SECTION 27 51 29

IN BUILDING DISTRIBUTED ANTENNA SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes technical and performance criteria for deploying an active Neutral-Host Distributed Antenna System (DAS) capable of supporting LMR/ RIP/2-Way Radio UHF/ VHF Radios, Public Safety Networks (PSN), and Wireless Service Providers (WSP). The components specified in this document include: Donor Antennas, Coverage Antennas, Coax Cable, Singlemode duplex fiber, composite fiber with singlemode duplex and 16/2 AWG copper, and analog repeater.

1.2 PROJECT DESCRIPTION

A. Confidential Hyperscale Data Center in Clarksville, AR.

B. System Pricing:
   1. System pricing shall be provided based on the following requirements:
      a. Base Scope: LMR including 2-Way Radio UHF/ VHF Radio Repeater System Only
      b. Alternate 1: Base + Public Safety Network (PSN), also known as ERRCS or Emergency Radio Responder Communication System
      c. Alternate 2: Base + Alternate 1 + Wireless Services Providers (WSP)

C. LMR including 2-Way Radio UHF/ VHF Radio Repeater System Requirements:
   1. The 2-Way Radio UHF/ VHF Radio Repeater System shall be priced as the base DAS scope. Coverage area includes all interior spaces as well as well as the roof and equipment yards.

D. Public Safety Networks (PSN)/ Emergency Responder Radio Communications Systems (ERRCS) Requirements:
   1. The Public Safety Network (PSN) or Emergency Radio Responder Communication System (ERRCS) shall be priced as an add-alternate to the base DAS scope. This system shall only be procured and installed if the Local Authority Having Jurisdiction (AHJ) deems it a requirement. The contractor shall provide AHJ correspondence and code sections identifying proof of requirement with pricing.
   2. When allowed by the local AHJ, the DAS system shall support both 2-Way Radio UHF/ VHF Radio and the Public Safety Network (PSN) or Emergency Radio Responder Communication System (ERRCS). A single system that supports both use cases is strongly preferred.

E. Wireless Services Providers (WSP) Systems Requirements:

1. The Wireless Services Providers (WSP) System shall be priced as an add-alternate to the base DAS scope. This system shall only be procured and installed if owner deems the system a building requirement.
2. When allowed by the local AHJ, the DAS system shall support 2-Way Radio UHF/ VHF Radio, Public Safety Network (PSN) or Emergency Radio Responder Communication System (ERRCS) and the Wireless Services Providers (WSP) Systems . A single system that supports all use cases is strongly preferred.

1.3 SYSTEM DESCRIPTION

A. The Distributed Antenna System (DAS) shall be an active fiber-based system utilizing optical fiber for signal distribution and amplification. Coax-based passive DAS systems shall not be permitted.

B. Upon commissioning the DAS shall provide coverage for the following:
1. Base Scope: Site LMR/ ROIP/ 2-Way Radio UHF/ VHF Radio Bands
2. Alternate 1: Base Scope + Public Safety Banks
3. Alternate 2: Alternate 1 + AT&T, Verizon, Sprint, T-Mobile, US Cellular in the local market.
    a. The customer may add or omit WSPs at their discretion. Support for all WSPs is desirable, but in certain circumstances it may not be required.

C. Contractor shall review drawings for additional ROIP system requirements including:
1. Dedicated FCC Chanel Licenses
2. Radios
3. 6 bay Docking Stations
4. Extra Batteries

D. The DAS shall have expansion capabilities to support new licensed bands without replacing any existing hardware.

E. The DAS shall self-detect its components and errors and send alarm notifications when it detects network issues.

F. The Contractor shall propose and deploy a DAS with an RF design and installation that meets the requirements in order to enable WSP approval for interconnection to the WSPs' macro networks or BTS equipment.

G. The system will not be turned on without WSP acceptance and retransmission agreement. Contractor is responsible to obtain WSP approval. Contractor is responsible to ensure the RF design adapts to the carrier requirements in all stages of the project.

