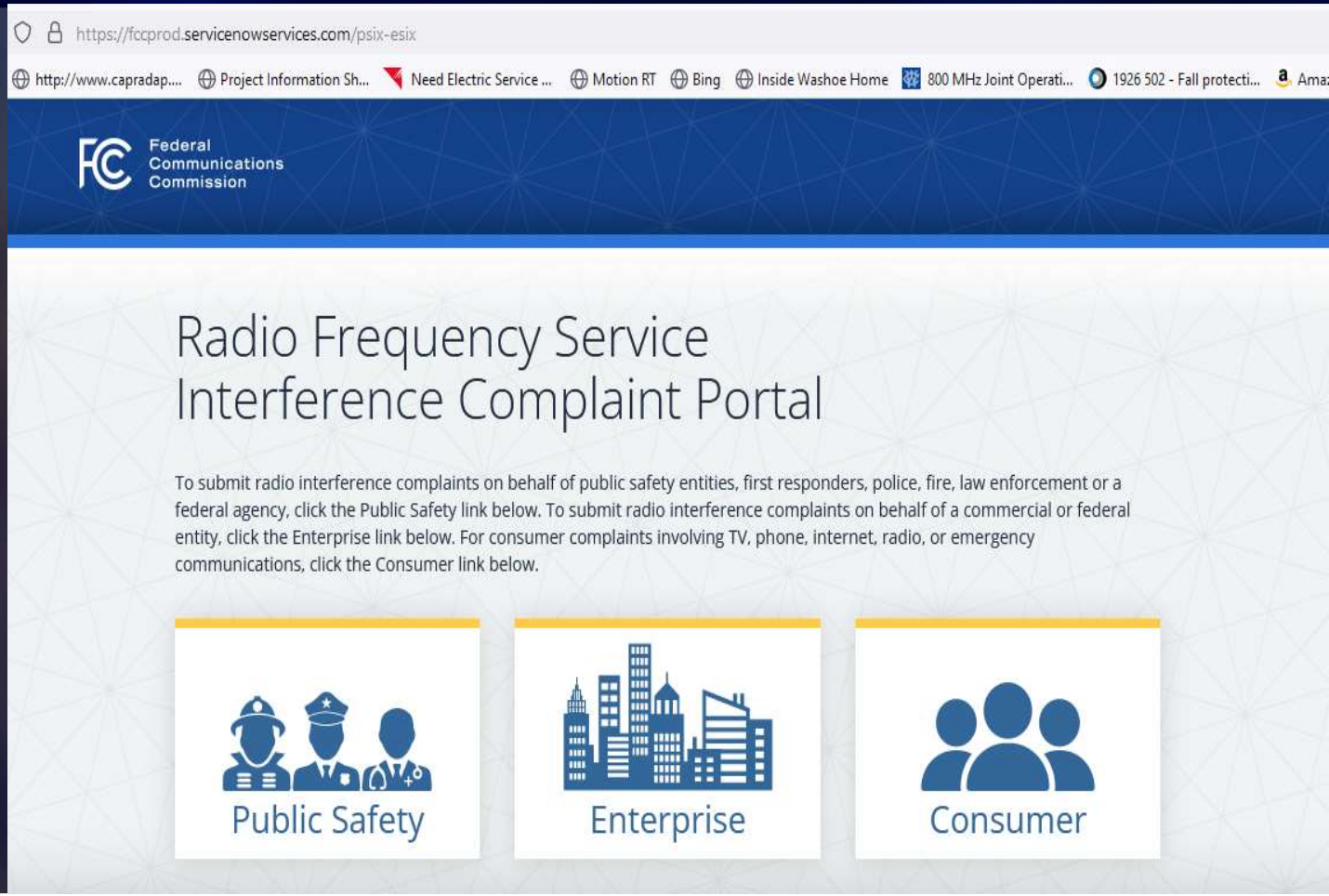
- Go to https://www.FCC.gov
- Click on Public Safety Reports
  - **It will take you to screen called Public Safety Support center**
  - **The support center has all kind of resources for PSAP's**



