PART 1 - GENERAL

**1. SUMMARY**

A. This specification describes technical and performance criteria for deploying a Public Safety Radio Distributed Antenna System (DAS), designed to provide in-building, 2-way radio coverage for ail frequencies used by local first responder agencies. The DAS components specified in this document include: Bi-Directional Amplifiers (BDA), Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners and Couplers. These devices shall be used as part of a system, to be designed by a DAS integrator, experienced with design-build projects for in-building, public safety, amplification systems. Quantities and locations of antennas shall be as determined by the equipment selected and the DAS integrator's design.

* 1. **DESIGN-BUILD PROJECT - GENERAL DESCRIPTION**

A. Services: The design-build DAS integrator shall meet the required qualifications, experience and expertise in the design and installation of Public Safety Radio DAS's.

B. Areas requiring coverage include stairwells corridors, hallways, fire pump room, fire command center and other areas designated as critical by the 2018 NFPA 72, Section 24, NFPA 1221, IFC 510 and other information necessary to deploy a complete and fully operational PSR DAS At this location.

C. The DAS shall have expansion capabilities and the flexibility to support the addition or changes of radio frequencies and future building expansions and renovations.

D. The BDA shall include alarms in accordance with NFPA 72, to be connected to an indicating light in the fire alarm panel. The DAS integrator shall coordinate the installation of this alarm light with the fire alarm contractor.

E. The DAS Integrator, as part of his design, will be responsible for selecting locations for the BDA, coverage and donor antenna as required to provide the required coverage. The BDA shall be mounted in a Telco room, IDF closet or similar low voltage electronic control room which is not equipped with a wet sprinkler system. The BDA shall be enclosed in a NEMA 4 enclosure.

**1.2 ALTERNATIVES**

A. No alternates shall be accepted as equal, unless the Contractor provides satisfactory proof demonstrating the proposed alternate is equal or superior to the specified integrator or product, in experience, value, and quality, and that the proposed alternates have successfully performed or have been used in projects of similar size and complexity for no less than 5-years. The following information shall be required to be submitted for approval for each alternative component. The owner's decision to accept or reject the alternate products shall be final.

1. DAS Integrator:

a. Years of experience with Design-Build, In-Building 2-way radio Public Safety Systems,

(3-years minimum, requirement may be met by subcontractor).

 b. Certifications of factory training from proposed equipment manufacturers.

d. Personnel qualifications and experience to include industry certification in BDA /DAS

 (requirements may be met by subcontractor)

e. Detailed product specifications.

f. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for purchase for a period of 5-

years from the date of system acceptance.

2. Active Components:

a. Hardware and software manuals.

b. Detailed product specifications.

c. Written documentation from the manufacturer guaranteeing that the alternative

component(s) shall be supported for a period of 5-years from the date of system acceptance.

**1.3 CODES, STANDARDS AND CERTIFICATIONS**

A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Fire Protection Association (NFPA72), National Electrical Code, and National Electrical Safety Code, as adopted by the county or municipality where the project is located, including all applicable local codes, rules and regulations. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent of the requirements. B. Requirements set forth by first-responder code, ordinance, or the AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.

C. Abbreviations and Acronyms

1. ACG: Automatic Gain Control.

2. AHJ: Authority Having Jurisdiction.

3. ATP: Acceptance Test Plan.

4. BDA: Bi-Directional Amplifier.

5. BOM: Bill-of-Material.

6. DAS: Distributed Antenna System.

7. LMR: Land Mobile Radio.

8. MTBF: Mean Time Between Failure.

9. NFPA: National Fire Protection Association.

10. PSN: Public Safety Network.

11. RSL: Received Signal Level.

12. SMR: Specialized Mobile Radio.

13. SMS: Short Message Service.

14. SNIR: Signal-to-Noise Interference Ratio.

15. SOW: Statement of Work.

16. VSWR: Voltage Standing Wave Ratio.

**1.4 DEFINITIONS**

A. Acceptance: Expressed approval by the AHJ and owner’s representative.

B. Active: DAS components that require AC/DC power for operation and/or require RF to optics conversion.

C. DAS Integrator: The sub-contractor with the required qualifications and experience in the design installation and commissioning of 2-way Public Safety Radio, in-Building Amplification Systems, also known as Distributed Antenna Systems (DAS).

D. Passive: DAS components that do not require AC/DC power for operation or transmission and systems not requiring RF to optics conversion.

