

SECTION 27 53 19 – DISTRIBUTED ANTENNA SYSTEM (DAS)

1.1 REFERENCES

A. Applicable Codes, Standards, and Specifications.

1. The following table of codes, standards, specifications, recommendations, and methods and procedures are applicable to the provisioning of a DAS for the University of Colorado Denver | Anschutz Medical Campus, Office of Information Technology (OIT). The latest editions are incorporated by reference.

| Number | Title |
|-----------|--|
| NFPA 70 | National Electric Code (NEC) |
| IEEE C2 | National Electric Safety Code (NESC) |
| IEC 62037 | RF Connectors, Connector Cable Assemblies and Cables – Intermodulation Level Measurement |
| BICSI | Telecommunications Distribution Methods Manual (TDMM); Network Design Reference Manual; Customer-Owned Outside Plant Design Manual; Wireless Design Reference Manual |
| OSHA | Standard 29 CFR 1910.268 |

2. All work, including, but not limited to: cabling, pathways, support structures, equipment placement and installation, workmanship, maintenance, and testing shall comply with the latest editions of the NEC, NESC, FCC, all applicable rules and regulations, manufacturer's instructions, and University of Colorado Denver | Anschutz Medical Campus OIT standards and related methods and procedures.
3. OIT shall be regularly consulted with during DAS project design and deployment through the assigned University of Colorado Denver | Anschutz Medical Campus project manager.

1.2 ABBREVIATIONS AND ACRONYMS AND DEFINITIONS

A. Abbreviations and Acronyms

1. AHJ: Authority Having Jurisdiction
2. ATP: Acceptance Test Plan
3. BICSI: Building Industry Consulting Service International
4. BDA: Bi-Directional Amplifier
5. BOM: Bill-of-Materials
6. BTS: Base Transceiver Station
7. CDMA: Code Division Multiple Access
8. DAS: Distributed Antenna System
9. FCC: Federal Communications Commission
10. iDEN: Integrated Digital Enhanced Network
11. LTE: Long Term Evolution
12. NEC: National Electrical Code
13. NFPA: National Fire Protection Association
14. OTDR: Optical Time-Domain Reflectometer
15. PIM: Passive Intermodulation
16. PTT: Push-to-Talk
17. RF: Radio Frequency
18. RSL: Received Signal Level
19. RSSI: Received Signal Strength Indicator
20. SNIR: Signal-to-Noise Interference Ratio
21. SNMP: Simple Network Management Protocol
22. SOW: Statement of Work
23. TR: Telecommunications Room
24. WSP: Wireless Service Provider

B. Definitions

1. Acceptance: expressed approval by the university
2. Active: DAS components that require AC/DC power for operation
3. Carrier Approval: expressed approval to interconnect to the WSP macro network
4. Channel: a path for RF transmission between two points
5. Component: a main system element of the DAS
6. Contractor: the prime contractor bidding the project
7. dBc: power ratio in decibels of a signal compared to the carrier level
8. dBm: power ratio in decibels of the measured power referenced to one milliwatt
9. OIT: the university DAS owning agent or customer
10. Passive: DAS components that do not require AC/DC power for operation
11. PIM: passive intermodulation distortion resulting from high frequency mixing in passive components such as connectors

1.3 QUALITY ASSURANCE

A. Consult with the OIT department for the following:

1. Acceptability for substitutions for specific components.
2. Guidance in the application of a standard or specification in a design or deployment situation.
3. Approval for deviation from standards, specifications, or industry-standard methods and procedures.

B. Qualifications.

1. The contractor and subcontractors shall have a minimum of 3-year's experience performing work of a similar nature.
2. The installation contractor shall have installed similar systems in at least three locations in the previous 2-years.
3. All DAS equipment shall be furnished and installed by an authorized factory distributor. The installer shall have proven experience in the design, installation, and commissioning of the specified DAS solution.

C. Certifications.

1. Contractor or subcontractor shall provide manufacturer certification that the contractor or subcontractor personnel have been trained on the active and passive DAS components being installed.

D. Warranty.

1. Warrant all equipment and materials for 1-year from date of final OIT acceptance.
2. Labor and material shall be covered by the warranty.
3. Contractor shall do all registrations and provide proof of purchases required to activate any manufacturer's warranty.