FCC Interference Assistance

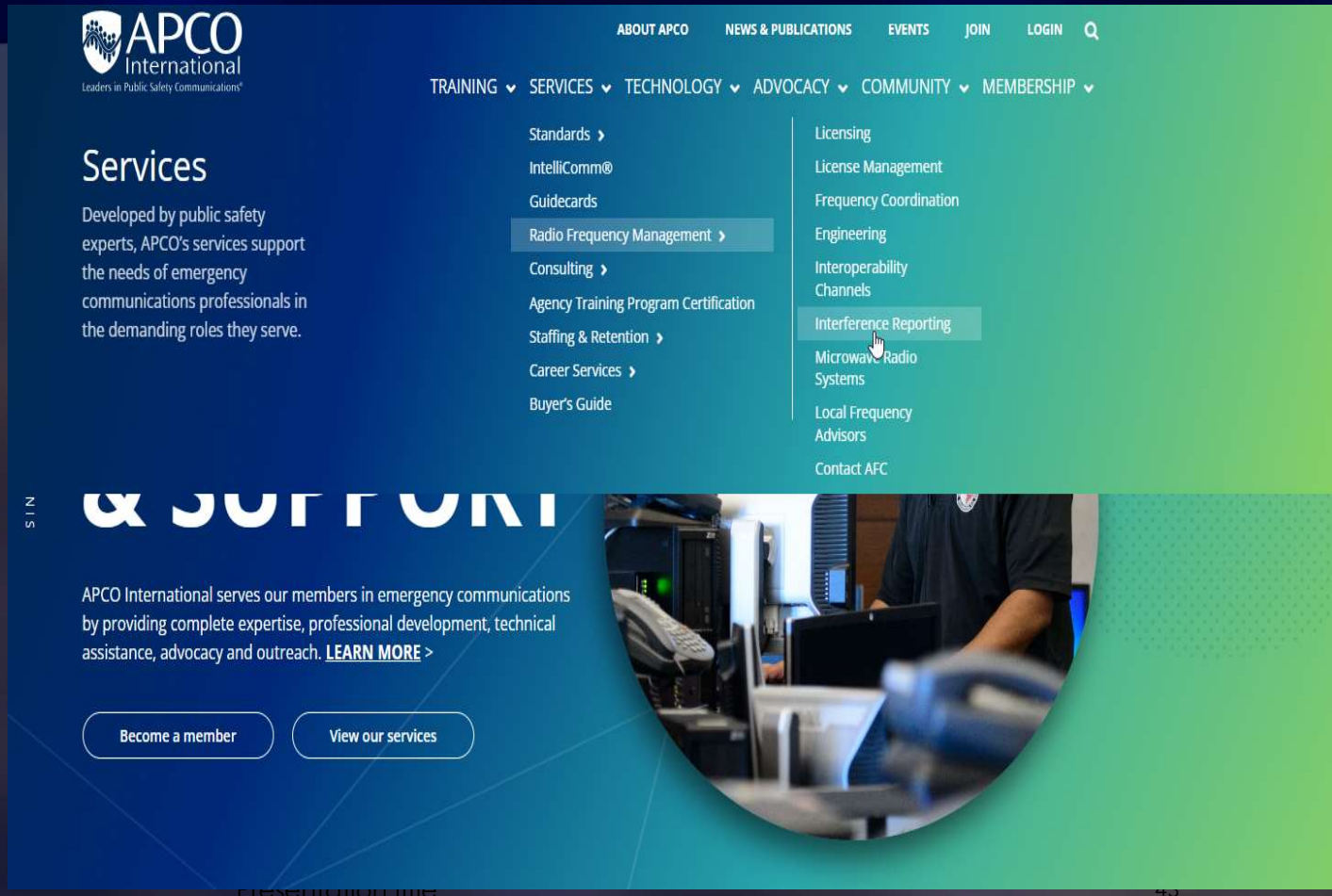
- Click on Public Safety Interference Complaints.
- Click on Public Safety

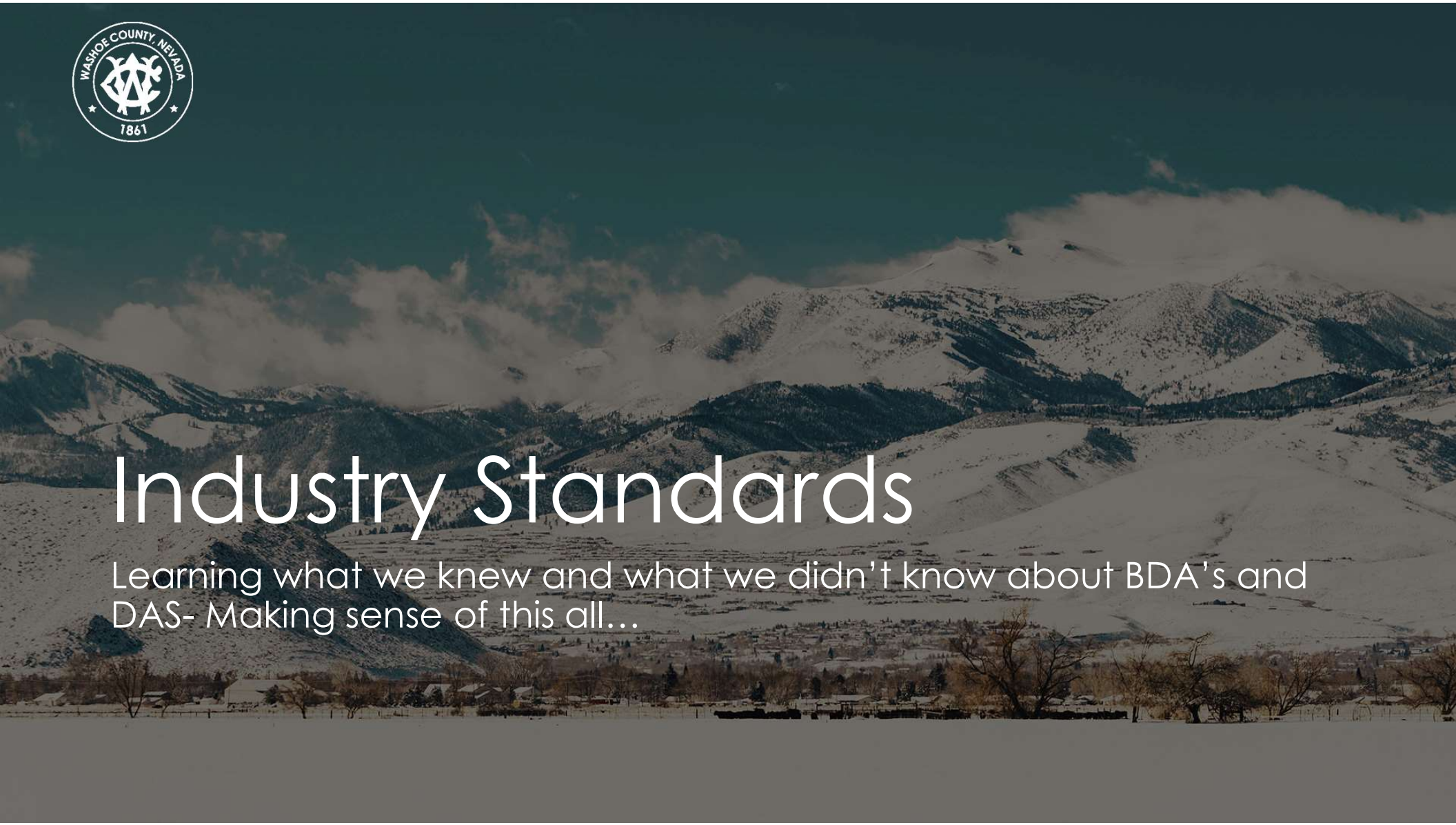
• On the splash screen there is a document you can download the PSIX Complaint Submission Guide.
• Download the guide and gather all the information you need.
• There is a sections where is asks for the degradation if you put more than 50% . As a mental Note : they will respond within 24 hours if that is selected. Everything else get put into a schedule, and you are handled in an order they receive your request.



