SECTION 275319 DISTRIBUTED ANTENNA SYSTEM (DAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings found in Exhibit G – PA Convention Floor Plan and Exhibit H – PDF and CAD drawings

1.2 SUMMARY
   A. The Owner is seeking a Contractor/Service Provider to provide a complete and fully functioning and supported neutral host distributed antenna system (DAS) including equipment, installation, support, and maintenance. The Contractor shall provide options for installation, funding, and procurement as well as disclosure revenue opportunities as part of the Vendor’s proposal response. The Contractor shall be responsible for providing a neutral host DAS that will support all major and local Cellular Carrier signals. The Contractor shall be solely responsible for negotiating and coordinating all legal agreements, technical requirements, utility costs, and financial/revenue obligations of each Cellular Carriers.
   B. The Contractor shall be fully responsible for supporting and maintaining DAS.
   C. The Contractor shall include the following information in the bid response.
      1. Cellular Carrier Agreements, Coordination, and Requirements
      2. Procurement Options
      3. Financial Obligations and Shared Revenue Opportunities
      4. Cellular Carrier Agreements and Utility Service Agreements
      5. System Maintenance and Support Options
      6. User Support Options – Events, Regular Venue Operations, and Afterhours
      7. Public Safety/Emergency Responder Coordination and Requirements
      8. DAS Equipment Room
      9. DAS Head-End, Infrastructure, Equipment, Remote Units, Antennas
     10. DAS Support Systems – Mechanical, Electrical, Plumbing, and Fire Suppression
   D. The DAS shall meet the all coverage and capacity requirements for a convention center based on the highest occupancy allowed by code. The coverage shall be ubiquitous throughout venue in public and non-public area. Coverage shall fully cover multiple event types that may occupy the building such as trade shows, concerts, conventions and large meetings.
   E. Contractor shall provide all detailed coordination of antenna placement for approval by Owner and Manager. Work shall include all necessary concealment, facades, and painting to hide equipment including antennas, cables, raceway, remote units, and any other exposed equipment.
   F. The term “provide” used throughout this specification and drawings shall mean “furnish, install, test, certify, support, and maintain”.
   G. Coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Construction Manager and all necessary Trades to ensure successful completion of work.
   H. Phasing, temporary distribution/equipment, cut-over and implementation shall be coordinated with Owner and Manager.
   I. This specification is not intended to contain proprietary information or requirements based on any specific manufacturer or system. Any proprietary information included in this specification is unintentional.
   J. This specification is intended to establish the minimum performance criteria requirements for providing a neutral host distributed antenna system (DAS). The contractor shall coordinate all system and performance requirements and criteria with all DAS users to ensure signal strength, coverage, capacity, and other requirements are all maintained. This includes coordination with Cellular Carriers.
   K. This specification outlines general wireless requirements for implementing a neutral host DAS used for supporting applications such as cellular telephones and two-way public safety (police/fire/EMS radios).
   L. The Contractor will coordinate all Public Safety frequencies, preferred manufacturer make/model, antennas, equipment, power conditions and locations with IJ Rosenblum, IT Director irosenblum@paconvention.com.
M. The DAS shall include an in-building system. The Contractor shall get written confirmation regarding verifiable DAS performance and cellular strength and capacity requirements from all Carriers for exterior DAS coverage and associate adjustment of macro cells.

N. Design, furnish, install, and configure a turnkey DAS, wireless carrier interfaces, two-way radio head-end equipment, and system management and monitoring software. Work shall include all necessary fiber optic backbone, distributed antenna system components and installation thereof required including raceway, cable, cable terminals, transceivers/media converters, amplifiers, equipment, fireproofing, fire suppression, etc. for a fully operational and functional DAS.

O. The distributed antenna system (DAS) scope of work shall be for a complete and fully functioning DAS system including but not limited to wireless surveys, technical design, procurement, installation, cellular carrier coordination, and full support and maintenance of system. These elements of this scope shall include all necessary components and infrastructure such as DAS head-end, fiber optic backbone, remote units, antennas, antenna cables, horizontal raceway, and miscellaneous power distribution.

P. The system shall fully support multi-cast and unicast communications for application including but not limited to audio streaming, video streaming, IPTV, and multi-point video, etc. All necessary licensing and patent agreements shall be included to utilize this technology as part of this work.

Q. The base project will construct a DAS Equipment Room (shell only). The complete fit-out of the DAS equipment shall be provided by Contractor including all necessary HVAC systems, power distribution, electrical meters, UPS, fire suppression system to cover the entirety of the DAS and main communications room, equipment racks/cabinets, cable trays, raceways, etc. Any additional infrastructure and/or space required are the responsibility of the Contractor and shall coordinate these with the Owner for approval. The Contractor shall review and inspect current Construction Documents to determine where this raceway infrastructure exists and what additional infrastructure will be required for their installation. In some cases, backbone and antenna cables may be routed in shared riser conduits and/or cable trays but Contractor must verify Building Codes and Industry Standards for fill capacity requirements. Contractor shall be responsible for field coordinating use of any shared raceway with other trades.

R. The DAS shall include a real time management and monitoring software control system. This control system shall be set up and fully configured and monitored offsite in real-time 24-hours per day.

S. The contractor shall provide all necessary power to DAS room from Electrical Distribution Board including transformer, panel boards, UPS, receptacles/outlets, and equipment connections, etc.

T. The Contractor shall provide meters all electrical power distribution to DAS equipment room including DAS head-end, Cellular Carrier base station equipment, air conditioning, lighting, and other support systems. Contractor shall pay the monthly utility costs to Owner.

U. The DAS solution shall include options for technology that seamlessly offloads a user’s cellular service to Wi-Fi. The Contractor shall present options for supporting this technology and information on maintaining quality of service. Additionally, Contractor shall provide options for amount of traffic that can be offloaded and associated requirements for ensuring performance and uptime of Wi-Fi system.

V. This work shall include onsite wireless/RF surveys, virtual antenna placement, physical design of DAS, submittals, equipment, and installation.

