

SECTION 27 53 19
DISTRIBUTED ANTENNA SYSTEM
Construction Specification

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Distributed Antenna system (DAS) to support multiple wireless services, primarily in-building. The DAS integrator shall provide a complete turn-key system that supports all identified frequencies within the identified coverage spaces.
- B. Related Sections
 - 1. Comply with the Related Sections requirements of:
 - a. Section 270000, "Basic Communications Requirements"
 - b. Section 270526, "Grounding and Bonding for Communications Systems"
 - c. Section 270528, "Communications Building Pathways"
 - d. Section 270536, "Communications Building Pathways – Cable Tray"
 - e. Section 271100, "Communications Equipment Rooms"

1.2 REFERENCES

- C. Comply with the References requirements of Sections 270000, 270526, 270528, 270536, 271100,
- D. In particular or addition to the codes and standards listed in Section 270000, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. FCC Regulations:
 - a. Part 22: 850 MHz cellular band services
 - b. Part 24: Personal Communications Server
 - c. Part 27: Miscellaneous Wireless Communications Services
 - d. Part 95: Personal Radio Services Rules

1.3 DEFINITIONS

- E. Definitions as described in Section 270000 shall apply to this section.
- F. In addition to those Definitions of Section 270000, the following list of terms as used in this specification defined as follows:
 - 1. "AWS": Advanced wireless services (synonymous with AWS-1)
 - 2. "BOM": Bill-of-Material
 - 3. "BTS": Base Transceiver Station
 - 4. "CDMA": Code Division Multiple Access
 - 5. "C/N": Carrier-to-Noise Ratio
 - 6. "DAS": Distributed Antenna system (synonymous with in-building antenna system)
 - 7. "FCC": Federal Communications Commission
 - 8. "GUI": Graphical User Interface
 - 9. "iDEN": Integrated digital enhanced network

10. "LBS": Location based services
11. "LTE": Long Term Evolution
12. "MIMO": Multiple Input, Multiple Output
13. "MTBF": Mean Time Between Failure
14. "NMS": Network Management System
15. "PCS": Personal communications service
16. "PIM": Passive Intermodulation
17. "RF": Radio Frequency
18. "RFID": Radio frequency identification
19. "RSSI": Received signal strength indication
20. "SISO": Single-Input, Single-Output
21. "SNMP": Simple Network Management Protocol
22. "SNIR": Signal to Noise Interference Ratio
23. "SOW": Statement of Work
24. "WSP": Wireless Service Providers (carriers)

1.4 SYSTEM DESCRIPTION

G. System Description

1. The in-building distributed antenna system, herein "system" or "DAS", shall reliably distribute RF signals and/or wireless services throughout the specified frequency ranges and the throughout the specified coverage spaces. The system shall be implemented based on proven state-of-the-art technology that can seamlessly integrate with the rapid evolution of wireless technologies and business applications. The system shall be flexible and shall easily accommodate additional wireless services within the system's frequency bands without requiring significant upgrades or system modifications.
2. The system shall include subsystems, equipment, components, transmission media, connection/ termination apparatus, etc., necessary for a complete operating system as described herein.
3. The DAS shall include a head end subsystem. The head end shall be a common interface node. The head end shall be co-located with Base Station systems from multiple cellular common carriers.

H. Design Criteria

1. Frequency Range: The system shall support all frequencies between and 700 MHz to 2600 MHz
2. The system shall distribute RF coverage at levels outlined below in the following areas of the building(s) – herein specified coverage areas:
 - a. Floor areas
 - b. Classrooms
 - c. Basement
 - d. Garage
 - e. General Use spaces (break rooms, staff rooms)
 - f. Mechanical / Electrical Rooms

- g. Restrooms
 - h. Stairwells
 - i. Elevators
 - j. Penthouse
 - k. Sub Floor and other ancillary spaces
 - l. Exterior public spaces
3. The system shall be able to simultaneously support the following wireless services, technologies and associated frequencies: Also to include any and all technologies in service or planned like 5G, LTE etc.
- a. Wireless Operators