APCO Website

- APCO International - Leaders in Public Safety Communications (apcointl.org)
  - Click on Services
  - Click on Radio Frequency Management
  - Click on Interference Reporting
- Complete the form as needed. APCO also has other resources and folks who can assist.





Industry Standards

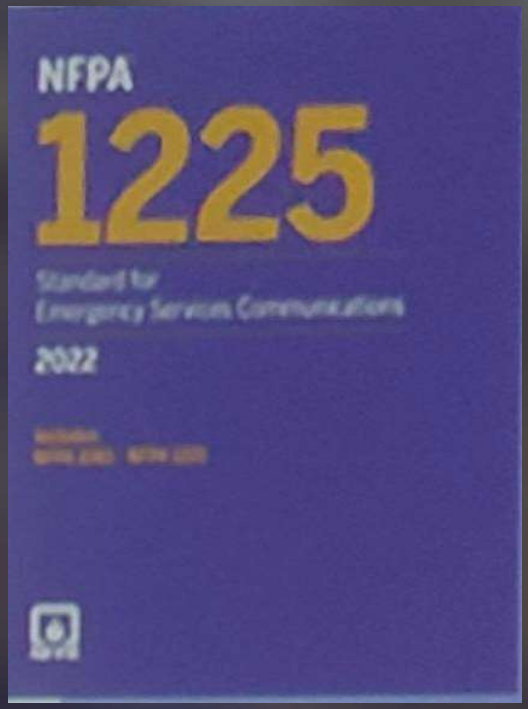
Learning what we knew and what we didn't know about BDA's and DAS- Making sense of this all…

What is a BDA, DAS, or ERRCS, and when do you need one?

- Terminology:
  - BDA is a Bi-Directional Amplifier
  - DAS- Distributed Antenna System
  - ERRCS- Emergency Responders Radio Communication System
  - All of these are the same (just different technology)
    - Law Enforcement in my jurisdiction uses the term BDA
    - Fire uses ERRCS matching Fire Code Language
    - IT Guys say DAS
    - FCC Says Signal Boosters
- BDA is required when Emergency Responders cannot send and receive radio traffic within a particular building
  - Signal outside must be above -95 dBm

DAS for Public Safety Mandate

- NFPA 1225-2022 National Fire protection Association- Emergency Services Communications
- NEC- National electric Code
- ICC International Code Council International Fire Code Section 510, emergency responder radio coverage. This council puts the IFC codes together.
- AHJ- Authority Having Jurisdiction: determines which code to be utilized for public Safety Radio Coverage
- FCC Rules and Regulations supersede all other requirements.