W. An onsite wireless/RF survey shall be provided to establish existing signal strengths and potential interfering sources. This study shall be completed on all levels and areas and as necessary to finalize locations of antennas as well as validate signal strength and coverage after installation and during commissioning. The Contractor shall coordinate project construction schedule with the Construction Manager to establish milestone dates for substantial completion, that affect occupancy certificates, system completion, commissioning, and turn-over.

X. The DAS design shall be developed and optimized using wireless software such as iBwave for establishing antenna locations based on electronic architectural drawings and various wireless frequency bands. Construction materials shall be inputted into the software program for structure, walls, floors, and ceilings. This software shall be used to predict antenna locations. Exact locations will need to be field verified using onsite wireless surveys as well as coordinating locations with Owner and Manager for approval.
Y. The DAS wireless coverage and signal strength shall be field-tested and verified, certified, and
guaranteed upon installation against design requirements.

Z. The DAS shall support major national and local Cellular Carriers including AT&T, Sprint, T-
Mobile/MetroPCS, and Verizon Wireless and any new formats the Carriers implement over time
such as; 850Mhz LTE 2xMIMO and LTE850-MIMO and PCS LTE 2xMIMO dual streams.

AA. Contractor shall provide all necessary coordination, requirements and contracts/lease
agreements with Cellular Carriers. These shall include but not be limited to equipment room and
all DAS technical requirements necessary to interface with base stations, transport the signal,
and transmit the signal throughout building and exterior.

BB. The Cellular Carriers shall be contacted only through the Contract in conjunction with Owner
and/or their assigned representative.

CC. The Contractor shall coordinate support systems requirements directly required by the DAS and
Cellular Carrier equipment such as architectural, HVAC, electrical, and technology systems.

DD. The Contractor shall provide, furnish, and install the required vertical and horizontal raceways
and cabling required for the DAS.

EE. Placement of all equipment including antennas, cable, and electronics shall be coordinated with
Owner, Manager, and other Construction Trades to ensure neat and functioning installation.

FF. All antenna locations and cable routing shall be coordinated by the Contractor with the Owner
and/or Manager prior to installation to maintain the highest level aesthetics sought on this project.
The Contractor shall position antennas discreetly. Key contact for this activity is IJ Rosenblum,
irosenblum@paconvention.com

GG. The installation of the distributed antenna system shall comply with all local building
codes, and applicable rules and regulations of the authority having jurisdiction (AHJ), FCC,
BICSI, EIA, IEEE, NEC, TIA, UL, and other industry standards, codes, and methods.

HH. Provide a dedicated fiber optic backbone to support the DAS from the DAS Head-end to remote
units and/or intermediate communications room. The Contractor is not permitted to use the
building backbone to support telecommunications and IT systems.

II. Extent of DAS work is indicated by Division 27 Specifications and Technology drawings and
schedules and is hereby defined to include, but not by way of limitation, the provisions of:

1. Raceway systems including but not limited to conduits, cable trays, sleeves, surface
raceways, pull-boxes, junction boxes, back-boxes, etc., as required and specified in
Division 27 sections and select Division 26 sections. The Contractor shall coordinate this
with the Construction Manager and Sub-Contractor performing work and determine how
the scope of work is assigned. The purpose of this specification is to establish design
intent and general system scope.

2. All infrastructure shall be provided as part of this work including but not limited to
raceway, cable, cable terminals, room fit-out, etc. unless noted otherwise in this
specification and drawings.

3. Horizontal cables between the Intermediate Communications (IC) Rooms and the
antennas.

4. Dedicated fiber optic backbone cable between remote units and intermediate
communications room and the DAS equipment room.

5. Cable terminations and terminals including but not limited to wiring panels/blocks, patch
panels, fiber optic terminals and panels, and outlets/jacks.

6. Patch cords, jumper cables, and cross-connect cables to interconnect wiring terminals,
antennas, and electronic equipment.

7. Connection from power supplies to electrical power receptacles located on walls, UPS,
and/or vertical power strips. The Contractor shall be responsible for providing all
necessary disconnects, transformers, and panel boards required to interface at
distribution board located at electrical room serving DAS room.

8. Grounding and bonding of all metallic hardware components to the nearest
telecommunications grounding bus (TGB) bar including but not limited to equipment
chassis, metallic cable sheaths and shields, cable terminals, conduits, sleeves, etc.
Grounding shall include insulated bonding conductors, lugs, and attachment hardware.
9. All physical cable management hardware including, but not limited to: “J-hooks” in accessible ceiling areas, “D-rings” on backboards, horizontal managers in racks and cabinets within all communication rooms, etc.
10. Fire stopping as required.
11. Testing of system, components, and infrastructure as noted by specification, drawings, and applicable industry standards.
12. Testing of all grounding systems as noted by specification, drawings, and applicable industry standards.
13. Labeling of all system equipment, components, hardware, cable, and terminations with mechanically printed labels.
14. Preparation and submission of product data, shop drawings, testing reports, as-built drawings, and cabling documentation as required in this specification.
15. Construction and Installation warranties.
16. Manufacturer components, channel and solutions warranties.
17. Installation and testing of all system and components.
18. Onsite administrative and user training (as applicable).
19. Manufacturer training of components (as applicable).
20. Preparation of maintenance plan recommended by system Manufacturer.
21. Spare parts for immediate onsite maintenance.