H. The Contractor working with the end user customer is responsible for confirming that the site has the necessary space and power to support the DAS as well as the RF Sources and identify the potential power required for Cellular Base Stations.

1.4 APPROVED MANUFACTURERS

A. Bidding contractors shall provide products and equipment from the pre-approved lists below.

B. Lead time estimates shall be provided with all equipment and product selections in writing from the manufacturer for owner and engineer review.

C. Alternate products and equipment:
   1. Alternates will not be considered without the submission of a full, turn-key solution as specified.
   2. Alternates may be submitted along with a pre-approved solution as an alternate pricing option for owner and engineer approval
   3. Alternate products and equipment shall be provided with equal or better specification documentation.
   4. Approval of alternate products and equipment shall be at the sole discretion of the owner and engineer.

1.5 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 Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractor's Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements.

B. It is the Contractor’s responsibility to ensure that the components comply with local code, ordinances or requirements established by the AHJ.

1.6 ABBREVIATIONS AND ACRONYMS

A. AHJ: Authority Having Jurisdiction

B. ATP: Acceptance Test Plan

C. AWS: Advanced Wireless Service

D. BDA: Bi-Direction Amplifier

E. BOM: Bill-of-Material

F. DAS: Distributed Antenna System

G. DAQ: Digital Audio Quality

H. ESMR: Enhanced Specialized Mobile Radio

I. FCC: Federal Communications Commission

J. iDEN: Integrated Enhanced Digital Network

K. LMR: Land Mobile Radio

L. LTE: Long Term Evolution

M. MTBF: Mean Time Between Failure

N. NFPA: National Fire Protection Association

O. NMS: Network Management System

P. PCS: Personal Communications System

Q. PSN: Public Safety Network

R. RoF: Radio-over-Fiber

S. RoHS: Restriction of Hazardous Substances

T. RSL: Received Signal Level

U. SIMO: Single-Input, Multiple-Output

V. SISO: Single-Input, Single-Output

W. SMR: Specialized Mobile Radio

X. SMS: Short Message Service

Y. SNMP: Simple Network Management Protocol

Z. SOW: Statement of Work

AA. VSWR: Voltage Standing Wave Ratio

BB. WSP: Wireless Service Provider

1.7 DEFINITIONS

A. Acceptance: Expressed approval by the customer

B. Active: Components that require AC/DC power for operation

C. Channel: A path for an RF transmission between two points

D. Component: A main system element of the Amplification system

E. Contractor: The prime contractor bidding the project

F. Delivered Audio Quality (DAQ): A measure of audio quality over a transmission medium used to quantify the quality of audio heard over a radio system. DAQ levels are defined by the following scale:
   1. DAQ 1: Unusable. Speech present but not understandable.
   2. DAQ 2: Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion.
   3. DAQ 3: Speech understandable with slight effort. Requires occasional repetition due to noise or distortion.
   4. DAQ 3.4: Speech understandable without repetition. Some noise or distortion present.
   5. DAQ 4: Speech easily understandable. Little noise or distortion.
   6. DAQ 5: Perfect. No distortion or noise discernible.

G. Sub-contractor: A qualified and experienced integrator performing the deployment for the Contractor.

H. Head-End Equipment: The equipment that accepts the RF Source, and then typically amplifies the RF source to the interior antennas

I. Passive: Components that do not require AC/DC power for operation

1.8 PERFORMANCE REQUIREMENTS

A. On a per channel basis, the downlink received signal level for each frequency band shall meet or exceed the criteria specified for the application as defined in this document.
   1. The DAS must support all existing carrier technologies including, but not limited to: 3G, 4G (LTE).
   2. Support for emerging 5G technologies will be considered and where this is an add-on cost to the above this should be called out as future provisions only.
   3. WSP :On a per channel basis, the downlink RSL for each frequency band shall meet or exceed the criteria in Table 1.
   4. Table 1: System Parameters:

Parameters	Unit	700 LTE	Cellular, PCS, AWS, Commercial 800 MHz
Minimum downlink receive signal RSRP	dBm	-105	-105

B. Contractor in their response shall identify the specific market criteria requested by each respective WSP.

C. It is the Contractor’s responsibility to confirm that all design requirements for each respective WSP are met with their proposed solution.