1.4 DAS DESCRIPTION

- A. This section includes technical and performance requirements for designing and deploying a DAS capable of supporting PTT public safety radios, cellular carriers, and other RF technologies. These entities are referred to as Wireless Service Providers (WSP). This standard does not list, describe, or delineate every active component, passive component, materials, or necessary means to complete the DAS project. The DAS contractor shall be responsible for determining and providing all elements necessary to create an operational, scalable, and maintainable system for use by OIT. Elements of a DAS include, but are not limited to:

1. Design
2. Project management
3. WSP coordination
4. Customer coordination with OIT
5. Coordination with other trades
6. Furnishing and installing all active DAS components
7. Furnishing and installing all passive DAS components, including cabling and fiber optics

8. DAS configuration, programming, adjustment, and tuning
9. Coordination and management of WSP RF interconnections to the DAS
10. DAS labeling to campus standards
11. Documentation and DAS training
12. System acceptance testing
13. Final system turnover to OIT
- B. The fielded, operational DAS will support these WSP, at the incoming RF specified by the WSPs:
 1. Convenience DAS that supports:
 - a. Verizon
 - b. Sprint
 - c. T-Mobile
 - d. AT&T
 2. Public Safety DAS (possibly a stand-alone system as determined by the AHJ)
 - a. The public safety DAS should be the same equipment vendor as the convenience DAS supplier
- C. Support of 4th generation LTE WSP solutions is required. Bolt-on support for 5G and other emerging standards is required.
- D. The contractor shall provide all DAS and WSP coordination to include:
 1. Coordination meetings with owner, general contractor, and the design team.
 2. Assist the university with WSP negotiations.
 3. Obtain WSP interconnect interest.
 4. Acquire WSP interconnect permissions.
 5. Coordinate layout and installation of DAS pathways, cabling, conduits, and antenna placement with the design team.
 6. Coordinate WSP power and cooling requirements with the design team.
 7. Verify carrier space requirements.
 8. Coordinate WSP deployment schedule and commissioning.
 9. Officially notifying WSP prior to system going on-air.
- E. The contractor supplied DAS will conform to all codes, ordinances, and supplemental requirements of the AHJ; including building a separate public safety DAS, if required.
- F. The DAS shall include a head-end that is able to service the University of Colorado Denver campus footprint, as defined by OIT. The head-end shall be collocated with the WSP systems necessary to support the systems and services described.
 1. The contractor shall provide head-end physical space requirements to the design team.
For design planning purposes, initially assume a head-end room sized to 14' x 16', minimum.
 2. The contractor shall provide head-end power requirements to the design team.
 - a. Assume a 200-amp dedicated head-end power panel for initial design purposes.
 3. The contractor shall provide head-end cooling requirements to the design team.
For design planning purposes, initially assume 6 tons of cooling for the head-end, minimum.
 4. The contractor shall provide head-end telecommunications requirements to the design team.
- G. The DAS shall have all active component remote units located in OIT Telecommunications Rooms (TR).
 1. OIT will specify where active and passive DAS components may be installed in the TR.
 - a. The contractor shall provide DAS TR space requirements to the design team.
 - b. The contractor shall provide DAS TR power requirements to the design team.
 - c. The contractor shall provide DAS TR cooling requirements to the design team.
 - d. The contractor shall provide DAS TR cabling requirements to the design team.
- H. Subject to compliance with the UC Denver | Anschutz Medical Campus DAS requirements, the contractor shall provide a complete and functioning Solid Technologies DAS.
- I. DAS performance.
 1. Long Term Evolution (LTE) carrier signal strength shall exceed -70 dBm or meet the WSP's signal strength requirements with 95% coverage, including basements, elevators and stairwells, but without penetration of the elevator shaft or stairwell.