1.3 ACRONYMS AND ABBREVIATIONS
A. Provided below is a general list of typical acronyms and abbreviations:
1. 2G: Second Generation mobile telecommunications
2. 3G: Third Generation mobile telecommunications
3. 4G: Fourth Generation mobile telecommunications
4. AHJ: Authority Having Jurisdiction
5. AMPS: Advanced Mobile Phone Service
6. ARPU: Average Revenue Per User
7. BICSI: Building Industry Consulting Services International
8. BTS : Base Transceiver Station
9. CDMA: Code Division Multiple Access
10. DAS: Distributed Antenna System
11. FCC: Federal Communications Commission
12. GSM: Global System for Mobile Communications
13. iDEN: Integrated Digital Enhanced Network
14. IEEE: Institute of Electrical and Electronics Engineers
15. LMR/SMR: Land Mobile Radio/Specialized Mobile Radio
16. LTE: Long Term Evolution mobile broadband telecommunications
17. MIMO: Multiple Input / Multiple Output
18. NEC: National Electrical Code
19. PCS: Personal Communications Service
20. PoE: Power over Ethernet
21. POI: Point of interface
22. PSTN: Public Switched Telephone Network land based telecommunications providers
23. Telephone Company.
24. RF: Radio Frequency
25. SHF: Super High Frequency (3-30 GHz)
26. TDMA: Time Division Multiple Access
27. UHF: Ultra High Frequency (300-3000 MHz)
28. VHF: Very High Frequency (30-300 MHz)
29. WCDMA: Wideband Code Division Multiple Access
30. WiMAX: Worldwide Interoperability for Microwave Access
31. WLL: Wireless Local Loop

1.4 SUBMITTALS
A. General Description and Requirements:
1. Within 15 days after award of contract or as dictated by the construction schedule (whichever period of time is shorter), the Contractor shall submit prefabrication submittals consisting of product data and shop drawings for approval. Partial submittals will not be accepted without prior written approval from the Owner Representative. Coordinate all submittal dates with IT Director.

2. Review of the Prefabrication Submittals by the Owner Representative is for purposes of tracking the work and contract administration and does not relieve the Contractor of responsibility for any deviation from the Contract Documents, or from providing equipment and/or services required by the Contract Documents which were omitted from the prefabrication submittals.

3. No portion of the project shall commence nor shall any equipment be procured until the prefabrication submittals have been approved in writing by the Owner and Owner Representative. All installations shall be in accordance with the Contract Documents.

4. Prefabrication submittals shall be accompanied by a letter of transmittal identifying the name of the project, Contractor's name, date submitted for review, and a list of items transmitted.

B. RFP Documents: Refer to RFP - DAS Information for requirements.

C. Compliance Matrix: Provide a specification compliance matrix indicating compliance or deviation for each item in the specification. Refer to Section D later in this specification for requirements.

D. Product Data: The DAS Product Data Submittal shall be submitted for review and approval by Owner and Manager prior to starting any work. Information shall include detailed manufacturer's specifications for each component to be installed. Submittal shall include a list every component with Manufacturer's part numbers referenced, and, if available, Manufacturer data sheets with features, options, ratings, and performance. Product numbers and options to be used shall be highlighted with color marker.

1. Component List: Provide complete submittal component list at the beginning of the submittal package. Component list shall identify each component name, manufacturer, and specific product/part number. All part numbers shall clearly indicate special options, color, accessories, etc.

2. Cut-Sheets: Submit manufacturer's cut-sheets on all components listed within this specification and corresponding appendix. All components and parts being used shall be highlighted in color or clearly underlined on cut-sheets to distinguish specific product/part numbers, options, colors, accessories, etc.

3. Product Substitutions: This specification is intended to be performance based, thus requirements and products noted are benchmarks. The Contractor may substitute manufacturers and models that may be more cost effective or readily available. All substitutions shall meet or exceed the minimum functional, physical, and technical specifications. Acceptance of such substitutions is at the discretion of the Owner and Manager. Additionally, the requirements of Division 1 Specifications shall apply and may supersede requirements noted herein.

4. Schedule: A detailed completion schedule shall be submitted with the prefabrication submittals.

5. Warranty Information: Provide all warranty information as described in this specification section for review and approval.

6. Product Certificates: Signed by manufacturers of systems certifying that products furnished comply with requirements.

7. Installer Certificates: Provide manufacturer certification signed by manufacturer certifying that installers have been trained to install all components of the system and comply with manufacturer’s requirements.

E. Equipment Coordination and Mock-Ups:

1. Contractor shall provide all detailed coordination of antenna placement for approval by Owner and Manager. Work shall include all necessary concealment, stealthing, facades, and painting to hide equipment including antennas, cables, raceway, remote units, and any other exposed equipment.
2. Contractor shall provide full-scale mockups in stadium for all typical equipment placement including remote units, antennas, backbone/antenna/power cable routing, conduits, etc. Mockups shall include all painting and stealthing to match condition to be installed.

3. Contractor shall present mock-ups for approval to Owner and Manager prior to installation.

F. Not Applicable

G. Coordination Data: A detailed equipment and component schedule with supporting manufacturer cut-sheets shall be developed for all components and equipment for architectural, engineering, and construction coordination. These documents shall include electrical requirements (volts, phase, amps, power consumption, receptacle configuration, etc.), UPS requirements, heat dissipation, temperature operating range, target operating temperature, physical equipment sizes (LxWxH, rack units, racks, cabinets, panels, etc.).

H. Shop Drawings: The DAS Shop Drawings shall be submitted for each “construction phase configuration” and “final configuration” prior to starting any work for review and approval by Owner and Manager. Additionally, Shop Drawings shall be used for coordination with Manager and Trades by this installer. Information shall include all drawings necessary to present installation intent including plans, enlarged plans, elevations, sections, details, and interface to other work or systems.

1. Legend Sheet: Provide drawings including descriptions of all abbreviations and symbols.

2. One-Line Diagrams: Provide drawings that indicate backbone and horizontal cable infrastructure, antennas, and all equipment. Drawings shall include relevant information such as room numbers, panel numbers, cable and raceway requirements.

3. Floor Plans: Provide scaled plan drawings based on architectural background indicating device and equipment locations including point of interface (POI) antennas, radiating cable antennas, backbone and horizontal cable distribution, panels, conduits, backboxes, junction boxes, etc. Additionally, provide wiring diagrams for indicating cable origination and routing.

4. Enlarged Plans: Provide enlarged scaled plan drawings for equipment layouts in communications rooms.

5. Elevations: Provide scaled drawings for elevations of all equipment layouts in communications rooms, equipment racks, and panels.