System Type	AT&T	Verizon	Sprint Nextel	T-Mobile	Metro PCS
GSM (voice)	850 1900			1900	
PCS (2.5G / 3G)	1900	1900	1900	1900	
CDMA2000 (voice)		850 1900	800 1900		1900
iDEN (2G)			800 900		
Edge (2G Data)	850 1900			1900	
UMTS (3G data)	850 1900			2100	
EV-DO (3G data)		850 1900	1900		1900
HSDPA (3G)	850 1900			2100	
HSUPA (3G+)	850 1900			2100	
LTE (4G Data) SISO	700 1900 2100	700 2100	1900 2600	700	2100
WCS (4G Data)	2300				
Wi-Max (4G data)			2600		
AWS (3G / 4G)	1700 2100	1700 2100		1700 2100	1700 2100

- 4. The system shall have the capability for separate control over each service (or wireless operator) to allow the ability to adjust and control power levels without disturbing other services/operators.
- 5. The system shall support multiple services in a modular architecture so services can be added or removed without requiring new infrastructure, without readjustment of signal power levels, or disturbing existing services.
- 6. The system shall enable services to be added without requiring additional cabling or antennas.
- 7. The system shall not impede any management features or functionality of any attached network and/or device management system. The system shall allow for proactive management and end-to-end alarming of active electronics. The system shall be able to engage with 3rd party SNMP-based element management systems and provide fault management information.
- 8. It is preferred that the system's antennas be mounted above ceiling grids. RF design, antenna placement and mounting must be coordinated with both the architect and the owner throughout the project.
- 9. E911: The system must support E911 and associated sectors.

10. Cellular Services:
- a. The system's transmission media can take many forms, from traditional off-air repeater, or Base Transceiver Station (BTS) to a tethered architecture consisting of coaxial, fiber optic, or hybrid fiber/coaxial base solution. The DAS shall extend the common wireless carrier services from the head end system by interfacing to either a passive or active DAS that is deployed in each of the building structures. The following system solution designs are meant to be typical only. Bidders are expected to describe their proposed system solution.
 - b. The system shall support the use of legacy cellular enhancement and technologies such as EDGE, and UMTS-HSPA technologies.
 - c. The GPS navigational signal must be brought to the Base Station at the system's head end to support LBS functionality. Coordinate with the cellular carriers and the DAS system for GPS services. If the carriers provide the GPS systems then coordination is required by the DAS supplier.
 - d. The system shall support the latest advancement in Mobile broadband and LTE, where it supports the growth of mobile computing, low latency, and the demand for higher throughput requirements has necessary for different applications such as:
 - 1) Micro-browsing (for example, Wireless Application Protocol [WAP]): 8 to 128 kbps
 - 2) Multimedia messaging: 8 to 64 kbps
 - 3) Video telephony: 64 to 384 kbps
 - 4) General-purpose Web browsing: 32 kbps to more than 1 Mbps
 - 5) Enterprise applications including e-mail, database access, and VPNs: 32 kbps to more than 1 Mbps,
 - 6) Video and audio streaming: 32 kbps to 2 Mbps
 - 7) Mobile broadband evolving to OFDM and MIMO using the spectrum and IP based networks
 - 8) Cellular which includes: 1G Analog, 2G TDMA, 3G WCDMA, 4G LTE, and. Broadband Wireless. Note: LTE has the same level of upgrade and requires new RAN equipment and devices that are not backward compatible to 3G networks.
 - e. Cellular signal strength shall be -75 dBm or stronger for lower 700 MHz and -85 dBm for cellular, PCS, AWS, Commercial 800/900 MHz throughout 95% of the required coverage areas. At least 8 dB higher (Signal Dominance) than the cellular carriers macro signal based upon the current macro coverage. A minimum signal strength of -85 dBm must be provided for the remaining 5% of the building
 - f. PIM level of -160 dBc or better on all segments
11. The system shall be FCC certified with the specific access points that are to be deployed.
12. The system and the associated wireless devices shall comply with FCC's and Regional regulatory authorities' emission rules for wireless devices.
- a. Refer to: FCC advisory: "A Local Government Official's Guide to Transmitting Antenna RF Emission Safety Rules, Procedures, and Practical Guidance", FCC's OET Bulletin 65, FCC Rule 47-part 17 and (ANSI/IEEE C95.1-1992) Hazardous Emission document.