**1.5 PERFORMANCE REQUIREMENTS**

A. DAS:

1. Prior to making submittals, the DAS integrator shall confirm the correct Agency frequencies

used first responders at time of submission and shall guarantee coverage for these frequencies per DAQ 3.4 criteria.

2. The DAS shall deliver coverage throughout 95 percent of the building, and 100 percent of areas designated as critical. Coverage areas shall include stairwells, elevators, fire pump room, underground spaces and other areas as listed in NFPA72 and required by the AHJ.

3. The BDA shall have a common alarm output which is to be connected to an alarm light in the Fire Alarm Annunciator panel.

4. The DAS shall be connected to the buildings emergency power and equipped with a 12-hour Battery Backup System, or more, if required by the AHJ, capable of providing the following alarms to be monitored by the fire alarm system.

5. Loss of Normal AC power.

6. Battery Charger Failure.

7. Low Battery Capacity

8. The DAS shall be capable of modifications and upgrades, without the need to replace the proposed hardware or software. Frequency changes and additions within the Public Safety Radio frequency band, shall be accomplished without the need to replace the existing hardware. The DAS design shall allow future expandability to cover additional public safety radio frequencies.

9. Equipment Shall be available in Class A or Class B versions, preferred to be Listed to the UL2524 Standard, include Intelligent Oscillation Management, have alarm annunciation readily visible on the unit, and contain adjustable Uplink squelch circuitry.

**1.6 SUBMITTALS**

A. Submittal Requirements.

1. The DAS integrator is required to submit, for approval by the owner's technical representative, a complete list of the proposed equipment with a system diagram showing how the various components are interconnected and their function. Included in the submittal shall be:

2. Product Data: Submit manufacturer datasheets for the following components:

a. Bi-Directional Amplifiers (BDA).

b. Uninterruptible Power Supply.

c. Donor and Coverage Antennas.

d. Lightning Suppressor.

e. Coaxial Cable and Connectors.

f. Splitters, Combiners and Couplers.

g. Fiber-Optic Master Unit (if required).

h. Fiber-Optic Remote Units (if required).

i. Shop Drawings: Submit the following items.

j. RF site survey results.

k. System riser diagram.

I. Overlay of antennas and other system components on the architectural floor plans,

m. Donor Antenna lightning suppression and grounding details.

3. Acceptance Test Plan (ATP): Submit a proposed ATP including cable testing reports. At a

minimum, testing requirements shall be designed to satisfy requirements of the local AHJ and NFPA 72.

4. Warranty Documents:

a. Submit for all manufactured Components specified in this Section.

b. Submit DAS Integrator System Warranty.

B. Submittal Requirements at Close Out:

1. Drawings: Submit as-built drawings indicating:

a. A final, signed copy of all previously submitted documents reflecting the final, as-built representation, equipment used and details.

b. Cable routing, splitters, couplers and coverage antenna final locations.

c. Active component locations, layout, configuration and programmed parameters.

2. Test Reports.

a. Submit Accepted ATP reports confirming the requirements of Section 1.5 have been met.

b. Submit a Certificate of Radio Coverage Compliance signed by a local Fire Marshall,

certifying that the system has been installed in accordance with the requirements listed, successfully tested and found to meet local code requirements and the requirements of this specifications.

3. Field Reports: Submit sweep-testing results for all coaxial cable runs.

4. Technical Data Sheets: Submit hardware and software manuals for all Active Components.

5. Warranty Documents:

a. Submit for all manufactured components specified in this Section.

b. Submit Contractor's System Warranty.

**1.7 QUALITY ASSURANCE**

1. Qualifications: The DAS Integrator shall have a minimum of 3-years full-time, in-building, public safety radio experience executing work of similar scope and complexity, and have, as full-time employee, at least one industry Certified BDA / DAS employee.

B. Certifications:

1. Passive Components: The DAS Integrator shall provide manufacturer certification that their personnel have been trained on the installation of the components being installed.

2. Active Components: The DAS integrator shall provide manufacturer certification that their personnel have been trained on the installation of the components being installed.

3. Personnel: Personnel involved in the installation and maintenance of the DAS / BDA must Possess manufacturer’s certification as to equipment training. A Certificate of such certification will be made available upon request.