6. Details: Provide detail drawings as required to show components requiring greater detail. This should include various antenna types and mounting configurations.

7. Labeling: Provided documentation of all labeling schemes for conduit, back-boxes, junction boxes, antennas, panels, cable, terminations, patch panels, cross-connects, patch panels, etc.

8. Test Results: Provide all final RF test results in a table or matrix as well graphically on plan drawings. Test results shall indicate the signal strengths and interference levels (signal-to-noise, Eb/No, or equivalent).

I. As-Built Drawings: The DAS As-Built Drawings shall be submitted to Owner after completing work. As-Built Drawings shall indicate final installation of system. Information shall include all drawings necessary to present final installation intent including plans, enlarged plans, elevations, sections, details, and interface to other work or systems.

1. Legend Sheet: Provide drawings including descriptions of all abbreviations and symbols.

2. One-Line Diagrams: Provide drawings that indicate backbone and horizontal cable infrastructure, antennas, and all equipment. Drawings shall include relevant information such as room numbers, panel numbers, cable and raceway requirements.

3. Floor Plans: Provide scaled plan drawings based on architectural background indicating device and equipment locations including point of interface (POI) antennas, radiating cable antennas, backbone and horizontal cable distribution, panels, conduits, backboxes, junction boxes, etc. Additionally, provide wiring diagrams indicating cable origination and routing.

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7. Labeling: Provided documentation of all labeling schemes for conduit, back-boxes, junction boxes, antennas, panels, cable, terminations, patch panels, cross-connects, patch panels, etc.

8. Test Results: Provide all final RF test results in a table or matrix as well graphically on plan drawings. Test results shall indicate the signal strengths and interference levels (signal-to-noise, Db/No, or equivalent).

J. Field Test Reports: Indicate and interpret test results for compliance with performance requirements of installed systems.

K. Commissioning:
   1. Check-List: Contractor shall create and submit a detailed checklist for commissioning system equipment and components. The list shall be submitted for Owner review. System commission shall include the following categories.
      a. Procured Components Validation
      b. Physical Installation and Location
      c. Equipment Connectivity and Inter-Connectivity
      d. Support Systems Functioning (HVAC, electrical, and UPS)
      e. System Setup and Operation
      f. Wireless Surveys
      g. Testing
   2. Report: The Contractor shall complete commissioning of the system and issue a final report. Commissioning shall be performed upon completion of system, and after its testing and retuning. Report shall be completed and finalized by the Contractor prior to system acceptance by Owner. A formal report shall be generated that includes sign-off and notes of all checklist items.

L. Maintenance Information: The Contractor shall provide Maintenance Manuals for the DAS equipment and components as specified in Division 1. Maintenance information shall include the following:
   1. Detailed operating instructions under both normal and extraordinary conditions.
   2. Routine maintenance requirements for system components.
   3. Lists of spare parts and replacement components recommended for storage at the site for ready access.

M. Warranties: The Contractor shall fully warranty and provide necessary maintenance on all parts, components, and labor for the entire duration of the DAS agreement with Owner. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the Wireless Carriers.

N. Documentation: All documents submitted by Contractor including product data, submittals, as-built, test results, drawings, reports, etc. shall be provided in electronic (pdf) and paper format.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The installation supervisor for both installation and maintenance of units required for this Project must be an experienced installer who is an authorized representative of the DAS manufacturer.
   1. Contractors shall have at least five (5) years of successful installation experience with projects utilizing wireless systems including DAS.
   2. The Contractor shall have a fully staffed office with technical installations support personnel within 30 miles of the project.
   3. The company shall be a certified installer of the DAS manufacturer, and shall provide a 1-year warranty on installation/applications.
   4. The company shall be a certified installer of structured cabling systems, and shall provide a 25-year warranty on installation/applications.
   5. The Contractor shall have a professional engineer licensed to practice in jurisdiction where Project is located and who is experienced in providing engineering services of similar scope. The Contractor’s design shall be reviewed, signed, stamped, and sealed by the engineer.

B. Manufacturer and Product Qualifications
1. Provided products shall come from manufacturers regularly engaged in the production of DAS and wireless systems.

2. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar projects for not less than five (5) years.

C. Products and Substitutions: Other manufacturers’ products complying with requirements may be considered. All manufacturer solutions, products components and/or substitutions shall be submitted at bid time for review and acceptance by Owner. Cost changes including additions or deductions, shall be submitted for all items.

D. Alternates: All alternates requested or proposed by the Contractor shall be submitted at bid time for review and acceptance by Owner. Cost changes including additions or deductions shall be submitted for all items.

E. Electrical Components, Devices, and Accessories: These shall be listed and labeled as defined in NFPA 70, NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All materials shall be Underwriters Laboratories (UL) Listed unless otherwise noted or required by AHJ.

1.6 CODES AND STANDARDS

A. All work including materials and installation shall conform to all applicable sections of currently adopted editions of the codes and standards listed below or the codes, standards and specifications published by the organizations listed below:

2. State and local codes.
5. ANSI/EIA/TIA-568-C: Commercial Building Telecommunications Cabling Standard.
8. ANSI/EIA/TIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
14. ICEA: Insulated Cable Engineers Association
15. IEEE: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
16. IEEE-802.11 a, b, g, n: Wireless Local Area Networks
17. IEEE-802.3: 10Mb/s, 100Mb/s, 1Gb/s, and 10Gb/s Ethernet Standards as applicable based on media types (twisted pair copper, fiber optics, etc.)
18. IEEE-802.3ak: 10Gb/s Ethernet (evolving copper standard).
21. IEEE-141: Comply with applicable requirements for installation of cable tray systems.
24. NEC: Applicable local electrical code requirements of the authority having jurisdiction, and the NEC as applicable to electrical boxes and fittings, cable tray systems, and grounding and bonding, pertaining to systems, circuits and equipment.
26. NEMA: Applicable requirements of NEMA Stds/Pub No.’s OS1, OS2 and PUB 250 pertaining to raceways, outlet and device boxes, covers, and box supports.
27. NEMA: NEMA Stds/Pub No. VE 1 “Cable Tray Systems”
29. NFPA-70B: “Recommended Practice for Electrical Equipment Maintenance” pertaining to installation of cable tray systems.
30. UL Compliance.
31. UL Compliance: Applicable requirements of UL 50, UL 514-series, and UL 886 pertaining to electrical boxes and fittings.
32. UL Compliance: Applicable requirements of UL Standards No.’s 467, Electrical Grounding and Bonding Equipment”, and 869 “Electrical Service Equipment”, pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, “Wire Connectors and soldering Lugs for Use with Copper Conductors.” Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

B. Where there is a conflict between the code and the contract documents, the code shall have precedence only when it is more stringent than the contract documents. Items that are allowed by the code but are less stringent than those specified on the contract shall not be substituted.