I. Base Bid Work

1. The work of this section includes furnishing materials, installation, and coordination through the General Contractor with other trades for a complete, operational, and balanced system. Furnish necessary materials, accessories, fasteners, etc., and the labor and associated services required to provide the system specified herein.
2. The work of this section includes the following (described in greater detail in Part 3):
 - a. Project management services
 - b. Validate current and planned future carrier services and associated frequencies
 - c. Antenna placement and mounting coordination with both architect and owner
 - d. Detailed system design
 - e. Installation and system balancing
 - f. Coordination with the overall construction team and usage of pathways provided by others
 - g. Manage wireless service providers' connection to system
 - h. Manage FCC Licensing
 - i. Manage all FCC registration including Part 90 requirements
 - j. System acceptance testing and turn over to owner
3. The work of this section requires particular attention to the following:
 - a. Ceiling Types: The installer shall fully understand every ceiling type and its interaction with the system. For example, some ceiling types may impede RF signals and, subsequently, system performance.
 - b. Mounting details: the installer shall coordinate mounting of antenna and the RF impact. It may be preferred that antenna be mounted above or below ceiling grid. Coordination with both architect and owner is required.
 - c. Pathways: The work of this section requires the installer fully understand the pathways and to coordinate placement of cables within those pathways.
 - d. Fiber Distribution system: The DAS integrator shall provide fiber distribution for DAS system. The DAS integrator shall meet the requirements called out in Section 271323, Fiber Optic Backbone Cabling
 - e. Maintenance Contract for support services for 12-months from the completion of the project

J. Work Covered Under Other Sections

1. Pathways – backbone conduits and primary pathways
2. Telecommunications Rooms – equipment support (racks), power, cooling, and grounding

1.5 SUBMITTALS

K. Comply with Submittal procedural, quantity, and format requirements of Section 270000.

L. Submittal Requirements with the Bid:

1. A FCC-issued general radio operator's license (GROL) for the testing personnel
2. A certificate from the manufacturer of the equipment to be installed stating that the DAS installer is trained and qualified on the equipment.

3. Current calibration and test data on the test equipment to be used in the system commissioning.
 4. Equipment cut sheets on any equipment proposed for substitution
- M. Submittal Requirements Prior To Start Of Construction:
1. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
 2. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
 3. Final RF link budgets
 4. SNIR map
 5. Product Data Submittal
 6. Shop Drawings Submittal: Shop drawings shall include the following information:
 - a. System or functional block/line diagrams
 - b. Fiber optic backbone riser diagram
 - c. Plans indicating equipment, antenna and/or component locations, mounting details, cable routes, and other installation information – identify construction elements that would affect the system's performance (such as metallic ceiling materials)
 - d. Coverage plans, showing the design RF coverage (signal strength) for each frequency band required in 1.04 B.3 using IBWave or another industry acceptable RF modeling tool. State the number of channels in each frequency band for the RF coverage plots.
 - e. Equipment and/or wall / rack elevations, showing equipment layout, space requirements and integration with other systems (outside the scope of the DAS)
 - f. Installation details for antenna mounting, specialty cable hangers, and other components unique to the system, and other information that depicts the intended installation
 - g. Seismic Calculations: Include structural calculations for anchorage and seismic restraint of floor-mounted equipment (such as racks, frames, cabinets), wall-mounted equipment (amplifiers, etc.), and overhead-mounted equipment (such as antenna, overhead cable support, etc.) in conformance with CBC, Section 1601A. Calculations shall be based on fully loaded equipment and support systems. Calculations shall demonstrate that the equipment and support systems will remain attached to the mounting surface during and after experiencing seismic forces in conformance with the CBC. A Structural Engineer registered in the State of California shall prepare Structural Calculations, and shall wet stamp and sign them. Obtain approval from the structural engineer of record for the calculations.
- N. Submittal Requirements Prior to Acceptance Testing:
1. Acceptance Testing Procedures Submittal: describes in detail the procedure for testing the system's performance and balancing the system's signal strength, including a description of the test data (or an example of the test report). The Contractor shall demonstrate the desired services have been successfully deployed and tested. Specifically, the DAS must be deployed with the Wireless Operators criteria and approval.
- O. Submittal Requirements at Close Out:

1. As-Built Drawings including
 - a. Donor antenna, grounding and lightening protection details
 - b. Cable routing, splitters, couplers and coverage antenna locations
 - c. Active component locations, layout and configuration
 2. Test Reports
 - a. PSN: Submit accepted ATP reports confirming the requirements have been met
 - b. WSP DAS: Submit accepted ATP reports confirming the requirements have been met
 - c. Cable Test Reports: Submit cable test results for all cable segments. Testing shall include Return Loss (RL), Distance to Fault (DTF) and Passive Intermodulation (PIM).
 - d. Field Reports: Submit Power Meter and OTDR test results for all fiber runs.
 3. Operations and Maintenance Manual (refer to Section 270000 for contents)
 4. Warranty Documents
 - a. Submit for all manufactured components specified in this section
 - b. Submit Contractor's System Warranty
 - c. Submit Manufacturer's Extended Warranty
 5. Integration of components and pathways into the Building Information Model (BIM)
- P. Substitutions
1. Requests for substitutions shall conform to the general requirements and procedure outlined in Section 27 0000.

1.6 QUALITY ASSURANCE

- Q. Comply with Quality Assurance requirements of Section 270000.
- R. Comply with manufacturers specifications.
- S. DAS integrator must be an authorized distributor and installer for product supplied. Installing technicians must have manufacturer's certificate of appropriate training.
- T. DAS integrator must have and provide applicable state licenses

1.7 DELIVERY, STORAGE, AND HANDLING

- U. Comply with Delivery, Storage and Handling requirements of Section 270000.

1.8 WARRANTY

- V. Warrant Work and system to perform as described within this Section for a period of one year, including components, electronics, etc., and coverage. Correct deficiencies within 24 hours of notification.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Andrews/Commscope
- B. Motorola

- C. MobileAccess
- D. Tyco
- E. Solid
- F. Or equal

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with the Execution requirements of Section 270000.
- B. Comply with manufacturers specifications.

3.2 EXAMINATION AND PREPARATION

- A. Prior to the start of this section's installation Work, examine communications rooms and pathways for completeness, compatibility with the work of this section, and readiness for connections with the work of this section. Confirm network is ready for connection to the system.

3.3 INSTALLATION

- A. Project Management Services: Assign a single-point-of-contact to this project with overall responsibility for communications and ultimate delivery of contracted materials, installation, performance criteria, and services – "PM". This PM shall be responsible for interfacing with the owner, Telco's, General Contractor, Engineer, and their own subcontractors. The PM shall present the design iterations to the owner, coordinate cable routes with the Engineer, coordinate on-site construction activities with the General Contractor, shall manage the process to coordinate bringing wireless operators into the facility, and shall close out the project with the owner.
- B. Detailed system Design: Use the requirements of this Section to complete the detailed design of the system. Design shall include computer RF modeling and site surveys. The detailed design shall deliver the pre-construction submittals, including iterations for the owner's review and sign-off. The Contractor will show design RF signal levels to sub-room precision for all rooms within the defined coverage areas. The Contractor will obtain compatible drawings from architect. If drawings are within BIM then it is the responsibility of the contractor to modify the BIM model for use in their wireless modeling which includes the creation of 2-D floor plans, RCP plans and elevations.
- C. Installation: Coordinate the installation and schedule with the owner, General Contractor and Electrical contractor (for UPS) prior to the start of installation activities. Once the owner and General Contractor have accepted the coordination and schedule, the Contactor may proceed with installation.
- D. System Balancing: Balance the system component (e.g., antenna) signal strength to the device signal levels.
- E. Active Survey: Perform an active wireless survey demonstrating performance according to the design criteria of Part 1 (above). From this survey, produce an active survey report, including floor plans.