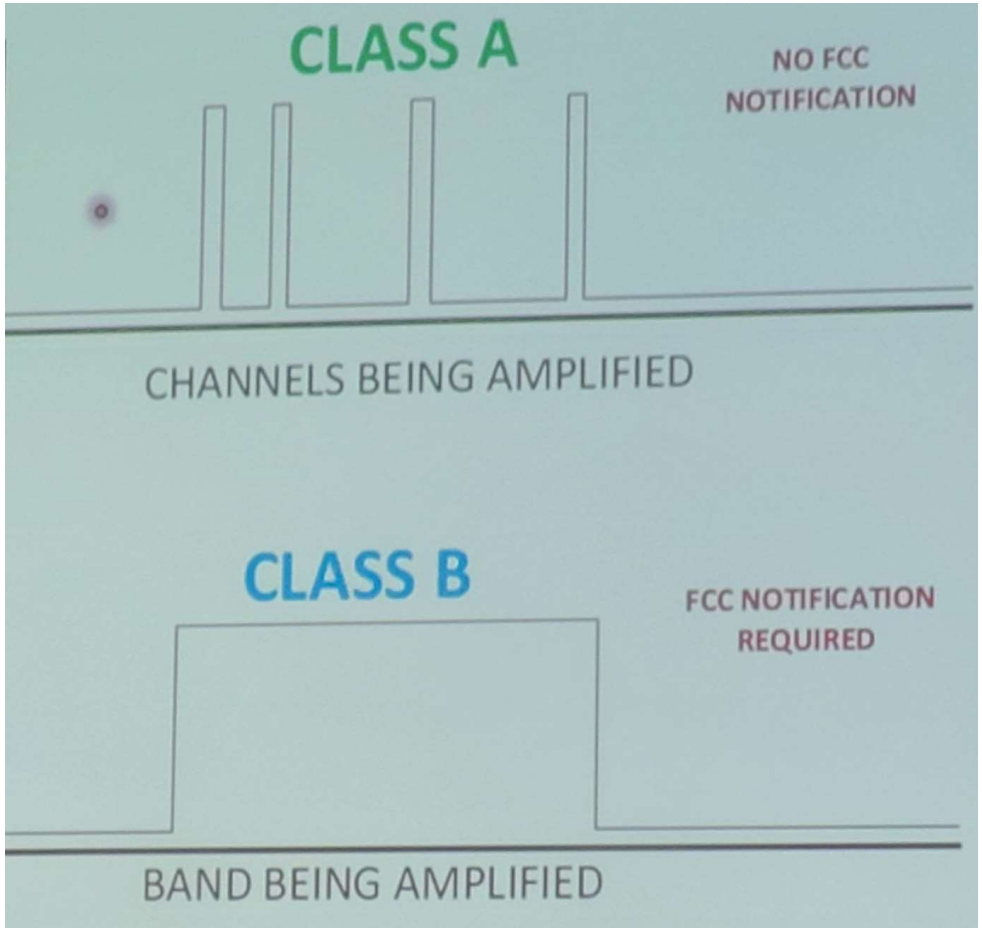


Basic DAS Configuration

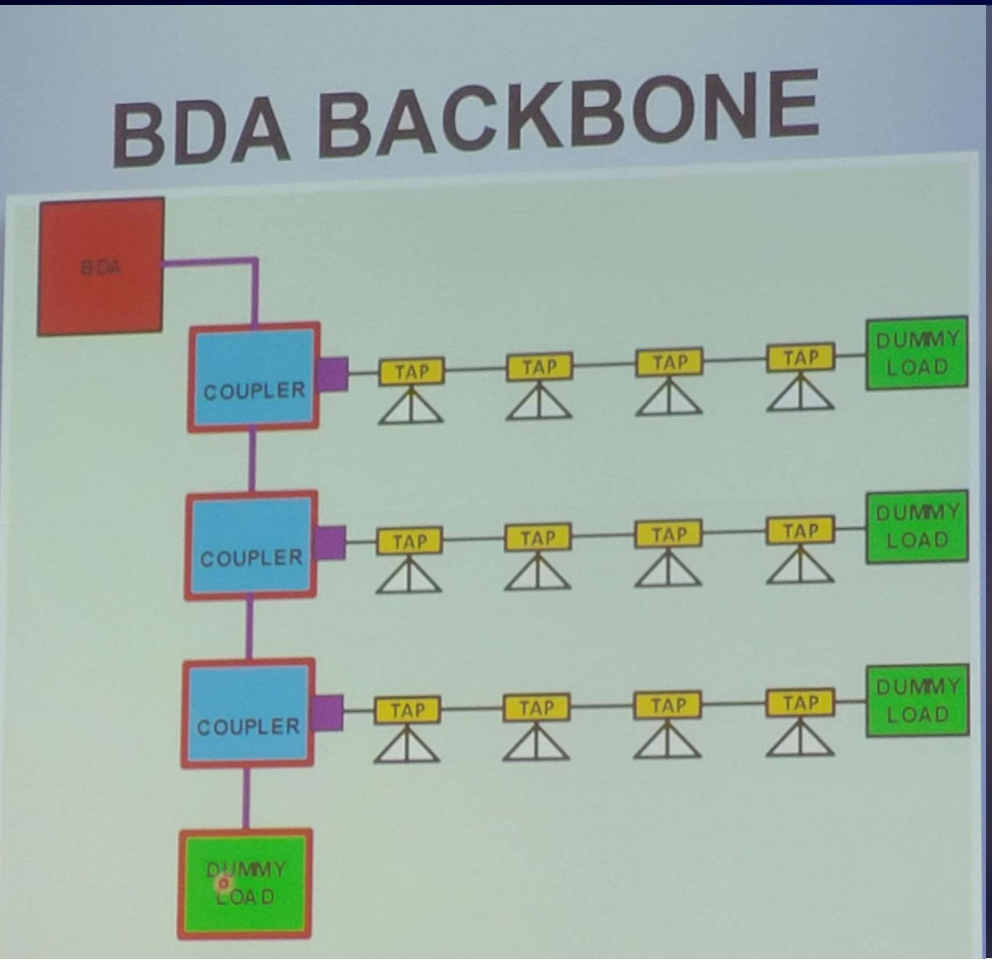
- Public Safety Communication Site
- Donor Antenna (rooftop)
- Distribution Antennas (Inside Antenna System)
- Signal Booster
- Battery Back-up