1.7 PROJECT CONDITIONS
A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner and Manager’s attention, in writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to its proposal.
B. The Technology Drawings schematically depict locations of major equipment and components. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.
C. System components and equipment shall be rated for the environments where installed. Normal temperature range requirements for each area within the project will be identified per the following categories noted below.
   1. Exterior Areas: -20 to +140°F (-29 to +60°C)
   2. Interior Areas-Seasonal: +32 to +104°F (0 to +40°C)
   3. Interior Areas-Temp Controlled: Typ. 72°F (22.2°C) but range over +50 to +104°F (+10 to +40°C)
   4. Riser Shafts: -20 to +140°F (-29 to +60°C)
   5. Communication Rooms: Typ. 69°F (20.5°C) but range over +32 to +104°F (+0 to +60°C)

1.8 DELIVERY, STORAGE, AND HANDLING
A. Equipment and components shall be delivered in factory-fabricated containers or wrappings, which properly protect equipment from damage.
B. Equipment and components shall be handled carefully to prevent damage including but not limited to breakage, denting or scoring of surfaces, etc. Do not install damaged units or components; replace with new. Replace damaged units or components following installation with new ones.
C. Equipment and components shall be stored in original packaging in a dry, clean, well-ventilated space, and shall be protected from construction traffic, weather, moisture, soiling, humidity, and extreme temperatures.

1.9 SEQUENCING AND HANDLING
A. All work shall be reviewed and coordinated with the IT Director prior to commencing.
B. DAS, infrastructure, and equipment are sensitive to environmental conditions including but not limited to temperature, dirt, dust, and water. The contractor shall ensure the storage and installation of all system components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty voiding. All mis-installed components shall be replaced with new parts and re-installed at the contractors’ expense.
C. Installation shall be coordinated with Structural, Electrical, HVAC, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.
D. Installation of DAS and infrastructure shall be sequenced with other work to minimize possible damage and soiling during the remainder of construction.

1.10 COORDINATION
A. The Contractor shall:
   1. Coordinate Work of this Section with the requirements of each wireless service provider.
   2. Coordinate layout and installation of DAS equipment, antennas, and radiating cable with other construction that penetrates ceilings or is supported by them, including but not limited to light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
   3. Coordinate location of cabling, antennas, and associated concealment with other trades.
   4. Coordinate location of equipment in the communications rooms and spaces with the Owner and Manager.

1.11 SPARE COMPONENTS AND EQUIPMENT
A. The Contractor shall maintaining all appropriate spare components and equipment as necessary to ensure operation of the system. The Contractor shall outline their specific plan.

1.12 WARRANTY
A. The Contractor shall be responsible for coordinating warranty requirements and/or issues with their preferred DAS Manufacturer and sub-contractors. The Contractor shall ensure that a warranty is in place for replacement of components to ensure uptime of system. Typical warranty requirements are listed below but it's the Contractor's sole responsibility to obtain warranties of their system.

B. The warranty requirements shall comply with Division 1 and as noted in this Section. Any conflicts shall meet the most stringent required unless approved otherwise by Owner.

C. A one (1) year warranty on the Work shall be provided by the Contractor. If, within one (1) year after the date of final acceptance by Owner of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the Wireless Carriers.

D. The manufacturer shall provide a warranty with a minimum term of 25 years for all structured cabling systems. This warranty shall cover all components including cable, terminations, patch panels, and wiring panels, etc. to maintain the specified performance and physical criteria. Any such components, link, or channel shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.

E. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period of one (1) year after the date of final acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which his obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to his obligations other than specifically to correct the work or equipment. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the Wireless Carriers.

F. Warranty response shall be as listed in Section 1.13 Response Time.

G. If system operation is not fully restored during the warranty period within 24-hours, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
H. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

I. Special warranty specified in this Specification shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Special Warranty for DAS and Components: There shall be a written warranty, signed by the manufacturer and Installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship within a specified warranty period when installed and used according to manufacturer's written instructions. This warranty shall be in addition to, and not limiting, other rights Owner may have under other provisions of the Contract Documents.

2. Contractor shall guarantee coverage and fix any coverage gaps or incorrect signal strengths at no cost to the Owner. The Owner will not accept the system at turn-over until the system has been field tested, verified, certified, and guaranteed that coverage limits have been fulfilled.

3. Contractor shall guarantee the Wireless Carriers and Service Providers will connect to the DAS provided as part of this work.

4. Contractor shall guarantee the Two-Way Radio Systems supporting Building Operations, Security, and Public Safety will connect to the DAS as part of this work.

1.13 RESPONSE TIME (WARRANTY AND MAINTENANCE)

A. Response time to failure of system, equipment, and/or component during warranty period and maintenance periods shall be within 4 hours of placed call.

1.14 BID INFORMATION

A. Instructions to Bidders

1. The following is a partial list of instructions. Bidders shall provide a complete proposal including all information requested in the Contract Documents.

2. Any questions or misunderstanding should be submitted in writing with the bid.

3. Copies of the bid proposal shall be submitted to the Owner and Manager for review and approval.

4. Bidders shall prepare equipment lists showing each item included in the bid. Equipment Lists must include the quantity, model number, manufacturer and price of each item listed under the generic description.