**1.8 WARRANTY**

A. Manufacturer Warranty:

1. Splitters, Couplers and Coverage Antennas: 1-year limited warranty from date of system acceptance.

2. Coaxial Cable and Connectors: 10-year limited warranty from date of system acceptance.

3. Fiber-Optic Cable: 20-year limited warranty from date of system acceptance.

4. Active Components: The earliest of 1-year limited warranty from date of system acceptance.

B. Contractor Warranty: Contractor shall warrant the system performance as specified in Article 1.5 for 1-year.

PART 2 - PRODUCTS

**2.1 MANUFACTURERS**

A. Specified BDA Manufacturers:

1. Westell Inc.

 2. Alternate Manufacturers: To be approved as equal, as permitted in Article 1.1.

**2.2 COMPONENTS**

A. LMR Yagi Donor Antennas:

1. Electrical:

a. Frequency band, as required by the County owning the PSR System.

b. Bandwidth > 1.5 VSWR: 20

c. Gain: > 10 dB or as required by the requirements of the DAS.

d. Maximum input power: 250 watts.

e. Front-to-back ratio: 16 dB.

f. Impedance: 50 Ohm

g. Azimuth Pattern: As proposed by the manufacturer to meet the performance

specifications in this Section.

2. Mechanical:

a. Connector: 50 Ohm N Type Female.

b. Mounting: Pole.

3. Environmental:

a. Temperature: -40 °C to +60 °C.

b. Lighting protection: Direct ground.

c. Waterproof level: IP 66.

d. Wind Speed, maximum: 125 mph.

e. Wind Load: 0.45 sq. ft.

4. Approved Manufacturer: Andrew/Commscope, Laird Technologies, Westell or as approved in accordance with Article 1.1.

B. Bi-Directional Amplifier (BDA):

1. Characteristics

a. Frequency: As required by the local municipality or County's PSR System.

b. Gain: Adjustable by software 55 dB to 90 dB as required by the DAS Integrator Design.

c. Maximum Output Power is determined by the system design.

d. Operating Temperature Range: -30 °C to +50 °C.

e. Chassis: Shall be capable of rack or wall mounting as required by the DAS integrators design and be housed in a NEMA 4 enclosure.

f. Filtering: Digital.

g. Alarming: Dry contacts for remote alarm.

2. Compliance:

a. NFPA: The BDA shall comply with NFPA 72, 2018 edition. In-Building Public Safety Radio Enhancement Systems.

b. FCC: Shall be FCC type certified.

C. Air Dielectric, Plenum Rated Cable:

1. Material Characteristics:

a. Jacket: Halogenated, Fire-Retardant, Plenum rated.

b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper.

c. Inner Conductor Material: Copper-Clad Aluminum Wire.

2. Electrical Characteristics:

a. Impedance: 50 ± 1.0 Ohm

b. Frequency Band: 1 - 8800 MHz.

c. Peak Power Rating: > 40.0 kW.

3. Mechanical Characteristics:

a. Diameter Over Jacket: 5 .627-inch.

b. Minimum Bending Radius: < 5-inches.

c. One Time Minimum Bending Radius: 3-inches.

4. Attenuation Characteristics:

a. Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F).

5. Approved Manufacturer: Andrew HL4RP-50A, Eupen equivalent or other equivalent, in accordance with Article 1.1.

D. Foam Dielectric Cable: To be used for donor antenna and outdoors.

1. Material Characteristics:

a. Jacket: Non-halogenated, Fire-Retardant Polyolefin.

b. Outer Conductor Material: Corrugated Copper.

c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube.

2. Electrical Characteristics:

a. Impedance: 50 + 1.0 Ohm.

b. Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz.

c. Peak Power Rating: 40.0 kW.

3. Mechanical Characteristics:

a. Diameter Over Jacket: 1/2" Nominal: s .630 in, 7/8-inch Nominal: < 1.1-inches.

b. Minimum Bending Radius: 1/2-inch Nominal: < 5 inches, 7/8-inch Nominal: < 10-inches.

c. One Time Minimum Bending Radius: 1/2-inch Nominal: < 2-inches, 7/8-inch Nominal: 5-inches.

d. Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F).

4. Approved Manufacturer: Andrew LDF4-50A, Eupen equivalent or other equivalent, in accordance with Article 1.1.

E. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

1. All passive equipment shall have a 698 to 2500 MHz range.

2. Approved Manufacturer: Andrew, Westell, or equivalent, in accordance with Article 1.1

Part 3 - EXECUTION

**3.1 INSTALLATION**

A. The contractor shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations

B. Cable and Equipment:

C. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceiling, or other structures and where required, penetration fire-stop, interconnecting wiring of the system components, equipment alignment and adjustments, and all other work whether or not expressly required herein which is necessary to result in complete operational DAS system.