BDA Classifications

- Class A- Channelized BDA
- Class B- Broadband BDA
  - Class B signal boosters must be registered (as defined in 47 CFR 90.219 online at:
    - www.FCC.gov/signal-boosters/registration
  - Unauthorized use may result in significant forfeiture penalties, including penalties in excess of $100,000 for each continuing violation.
  - Class B (Channelized) DAS
    - Unique BDA used for P25 Phase 2 applications in order to mitigate Time Delay Interference. (>12.5kHz but < 75kHz)



Design Details

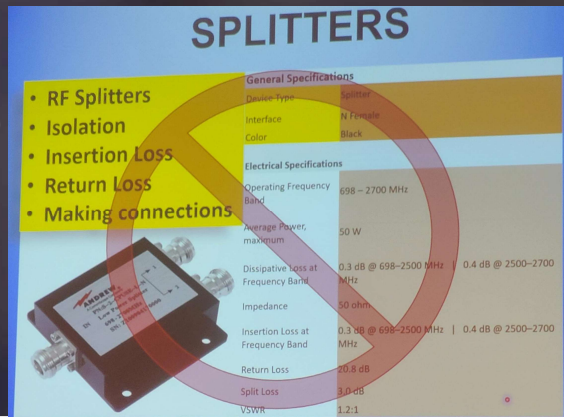


Technical Criteria Provided by AHJ

- Frequencies required for the in-building enhancement system
- Location and effective radiated power (ERP) of radio sites used by the public safety radio enhancement system
- Maximum propagation delay- in microseconds
- Supporting technical Information necessary to direct system design.

DAS Designer Components

- Donor Antenna
- Distribution Antennas
- Amplifier(s)
- Filters
- Splitters (NOT RECCOMENDED)
- Taps & Couplers
- Cables
- Dummy Loads



Designer Qualifications

RF Designer must have education, experience, training and understanding of RF Theory

FCC License: General Radio Operator License (GROL) (required by IFC 2021)

Professional Engineering License

Approved Training certificate from approved organization/manufacturer

Deemed qualified by Agency / AHJ

Design Considerations

- UL 2524 Rating: Public safety in-building wireless communication systems are required in commercial buildings to ensure emergency responders have undisrupted connectivity anywhere on premises including critical coverage areas like fire command rooms, exit stairwells, elevator lobbies, basements and exit passageways. (2 Hour burn rating)
- NFPA 1225-18.9.3- No rise to the noise floor for the Public Safety radio system
- NFPA 1225- 18.3.3.2- 20 dB isolation Minimum
- NFPA 1225- 18-11 Frequencies need to be upgradable (Example EDACS to P25 Phase 1 & 2)

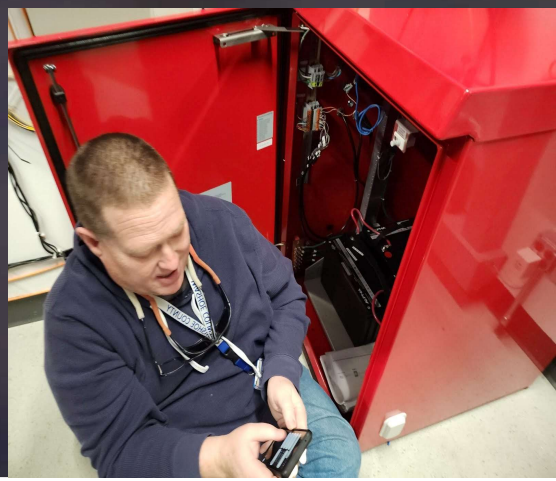
UL Standard

The Plenum Cables debate

- NFPA 1225-18.12.3.1 Plenum Cables- The Backbone, Antenna, Distribution, radiating, or any fiber optic cable shall be rated as plenum cables.
  - Plenum rated (CMP) cable has an outer jacket made of fire-resistant material like Teflon to prevent fire from spreading. When a fire happens, plenum rated cable is designed to: Restrict flame propagation to no more than five feet. Limit the amount of harmful smoke released.
  - Article 800 of the National Electrical Code (NEC) states that plenum cable should ALWAYS be used in plenum airspaces and air ducts to slow down the spread of flames and reduce smoke and toxic fumes from circulating throughout the building
- We believe it is our job to keep our First Responders Safe!