5. Bidders shall provide a detailed description of any and all voluntary alternates and include cost changes in the Voluntary Alternate Bid forms. Bidders should submit voluntary alternates that will either provide for a better system or reduce costs without degrading the system. This includes alternate manufacturer and product substitution.

6. If Drawings and Specifications do not directly coincide, or coincide individually, the item of better quality, greater quantity and/or higher cost shall be included in the base bid.

B. Unit Pricing and Labor Rates

1. Unit prices and labor rates submitted with the bid proposal shall be used for all additions, deductions, and alterations of the original contract and shall further be used for future purchases by the Owner from the Contractor for one (1) year from the date of final acceptance of the system.

C. Compliance

1. Bidders shall submit a Statement of Qualifications with their bid proposal that shall include the following information:
   a. Company name, address, telephone number and contact person.
   b. Brief company history.
      1) Years in business.
      2) Number of employees.
      3) Location of Headquarters and branch offices, including international locations.
   c. Resumes of key personnel.
d. Local staffing description (job descriptions and numbers of persons in each position).
e. Local service capabilities (hours of operation and parts availability).
f. Technician factory certifications.
g. Description of local engineering and project management capabilities.
h. Line sheet listing major suppliers of security equipment.
i. Annual dollar value of sales, installation and service of each product line carried.
j. List of all projects and references for all projects completed in the last five years, including a brief project description, location, construction cost, and completion date.
k. List of references describing five (5) completed projects of similar size and complexity, including names and telephone numbers of the contact persons.
l. List of references describing similar projects completed in the area and in the last year including names and telephone number of the customer's contact person.
m. List of similar projects currently under construction in the area including names and telephone numbers of the customer's contact person.
n. Licensing information.

2. Bidders shall provide a specification compliance matrix indicating compliance or deviation for each item in the specification. The matrix shall be comprised of a list of all numbered paragraphs that appear in this Specification. Compliance of the proposed equipment and/or services shall be indicated by the word "Comply" following each paragraph number. Exceptions to the requirement shall be indicated by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant. This matrix is critical for proposal evaluation. Failure to submit the matrix may result in the disqualification of the bid. Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete submittal review can be performed.

3. Additionally, and as described in this Specification, bidders shall submit the following information with their bid proposal:
   a. Manufacturer's literature sheets for all standard manufactured items included in the equipment list and as proposed in the Voluntary Alternate Bid form, if applicable.
   b. Workload and capability statements. The statements shall detail projects that will be active during the completion of this project, and the manpower that would be available for this project.
   c. Confidentiality and return statements. The statements shall guarantee that the Contract Documents shall not be copied or distributed physically or verbally. The Contractor shall also assure the Owner that the Contract Documents shall be returned in their entirety upon request. The successful Contractor will be provided with as many copies as requested.

4. Certain paragraphs of the Specification require the Bidder to provide information (possibly not listed above) in the proposal to demonstrate compliance with a requirement. If the Bidder fails to provide detailed responses to these items, the proposal will be deemed to be non-compliant to the paragraphs stated.

5. Bidders shall number all pages of the bid submittal.

D. Specification Response
1. The Bid Response Documents shall provide an overview and narrative description of the system architecture including but not limited to topology, application point of interfaces, backbone infrastructure, horizontal infrastructure, cables, terminals, amplifiers, repeaters, media converters, taps, splitters, and antennas.
2. The Bid Documents shall include a complete RF analysis of the project site as well as a complete design. The design shall include antenna layouts and cable routing. This information will be used to verify compliance with the DAS Specification, the extent of the Bidder’s proposed solution, and the DAS Scope of Work.

3. The Bid Documents shall include a full design including Product Data Submittals and Shop Drawings Submittal per the requirements noted below. The Bid Response Documents shall include a complete and comprehensive discussion of the products, processes, techniques, and methods that will be used to accomplish the tasks and functional requirements.

4. The Bid Response Documents shall include unit pricing for all components, cable, software, hardware, licenses, and labor.

5. The Bid Response Documents shall include all Service Agreements, Warranties, and Guarantees.

6. The Bid Response Documents shall include an implementation schedule and project timelines starting from Contract Procurement to System Turn-Over.

7. The Bid Response Documents shall include expected annual maintenance costs, consisting of:
   a. Annual maintenance cost beyond expiration of warranty.
   b. Annual maintenance for any items required outside of warranty.
   c. Annual maintenance for each year up to 5-years following the warranty period.

8. The Bid Response Documents shall include Customer Obligations.

9. The Bid Response Documents shall include a complete bill of materials indicating quantities, length, etc. of all components, cable, software, hardware, licenses, and labor required to complete the project.

10. The Bid Response Documents shall include any alternate or optional items that should be considered by Owner that has not been included in Base Bid. The Owner wants to ensure that they are aware of any items that should be evaluated that may enhance or allow support of future technologies.

11. The Bid Documents shall include completion of Appendix-A: Additional Bidder Questions

12. The Bid Document shall include completion of Appendix-B: Bidder’s DAS Design Assumptions

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided by one of the following DAS Manufacturers:
      1. Andrew/Commscope
      2. Solid
      3. TE Connectivity
      4. Corning/Mobile Access
      5. Others based on Contractor’s preference.