2. The DAS shall distribute cellular carrier signal strength so that it exceeds -75 dBm or meet the WSP's signal strength requirements with 95% coverage including basements, elevators and stairwells, but without penetration of the elevator shaft or stairwell.
3. Public Safety signal strength shall exceed -95 dBm with 95% coverage or as stipulated by the AHJ. The AHJ may stipulate which areas need specific coverage.
- J. DAS Coverage. The DAS shall provide 95% coverage throughout the building. A perimeter based design is preferred. The coverage areas include, but are not limited to the following.
 1. Public spaces
 2. All floors including corridors and lobbies
 3. Basement
 4. Stairwells as best enabled without penetrating into the stairwell
 5. Elevators as best enabled without penetrating into the elevator shaft
 6. Restrooms as best enabled without penetrating into the restroom
 7. Break rooms
 8. Telecommunications Rooms and Mechanical Rooms
- K. The DAS shall have the capability for separate control over each WSP to permit the adjustment and control of power levels without impacting other WSPs.
- L. The DAS shall support multiple WSPs in a modular architecture so that other WSPs can be added or removed without requiring new infrastructure.
 1. This modular architecture shall not require adding or replacing passive components such as cabling or antennas when services are added or deleted.
 2. The modular architecture will accept WSP changes without significant head-end modifications.
- M. The DAS shall be managed by a system that allows monitoring, alarming, and alerting of active components. The DAS management system will perform fault isolation and allow system configuration and control.
 1. The DAS will integrate into the university's Ethernet network via the SNMP protocol.
- N. The DAS components shall be rated for the environments in which they are installed.
- O. The DAS components shall be labeled per the OIT standards.
 1. Submit labeling samples to OIT for approval prior to placement to ensure color, format, and media are suitable to the task.
 - a. Permanent, machine-printed labels are required, as specified by OIT.
 - b. Cable labels shall be wrap-around and self-laminating to provide permanent marking.
- P. The contractor shall provide training for the OIT maintainer.
 1. Provide final copies of DAS active component manuals to OIT prior to scheduling system demonstration and instruction.
 - a. Provide two instruction sessions describing and demonstrating all maintenance and operational aspects of the DAS.
 - b. Training shall be conducted by a vendor or supplier's representative trainer who is thoroughly familiar with all aspects of the DAS.
- Q. The contractor shall perform system commissioning, tuning, acceptance testing, and sign-off activities.
 1. Submit an Acceptance Test Plan (ATP) that describes the systematic process for DAS validation and commissioning.
 2. The contractor shall sweep-test the entire system with a spectrum analyzer from the head-end to the last component in each distribution leg.
 - a. Test all cable segments at frequency sweeps around 160, 460, 700, 840, 930, and 1925 MHz. The sweep bandwidth should be reflective of common spectrum bands in that frequency range.
 1. The return loss at any connector shall be greater than 20 dB.
 - b. Notify OIT 2-weeks in advance of sweep testing so the university can witness the testing procedures and results.
 - c. Submit test results for all cable tests to the design team 2-weeks prior to punch list review.
 3. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - a. Visually inspect and clean all connectors before mating them.
 - b. Torque all connections to 16 to 18 ft-lbs (23-24 Nm) or to the manufacturer's specification.

- c. Premanufactured passive assemblies are preferred over field termination to help reduce PIM.

1.5 SUBMITTALS

- A. Submit a Bill-of-Materials (BOM) containing all active and passive components.
- B. Submit manufacturer cut sheets for the following components:
 - 1. Passive component cut sheets.
 - 2. Active component cut sheets.
- C. Submit hardware and software manuals for all active components.
- D. Submit shop drawings in hard copy and electronic format as specified by OIT
 - 1. Submit pictures of installation workmanship, showing locations of major active components such as BTSs, BDAs, donor antennas, and head-end racks.
 - 2. Submit pictures samples of typical passive component installations such as splitters, couplers, or ceiling antennas.
 - 3. Submit an RF link budget.
 - 4. Provide an overlay of system components on floor plans.
 - a. Submit as-builts showing final antenna locations, couplers, splitters, coaxial and fiber cable routing, active and passive component placement in each TR, and WSP connections.
 - 5. Submit heat maps showing DAS coverage and coverage density by floor.
 - a. Provide predictive modeling coverage plans (signal strength) by floor and WSP for each frequency band.
 - 6. Provide head-end documentation
 - a. Submit elevations and dimensions of head-end components
 - b. Submit WSP specifications and cut sheets on WSP equipment installed.
 - c. Submit a functional block diagram showing interconnections between head-end components and the DAS distribution system.
 - d. Submit a head-end wiring diagram for power, signal, and control wiring.
- E. Submit screen shots of the DAS management software showing initial system settings and status.
- F. Statement of Work (SOW) in hard copy and electronic format as specified by OIT
 - 1. Submit a SOW that has been accepted by the university.
- G. Acceptance Test Plan (ATP) in hard copy and electronic format as specified by OIT
 - 1. Submit an ATP that has been accepted by the university.
- H. Recommended spares
 - 1. Submit the DAS active component spares that are recommended to keep on hand to create a reliable, available, and maintainable system.
- I. Warranty documents in hard copy
 - 1. Submit warranty for all manufactured components used in the DAS.
 - 2. Submit contractor's system warranty.
 - 3. Submit manufacturer's extended warranty.
- J. Submit test results in hard copy and electronic format as specified by OIT
 - 1. Submit ATP reports confirming the DAS performance requirements have been met.
 - 2. Submit sweep-testing results for all DAS cable runs.
 - 3. Submit OTDR test results for all DAS fiber runs.
- K. Submit WSP contact information in hard copy and electronic format as specified by OIT.
 - 1. Provide technical points of contact for each WSP to include name, WSP position, telephone number, and email address.
- L. Submit a maintenance proposal for time and material support. Assume a one business day response window for the proposal.

END OF SECTION 27 53 19