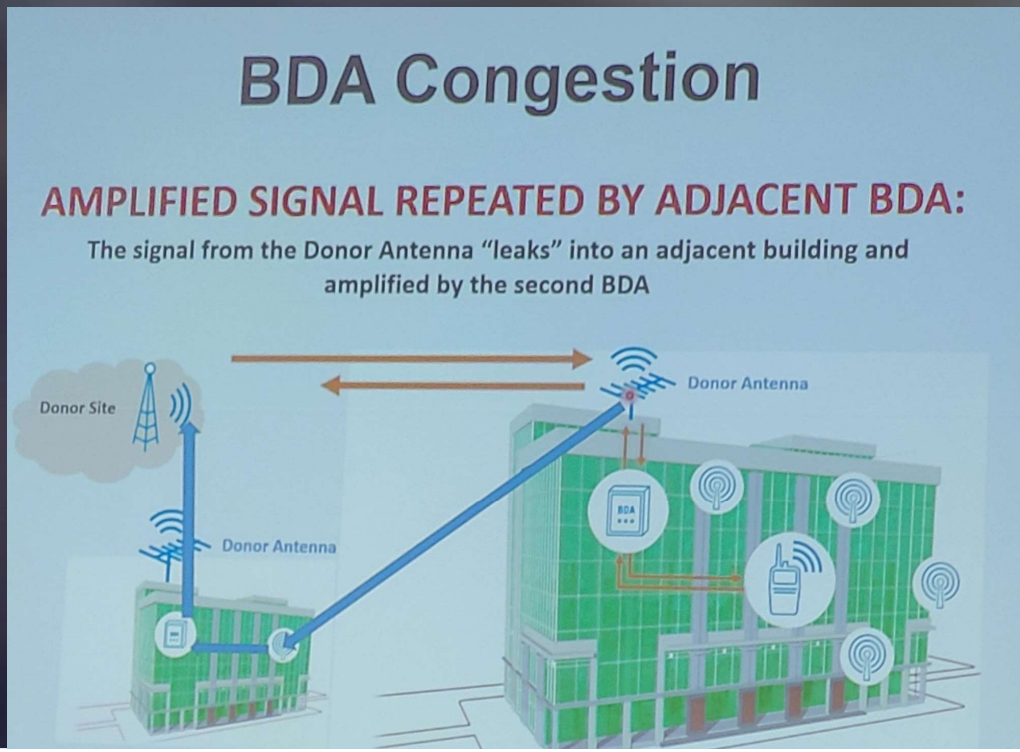
Connection to Fire Alarm

- The system shall automate supervisory signals for malfunction of the in-building emergency responders communications enhancement system that are annunciated by the fire Alarm system in accordance with NFPA 72
- Shall comply with Chapter 10 of NFPA 72
- System Supervisory signals (including power) shall include the following:
  - Signal source malfunction
  - Active RF emitter failure
  - Low-battery capacity (Under 70% of 12 hour supply)
  - Active system component failure
  - Loss of AC power
  - Failure of battery charger



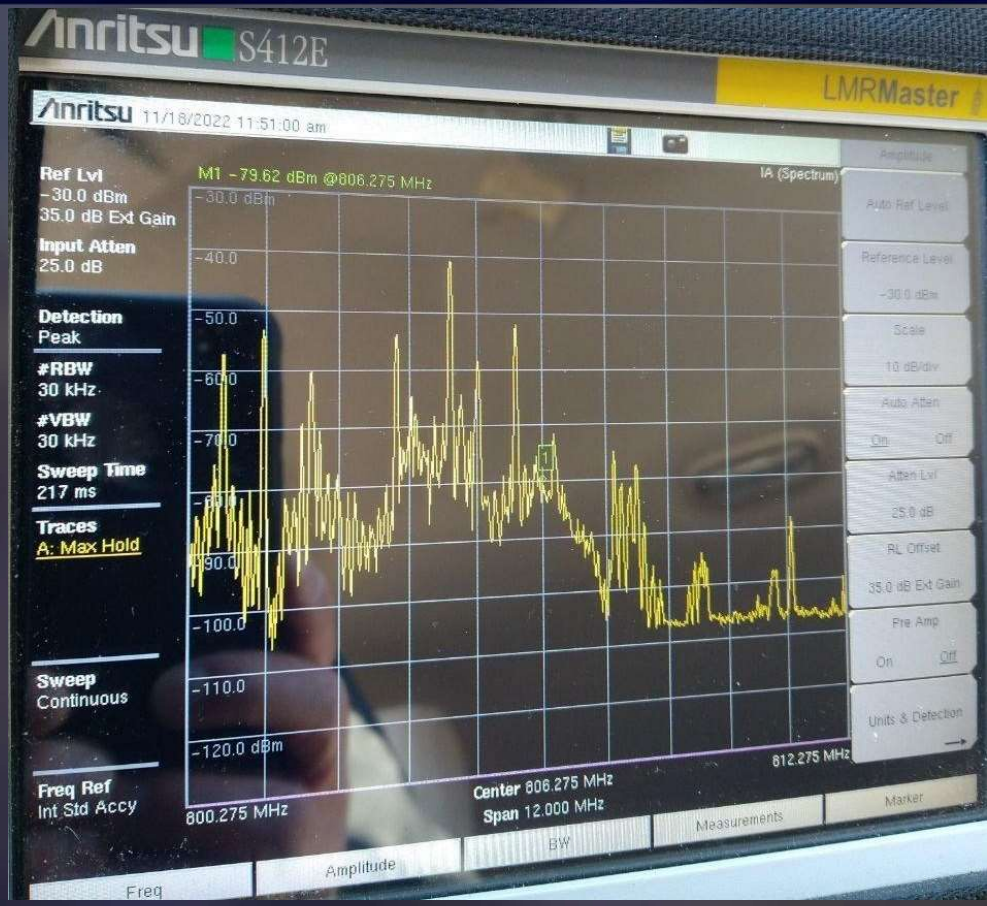
BDA Congestion

- Bohach Elementary School and Sky Ranch Middle School
  - Two separate antennas (pointing same direction)
  - too close and interfering with one another
  - Know where the BDA's and Other DAS' systems are to prevent BDA Congestion.