2.2 DISTRIBUTED ANTENNA SYSTEM
   A. General Requirements:
      1. The DAS shall be a single broadband radio frequency (RF) infrastructure that supports a wide range of current and future wireless technologies, protocols, and services. It shall be able to supply wireless services to multiple applications concurrently.
      2. The system shall fully support multi-cast and unicast communications for application including but not limited to audio streaming, video streaming, IPTV, and multi-point video, etc. All necessary licensing and patent agreements shall be included to utilize this technology as part of this work.
      3. The DAS shall include an in-building and exterior system. The exact requirements for the exterior system require coordination with wireless carriers.
      4. The DAS shall be an in-building wireless system and exterior wireless system for supporting frequencies in the 450 to 2500 MHz range and expandable to support emerging technologies up to 6000 MHz.
5. The DAS shall support all frequencies currently used by national and local Cellular Carriers including the following current technologies:
   a. AT&T: LTE-1900 (MIMO)
   b. AT&T: LTE-700 (MIMO)
   c. AT&T: LTE-2100 (MIMO)
   d. AT&T: UMTS-850
   e. AT&T: UMTS-1900
   f. Verizon: CDMA-850
   g. Verizon: EVDO-1900
   h. Verizon: LTE-700 (MIMO)
   i. Verizon: LTE-2100 (MIMO)
   j. Sprint: CDMA-800
   k. Sprint: CDMA-1900
   l. Sprint: iDen-900
   m. Sprint: LTE-1900
   n. T-Mobile: GSM-1900
   o. T-Mobile: LTE-2100
   p. T-Mobile: UMTS-1900
   q. T-Mobile: UMTS-2100
   r. T-Mobile/MetroPCS: CDMA-1900

6. The system shall provide a dominant signal within each individual antenna’s specific coverage area to overcome any existing signal by at least 10 dB and provide a minimum signal strength of -85 dBm within 95% of covered building areas.

7. Contractor shall ensure that ubiquitous coverage is provided throughout the facility on all levels.

8. All DAS components shall be the latest components available on the market. All components shall be new and have been manufactured within 6-months of installation.

2.3 ANTENNAS
   A. The Contractor shall propose antennas for each condition for approval by Owner and Owners Representative.
   B. Typical system antenna types shall conform to the following requirements:
         a. Frequency Range: 420 to 2500 MHz.
         b. Mounting: Pre-affixed bracket for bolting to any fixed structure.
         c. Radome must be rated to UL 94V0 Plenum standards for installation above ceiling in plenum rated lay in ceilings.
      2. Low Profile Broadband Log Periodic Antenna: Provides contiguous broadband directional RF signal power radiation.
         a. Frequency Range: 420 to 2500 MHz.
         b. Mounting: Pre-affixed bracket for bolting onto flat and non-metallic ceiling and wall structure. Must be able to mount above lay-in ceiling.
         c. Radome must be rated to UL 94V0 Plenum standards for installation above ceiling in plenum rated lay in ceilings.
         a. Frequency Range: 420 to 2500 MHz.
         b. Mounting: Pre-affixed bracket for bolting to any fixed structure.
c. Radome must be rated UL 94V0 plenum standards for installation above plenum lay in ceilings.

2.4 DISTRIBUTED ANTENNA SYSTEM COMPONENTS
   A. The system components shall meet the following requirements:
   B. Point of Interface (POI):
      1. Provide the neutral demark point-of-interface for RF services to be distributed over the DAS.
      2. Provide multiple connections among the primary RF services frequency bands (e.g. 450 to 512 MHz, 746 to 960 MHz, 1700 to 2170 MHz, 2.4 GHz WiMAX) to accommodate proposed wireless carriers, public safety services, in-house building operations, and any other service identified in this specification.
      3. Primary DAS head-end equipment shall include a data network interface for connecting to Management and Monitoring System. Interface shall be 10/100/1000 Mbps Ethernet (RJ45).
   C. Remote Distribution Units:
      1. Provide Remote Distribution Units or Expansion Units at Intermediate Communication Rooms and above ceilings as necessary to transition from single-mode fiber optic backbone to horizontal antenna cables (horizontal distribution).
      2. Provide multiple connections among the primary RF services frequency bands (e.g. 450 to 512 MHz, 746 to 960 MHz, 1700 to 2170 MHz, 2.4 GHz WiMAX) to accommodate proposed wireless carriers, public safety services, in-house building operations, and any other service identified in this specification.
      3. The remote units shall include a data network interface for connecting to Management and Monitoring System. Interface shall be 10/100/1000 Mbps Ethernet (RJ45).

2.5 SIGNAL TRANSMISSION COMPONENTS
   A. The signal transmission components shall be of the following types and meet the following requirements
   B. Cables:
      1. Types:
         a. Single-Mode Fiber Optic
         b. Cat. 6A UTP
         c. RG59 75-ohm Coaxial
         d. RG6 75-ohm Coaxial
         e. 1/2" 50-ohm Coaxial
         f. 7/8" 50-ohm Coaxial
         g. 7/8" Radiation Coaxial (Radiax or Leaky Coax)
      2. Ratings: All cable shall be UL-Listed for use in plenums.
   C. Terminals and Connectors: Equivalent to cable type and performance capabilities. Contractor shall provide connectors and terminals approved to work and comply with Manufacturer’s system.
   D. Cable Hangers: “Clic” Self Locking Hangar or approved equal.
   E. Transmissions methods and components vary by manufacturer, so this information shall be submitted in detail at bid time for review and acceptances by Owner.

2.6 PUBLIC SAFETY SYSTEMS
   A. Law Enforcement:
      1. The DAS shall include all necessary head-end equipment to rebroadcast all Local Public Safety and any Federal Law Enforcement radio traffic. The Contractor shall coordinate Public Safety requirements including equipment and radio frequencies, etc. with each authority.
      2. System requirements shall meet Police Department’s current wireless communication standards.
      3. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.
   B. Fire Department and EMS:
      1. The DAS shall include all necessary head-end equipment to rebroadcast all Fire Department and EMS Two-Way Radio Communications System.
2. The Contractor shall coordinate Public Safety requirements including equipment and radio frequencies, etc. with each authority.

3. System requirements shall meet Fire Department and EMS’s current wireless communication standards.

4. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.

2.7 BUILDING OPERATIONS SYSTEM

A. General:
   1. The DAS shall include all necessary head-end equipment rebroadcast the Owner’s Building Operations Two-Way Radio and messaging Communications System.
   2. Coordinate requirements including radio frequencies with Owner’s RF Strategy and Frequency Allocation Schedule.
   3. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.