D. During the installation, and up to the date of final acceptance, the integrator shall be under obligation to protect his finished and unfinished work against damage and loss. In the event of such damage or loss, he shall replace or repair such work at no cost to the owner.

E. All equipment shall be properly mounted on equipment racks or walls and secured in place. Wall mounted equipment shall be mounted over a 1/2-inch fire rated plywood, securely attached to the wall.

F. Cables shall be properly supported with dedicated hangers or brackets. Cable trays shall be used only if they are dedicated low voltage trays and only with approval from the owner.

G. Fastenings and supports shall be adequate to support their loads with a safety factor of at least

three.

H. All boxes, equipment, etc shall be secured plumb, level and square.

I. In the installation of equipment and cable, consideration shall be given to operational efficiency and overall aesthetic factors. Antennas shall be centered and in-line with other ceiling mounted devices.

J. All cables, regardless of length, shall be marked with cable markers reading "Public Safety Radio", at regular intervals but not less than every 50 ft. There shall be no unmarked cables at any place in the system. In addition, markings codes at each end of the cables and patch panels shall correspond to codes shown on drawings and/or run sheets.

K. All coax cables must be handled in accordance with the manufacturer’s guidelines. Transmission line cables have minimum bending radius specifications that shall be followed. In the event a cable is kinked or bent excessively during installation that section of cable cannot be used, even if subsequently straightened. The damaged area of the cable shall be removed, and a new section installed using correct splice methods. Ultimately the cable must pass the testing and meet the manufacturers requirements. L. Radio communications cabling shall not be grouped with electrical cabling. It can only share sleeves and raceways with other low voltage data and communications cables.

1. Connection between cables and other antenna components shall use N-Type premium connectors. No coax cable splicing is permitted.

2. All power dividers shall be securely mounted in place by bolting the mount to a solid surface or securing each by suspension on the cables within 4 inches of each connector termination at the power divider. The transmission lines connecting to the device shall be routed in the shortest possible path.

M. Grounding:

1. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:

a. System Ground: A signal primary "system ground" shall be established for the system.

All grounding conductors in that area shall connect to this primary system ground. The system ground shall consist of a copper bar of sufficient size to accommodate al! secondary ground conductors. An extension of the ground shall connect to the buildings lightning protection system per the direction of the on-site electrical engineer.

b. A copper conductor, having a maximum of 0.1 Ohms total resistance, shall connect the primary system ground bar to the primary system ground ring.

c. Secondary system grounding conductors shall be provided from all racks, radio consoles, and under grounded radio equipment in each area, to the primary system grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.

d. Under no conditions shall the AC neutral conductor, either in the power panel or in receptacle outlets, be used for a DAS system ground.

e. General: Because of the great number of possible variations in grounding systems, it shall be the responsibility of the integrator to follow good engineering practice, as outlined above, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios and reduce interference in the radio systems. R-56 Industry standard is preferred for the communication community. Certified R-56 installers should be used in this process.

**3.2 ACCEPTANCE TESTING**

A. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

B. Acceptance Test Procedure: Upon completion of installation, the building owner shall have the option to participate in the radio system tested to ensure that two-way radio coverage on each floor of the building is a minimum of 90 percent and be tested to meet DAQ 3.4 guidelines. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of 20 or more, approximately equal areas. No two test locations shall be greater than 50 ft apart

2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.

3. No area designated as critical and no two adjacent areas shall be allowed to fail the test.

4. In the event that any three non-adjacent, non-critical areas fail the test, in order to be more statistically accurate, the floor may be divided into smaller areas. In the event that three non-critical, non-adjacent areas still fail the test, the contractor shall reconfigure the system to meet the 90-percent coverage requirement with no three adjacent areas failing.

5. A test location approximately in the center of each grid area shall be selected for the test by the public safety or owner's representative, then the radio shall be enabled to verify two- way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire area. If the test fails in the selected test location, that grid area shall fail, and prospecting for a better spot within the grid area shall not be allowed.

6. The gain values of all amplifiers shall be measured and the test measurement results shall be noted on the as-built drawings and the O&M manuals so that the measurements can be verified during annual tests.

7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to insure spurious oscillations are not being generated by the subject signal booster.

8. When the DAS system is commissioned, the DAS integrator shall coordinate with the local Public Safety radio office and give them the opportunity to check the noise level generated by the DAS on the county system, and verify it is within an acceptable level as determined by the regulatory agency.