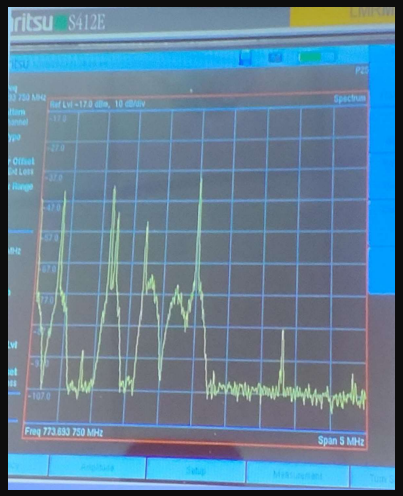
RF Degradation/Interference

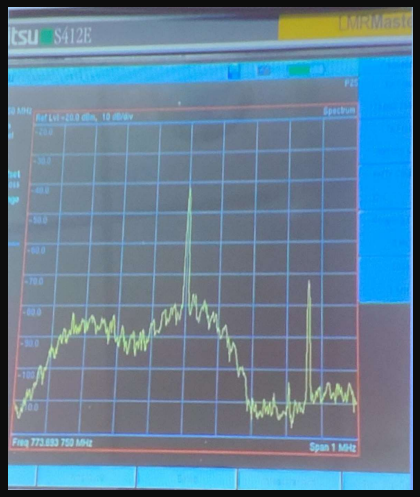
- RF interference symptoms include disruption or failure of wireless communications or equipment for unknown reasons.
- More specifically, responders may be experiencing interference if they:
  - Cannot communicate in areas where they typically have radio or cell coverage
  - Cannot communicate with normally reliable base radios or repeaters
  - Cannot communicate on multiple communications devices using multiple bands
  - Notice a significant loss of functionality or general failure of GPS systems
  - Realize communications improve significantly when moving a short distance away from a specific fixed area, or "dead zone.



Interference

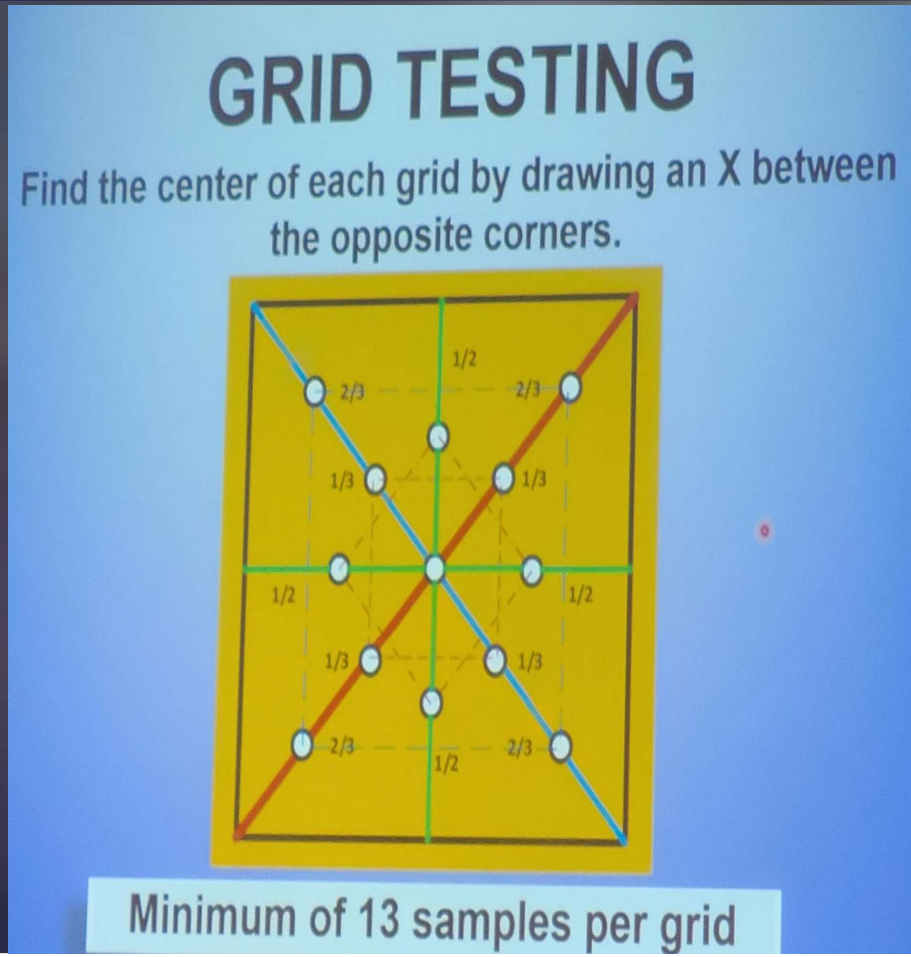
- Intermodulation Products
  - Requires two or more signals mixing together
  - Any non-linearity within the system
  - MAY INTERFERE WITH OTHER PROVIDERS OR SERVICES & CAN BE AN FCC VIOLATION!!