3.4 CONNECTIONS TO SYSTEM

- A. Manage Wireless Operators' Connection to system: Represent the owner during negotiations with wireless operators (Telcos) to obtain their approval, coordinate site preparation, E911, assist with wireless service providers' installation, and coordinate connection of wireless service providers to the system. Coordinate any RF rebroadcasting agreements with wireless operators. The Wireless Operator integration shall be turn-key.
- B. Manage FCC License: Acting as a representative of the owner, obtain required licenses for operation under FCC Regulations.

3.5 LABELING

- A. General Requirements
 - 1. Labeling, identifier assignment, and label colors shall conform to the TIA/EIA-606-A Administration Standard and as approved by the owner's representative before installation.
 - 2. Permanently label equipment, components, and cables. Affix label as close as practical to each end of cables.
 - 3. Coordinate labeling and identifier assignment with the Engineer or owner. Submit a labeling plan to the Engineer for approval prior to labeling work.
- B. Label Format
 - 1. Provide permanent labels with machine-generated text; hand written labels will not be accepted.
 - 2. Labels on cables shall fully wrap around cable jackets with a self-laminating feature to provide permanent marking.

3.6 SYSTEM ACCEPTANCE TESTING AND TURN OVER TO OWNER

- A. Complete the acceptance testing as prescribed in the accepted testing procedures submittal.
- B. Complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal. The DAS system shall be tested by a person or persons who are holders of a FCC General Radio Operator's License (GROL) or their designees.
- C. Testing Procedure
 - 1. Test Location
 - a. Each floor of the building shall be divided into a grid of 10 approximately equal test areas.
 - b. Downlink received signal level measurements will be recorded in the coverage area using a CW test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.
 - c. Failure of a maximum of two non-adjacent test areas shall not result in failure of the test.
 - d. In the event that three areas fail the test, the floor shall be divided into 40 equal test areas. Failure of five or more non-adjacent test areas shall result in failure of the test.
 - e. A test location approximately in the center of each test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.

2. Equipment Requirements

- a. Test equipment shall be allowed to stabilize in the test environment prior to calibration for a minimum of thirty minutes. Any change in temperature can void the calibration.
- b. Signal generator must be connected to the Head-end downlink (TX) interface via tested and approved coaxial cabling and connectors.
- c. Signal generator transmits frequency (MHz) and power (dBm) must be preapproved by the project engineer prior to testing. The control channel from the base station can be used as a signal source as well.
- d. Verify that all remote units for the area under test are ON.
- e. Test frequency and power must be recorded corresponding to the date and time of each site walk measurements.
- f. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be preapproved by the project engineer.
- g. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center / measured frequency.

3. Documentation

- a. Exact location of measurement must be marked on the grid print.
- b. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid## "A", Grid## "B" etc.
- c. Results of testing are reported to the project engineer for analysis and reporting.

- D. Present the completed system and wireless services to the owner, including functionality, features, ongoing maintenance, and warranty procedures. Demonstrate to owner and Engineer system operation, including signal strength at select locations. Turnover at least one set of both electronic records and printed records, per the owner's request.

3.7 EXTENDED SUPPORT SERVICES

- A. Provide support services for 12 months following the owner's acceptance of the system (for services such as integration of additional wireless operators).

3.8 FINAL INSPECTION AND CERTIFICATION

- A. Punch the Work of this Section compliant to the requirements of Section 270000.
- B. Comply with system acceptance and certification requirements of Section 270000.
- C. Provide Certificate of Compliance with manufacturers specifications
- D. Produce heatmaps representing each frequency range
- E. Produce impedance-based line sweeps and PIM testing for each DAS segment

3.9 TRAINING

- A. Comply with training requirements of Section 270000.
- B. For this system, provide up to 8 of training for the owner.

END OF SECTION