D. Contractor shall state the assumed channel loading and frequency bands for the proposed WSP in-building coverage. Prior to installation, contractors shall

confirm the channel loading and frequency use in the serving area, and shall guarantee coverage for these channels per the criteria in this document.

E. The DAS shall deliver coverage throughout 95% of the building. Unless stated separately in the floor plans it is expected coverage including stairwells, elevators, basement and garage.

F. The LMR UHF/ VHF system shall also provide coverage 95% coverage on the roof of the facility and in the equipment yard.

G. Design of a DAS to support multiple carriers including all current and future wireless communications and broadband data requirements.

H. All coordination and provisioning of additional carriers that desire to provide DAS coverage at the building.

I. Furnish all equipment and cabling required to support the DAS at all areas as noted by operator/owner. All materials to be consistent with base building standards.

J. Coordinate, attend, and conduct all necessary project meetings.

K. Verification of all floor layouts representing actual site conditions prior to device planning and modeling.

L. Perform all provisioning and system modifications of the DAS throughout the life of the contract.

M. Engage in-scope carriers for approval and sign-off on the design of the proposed DAS solution and their participation in it.

N. Provide operator/owner with daily, weekly, and monthly status reports as required.

O. Work with operator/owner & representative to create system/network reports for key metrics.

P. Provide all preventive maintenance along with any system repairs, including updates, as required to keep the DAS up to date with current software releases.

Q. Perform the installation of all necessary hardware and software.

R. Identify on-going technical support contact information.

S. Inter-trade coordination with Architectural, MEP, IT, etc. for DAS pathway, power & cooling design.

T. All electrical work installation of any kind must be performed in keeping with local codes.

U. Work shifts will vary, and operator/owner will advise of the shift schedule.

V. All personnel that will be on site will attend the necessary safety and security programs before being granted access to the building.

W. All permitting and licenses needed to perform this scope will be purchased by the awarded contractor before construction begins.

X. The awarded contractor will abide by all codes, work shifts, and other legal requirements of the local authorities and operator/owner.

Y. Security escorts may be required.

Z. All contractors may be requested to submit to drug testing and background checks.

AA. All contractors must comply with building rules and regulations.

BB. Hardware Requirements & Supporting Infrastructure
1. The service offering shall include all hardware necessary for a functional DAS solution.
2. All necessary hardware configurations and programming will be included.
3. All equipment shall be new.
4. Proposers are responsible for providing power, wiring, ground connections, cables, connectors, and adapters of any kind necessary to accommodate the system installation, operation, testing, and maintenance.
5. Provide final equipment connection to the cabling infrastructure.
6. Provide all required patch and equipment cables.
7. All equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions found at the building.
8. Uninterruptable Power Supplies
   a. All equipment installed in communications rooms shall be protected by a UPS or UPS circuit provided by others.
9. Proposer shall propose antenna options with explanation, mounting style and provide a sample.

1.9 SUBMITTALS

A. Submittal Requirements with Bid Response:
1. Product Datasheets
   a. Coverage Antennas
   b. Coaxial Cable
   c. Singlemode duplex Fiber
   d. Repeaters
   e. Masts
   f. Donor antennas
2. Shop Drawings: Submit the following items:
   a. RF Link Budget
   b. Overlay of system Components on floor plans

c. Propagation design based on assumed WSP design targets of -95 dBm RSRP for LTE and -85 dBm RSCP for UMTS. Assume all WSP RF sources are BTS fed
d. Bill-of-Material

3. Statement of Work (SOW): Submit sample SOW
4. Acceptance Test Plan (ATP): Submit sample ATP
5. Recommended Spares
6. Letter from manufacturer confirming authorization for solution
7. Letter from AHJ
8. Warranty Documents:
   a. Submit for all manufactured Components specified in this Section
   b. Submit Contractor's System Warranty

B. Submittal Requirements Prior to Start of Construction
1. Final RF link budget
2. Overlay of system Components on floor plans
3. RF propagation modeling
4. Bill-of-Material (BOM)
5. Maintenance Service Contract (Optional)
6. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
7. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.