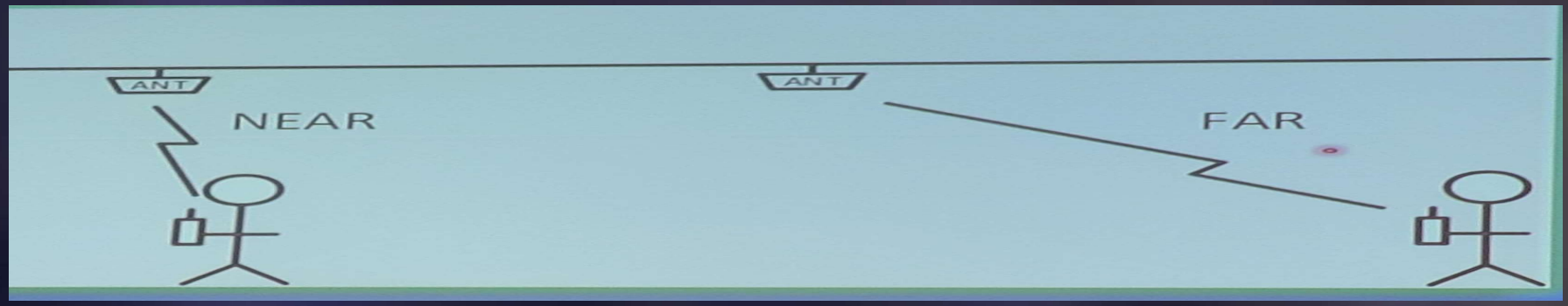
Grid Testing

- Grid Tests
  - Grid tests must be successful in 99% critical, 95% non-critical areas
  - BER=< 2.5%
  - RSSI=> -95dBm
  - DAQ=> 3.0
  - SINR=> 18dB
  - Normally, 20 grids per floor must be defined (Average of 13 sample readings of DAQ 3.0 is a pass)
    - Determine the number of grids needed
      - Max Size= 80 feet (80ft x 80ft = 6400 square feet)
      - Min Size= 20 feet (20ft x 20ft= 400 square feet)
- NFPA 1225-2022 20.3.10.2.3.3



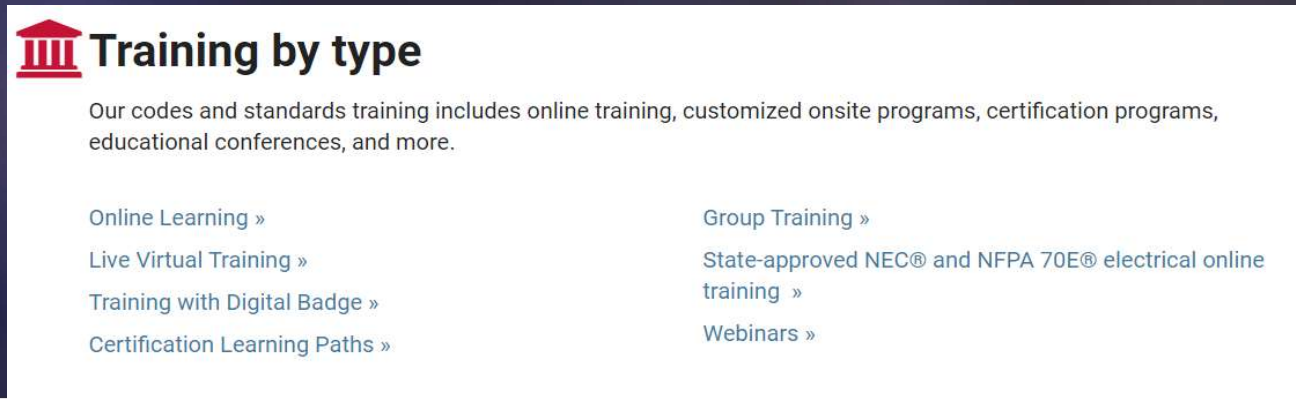
18.9 Two Radio Tests

- Not Required for Class A Analog or P25 Phase 1
- Since all DAS systems have built-in Automatic Gain Control (AGC as part of the FCC requirements, Near Far Affects must be tested.
  - One radio is immediately next to the antenna, and the other audio as far away as possible from an antenna to confirm that there us still signal available for the distant unit when the close unit is transmitting.
  - By Placing antennas no more than 100 to 150 feet from each other, the two raio test should be satisfactory in most cases.
- Purpose of this test is to figure out the affect of the System uplink AGC.



Educational Resources

- ETA Electronic Technician Association
  - https://www.etai.org/
  - Education Forum - Technical Classes And Training Opportunities (etai.org)
  -
  - IWCE Classes
    - Wireless Distributed Antenna Systems (ERCES) - Code Compliance (DASC)
      - Presenter: Ira Wiesenfeld, PE, CETms(RF), IWA Technical Services, Inc.
      - Part of the committee that wrote the Standard for NFPA 1225
- NFPA.org
  - Search on NFPA 1225



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Questions & Concerns?

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230 Edison Way
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