C. Submittal Requirements at Close Out
1. Drawings: Submit as-built drawings indicating:
   a. Cable routing and coverage antenna locations
   b. Active component locations, layout and configuration
2. Test Reports
   a. LMR DAS: Submit accepted ATP reports
   b. ERRCS: Submit accepted ATP reports
   c. WSP DAS: Submit accepted ATP reports
3. Field Reports: Submit test results for the cabling infrastructure.
4. Operation and Maintenance Data: 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
   c. Submit Manufacturer's Extended Warranty

1.10 QUALITY ASSURANCE

A. Qualifications: Contractor, and/or Sub-Contractors, shall have a minimum of 5-years full-time experience executing work of similar scope and complexity. Additional requirements below:
1. Contractor or Sub-contractor shall have deployed a minimum of 10 systems.
2. Contractor or Sub-contractor Project Managers must be System Certified.
3. Contractor or Sub-contractor shall provide an onsite construction foreman to oversee the installation.

4. Contractor or Sub-contractor shall provide a project manager to oversee the deployment.

B. Certifications:
1. The manufacturer(s) of the active components shall maintain a formal authorized and certified value-added reseller program, which consists of routine quality audits of the participating value-added resellers. The list of authorized value-added resellers shall be published and the Contractor or Sub-contractor shall be listed in the Manufacturer's publication of value-added resellers.
2. Passive Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.
3. Active Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.

1.11 WARRANTY
1. Manufacturer Warranty:
2. Splitters, Couplers and Coverage Antennas: 5-year limited warranty from date of system acceptance.
3. Cable and Connectors: 10-year limited warranty from date of system acceptance.
4. Active Components: The earliest of 3-year limited warranty from date of system installation or 15 months from date of shipment.

1.12 MAINTENANCE

A. The Contractor shall provide an optional maintenance service contract, covering for a period of one-year and 5 years: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time. Service contract shall include:
1. Diagnostics & Repair
2. 24x7x365 Technician Dispatch (On-site within 24 hours)
3. Annual Preventive Maintenance
4. Equipment Warranty Management

1.13 CONTRACTOR CREDENTIALS

A. The Contractor shall document their relations with the equipment manufacturer, certifications with the manufacturer and significant success stories.

PART 2 - PRODUCTS

2.1 SUSTAINABILITY REQUIREMENTS

A. Environmental Product Declaration (EPD): Product shall have a Type III Product Specific EPD.

B. Embodied Carbon Limit: Global Warming Potential (GWP) measured from cradle-to-date shall not exceed the limit noted for the relevant product type within Section 01 81 13

C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content shall not be less than the required amount noted for the relevant product type within Section 01 81 13.

2.2 MANUFACTURERS

A. Specified Manufacturers for 50 Ohm passive components: Wilson Electronics and Zinwave

B. Specified Manufacturers for Active components: Wilson Electronics and Zinwave

C. Acceptable Manufacturers: Wilson Electronics Pro Series Equipment and Zinwave

D. In the event that the local AHJ requires a standalone ERRCS system, the DAS contractor shall provide a list of AHJ acceptable manufacturers and systems for owner and engineer review and approval.

2.3 COMPONENTS

A. DAS Head End Equipment
1. Approved Manufacturer: Wilson Electronics and Zinwave

B. DAS Remote Units
1. Approved Manufacturer: Wilson Electronics and Zinwave

C. DAS Coverage Antennas
1. Approved Manufacturer: Wilson Electronics and Zinwave

D.

E. In the event that the local AHJ requires a standalone ERRCS system, the DAS contractor shall provide a list of AHJ acceptable components for owner and engineer review and approval.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor and/or Sub-contractor shall design, install, commission, and test the Cellular amplification system in accordance with the manufacturer’s instructions and recommendations.

B. The contractor and/or Sub-contractor shall install the Cellular amplification system in accordance with the accepted SOW.

C. The contractor and/or Sub-contractor shall adhere to all work and safety requirements while working at the job site.

D. The contractor and/or Sub-contractor shall have Cellular amplification system project foreman on site overseeing the installation.

E. The contractor and/or Sub-contractor shall have at a minimum one Project Manager on staff overseeing the project. The Project Manager will be responsible for the following:

F. Developing and maintaining a project plan consistent with the overall milestones of the project.

G. Overseeing and coordinating the activities of the Cellular amplification system project, including: initiating and holding weekly project conference calls, as well as maintaining and distributing meeting minutes.

H. Act as the point-of-contact interface for all Cellular amplification system project activities.

I. Provide weekly status updates regarding work performed, worked scheduled, open items, problems/issues and resolutions.

J. The contractor and Sub-contractor shall be prepared to deploy the Cellular amplification system in a phased approach as dictated by the building construction and/or work of other trades.

K. The contractor and Sub-contractor shall be System Certified.

L. Where possible, contractor shall utilize existing backbone power and fiber infrastructure for installation.

M. All single mode fiber connections shall be SC/ APC. No mechanical terminations. Fusion splicing only.

N. No more than 5dB optical loss and 35dB back reflection per optical link.

O. The contractor and Sub-contractor shall facilitate WSP registration and connection to their respective macro networks.

P. The contractor and Sub-contractor shall be prepared to connect to the WSP’s network(s) in a phased approach as dictated by the construction schedules.

Q. Install cabling designed for the environment the cable will be installed in.

R. Terminate and test all coaxial cabling with a sweep analyzer.

S. Test all fiber cabling utilizing level 3 tester or above.

T. Label all cabling per the contract drawings to indicate the segment number from each amplifier.

U. Provide exterior cell measurements according to the manufacturers recommendations.

3.2 ACCEPTANCE TESTING

A. Acceptance testing will be performed confirming the requirements of this document have been met.

B. The contractor shall complete the acceptance testing per the requirements and as prescribed in the approved Acceptance Test Plan (ATP) submittal.

C. Acceptance Testing
1. Acceptance Testing shall comply with the following:
   a. The Acceptance Test shall ensure that two-way coverage on each floor of the building meets the minimum coverage requirements detailed in Section 1.07.
   b. Tests shall be made using the frequencies listed in Section 1.02.A.
   c. Testing shall be coordinated with the Customer and AHJ to ensure no undue interference to any building operations.
   d. All testing shall be done on frequencies authorized by the FCC.
2. Test Procedures
   a. The test plan shall ensure testing throughout the building. Testing shall be performed on a grid system. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. 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 and a maximum grid dimension of 80 ft will suffice to encompass the entire floor area. A maximum of one area will be allowed to fail the test (95% coverage). Where a floor exceeds the sq ft, which is the floor area that can be covered by the system, the floor is subdivided into 40 equal sectors, with each sector being tested individually. A maximum of two non-adjacent areas will be allowed to fail the test (95% coverage). In addition to the above requirement, all critical areas, which include; the emergency command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the AHJ, shall be provided with 99 percent floor area radio coverage. Signal strength measurements shall be performed using standardized parameters as specified below.
3. Measurement Parameters
   a. Signal levels shall be measured to ensure the system meets the criteria specified in the Technical Proposal. Downlink measurements shall be made with the following standardized parameters:
   b. Measurements shall be recorded using a calibrated automatic signal-level measurement system measuring RSRP in each band with a dipole antenna positioned approximately 4’ above the surface.
   c. Measurements will be recorded for the test pattern as described above.

d. System acceptance is achieved when 95% of the averaged data points meet or exceed the requirements specified here and in Section 1.07.

END OF SECTION