2.8 GPS SYSTEM

A. General:
   1. The DAS shall include (2) GPS receivers and antennas located on the roof for location-based services.
   2. Contractor shall provide GPS distribution panels at the DAS Room for the base station interfaces for each GPS receiver and antennas.
   3. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.

2.9 MANAGEMENT AND MONITORING SYSTEM

A. General:
   1. The DAS shall be installed with Management and Monitoring System.
   2. The DAS shall be remotely monitored by Contractor.
   3. The Management and Monitoring System shall provide for interactive interfaces to all major DAS electronic components including base head-end, remote units, antenna points, and power supplies. The DAS components shall be interfaced to the facility’s converged data network.
   4. The Management and Monitoring System shall allow for real-time remote management and monitoring of the DAS.
   5. The Management and Monitoring System shall have a customizable graphical user interface (GUI) for visual display and indication of system status. The GUI shall include the following minimum criteria:
      a. Facility maps with interactive equipment icons of major system components and antenna locations.
      b. Interactive equipment icons, color coded to indicate current status and clickable by mouse to show device information, status, log, configuration, etc.

B. System Features:
C. The Management and Monitoring System software shall incorporate the following features:
   1. Remote Equipment Configuration and Troubleshooting
   2. Graphical User Interface (GUI)
      a. Facility Maps with Interactive Icons (equipment and antennas)
      b. Color coded icons for quick visual reference.
      c. Equipment Status (threshold, status, alarm, etc.)
   3. Alarm Notification
      a. Equipment and Antenna Status
   4. Web Based Access
      a. VPN credentials and User Login
      b. Remote Diagnostics
   5. Logs
      a. Status
      b. Alarm and Events
      c. History
      d. Performance
e. Maintenance
f. Users
g. System Inventory
h. Configurations

6. Maintenance Schedule, Alerts, Reminders, Notification, and Logs
7. System Administration
   a. Administrator Login, Passwords, and Security Access Level
   b. Users Login, Passwords, and Security Access Level

D. System Requirements
   2. Equipment Networking: Ethernet 10/100/1000 Mbps (RJ45 Jack).

2.10 UNINTERRUPTABLE POWER SUPPLY (UPS)
   A. All DAS equipment and components shall be connected to a UPS system to maintain uptime
during failover of normal power to generator power. This includes head-end, remote equipment,
and any other equipment/components requiring power, etc.
   B. All UPS equipment is being provided by Others as part of the Base Building Renovation Project.
This includes DAS Room, Main Comm Room, and Intermediate Comm Rooms. Contractor shall
coordinate all DAS power requirements with UPS installer to ensure requirements are included
with equipment provided by others.
   C. Contractor shall interface DAS power to UPS, power strips, and/or other power receptacles
provided as such.
   D. Any other UPS or battery backup equipment required to support the DAS shall be provided as
part of this scope. Contractor shall identify any locations that require UPS that has not been
included as part of Base Building Renovation Project.

2.11 ALTERNATES
   A. Wi-Fi Offload; the DAS solution shall include options for technology that seamlessly offloads a
user's cellular service to Wi-Fi. The Contractor shall present options for supporting this
technology and information on maintaining quality of service. Additionally, Contractor shall
provide options for amount of traffic that can be offloaded and associated requirements for
ensuring performance and uptime of Wi-Fi system.
   B. Contractor Proposed Alternatives
      1. The Contractor may propose alternatives for Owner consideration.
      2. All alternatives shall include procurement options, revenue sharing, pricing, description,
equipment cut-sheets and any other technical documentation necessary.
   C. Manufacturer Proposed Alternatives
      1. The DAS Manufacturer may propose alternatives for Owner consideration.
      2. All alternatives shall include pricing, description, equipment cut-sheets and any other
technical documentation necessary.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. The following examination tasks shall be performed by Contractor:
      1. Examine pathway elements intended for cable. Check raceways, cables trays, and other
         elements for compliance with space allocations, installation tolerances, hazards to cable
         installation, and other conditions affecting installation.
      2. Examine rough-ins for antenna to verify actual locations of cable connections before
         antenna installation.
      3. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions
         where equipment is to be installed.
      4. Proceed with installation only after unsatisfactory conditions have been corrected.
      5. Provide detailed site survey to determine best cable routing and location of antennas.

3.2 SYSTEM DESIGN CRITERIA
   A. General:
      1. The system must be able to handle the facility’s capacity requirements, growth and
technology upgrades within the primary DAS equipment room(s), communications rooms,
Owner, and service provider entrance facilities without being invasive to other areas. The system shall distribute and support the following:

a. All current technologies available to existing wireless providers authorized to provide service in the United States in all frequency bands.
b. All current public safety and emergency responders’ two-way radio communications including First Responders, Police, Fire, Ambulance, and other emergency systems utilized by Public Authorities and Agencies.
c. All current building operations two-way radio systems and other in-house two-way radio communication systems.
d. All current and planned technologies as required and noted in this specification.

2. The system must provide the ability to distribute additional protocols and frequencies in the 450 MHz to 2500 MHz range as well as other frequencies from 2500 MHz to 6 GHz. Contractor shall note the capability of the proposed solution.

3. The system must allow service providers to add capacity at any time, subject to space limitations in equipment rooms and telecommunications spaces. The system shall have spare capacity built-in and Contractor shall note spare capacity and expansion capability of the proposed solution.

4. The system must enable service providers to distribute signal uniformly inside locations in a manner that mitigates interference to their outside network.

5. The coverage inside the building (in all designated areas) shall provide dominant signal to overcome other signals from other zones or sectors within the building and from outside the building by at least 10dB at the coverage edge for 800 and 1900 MHz with a +28dBm input per RF channel into the POI.

B. Topology:

1. General: The topology will be a hierarchical star using a structured cabling system implemented for IT and telecommunications. The topology includes a backbone segment that connects comm room locations and a horizontal segment that connects antennas to comm rooms.

2. Main Equipment Room: A dedicated equipment room called a DAS Room has been provided on Level-01. This location will serve as the main distribution hub and main equipment room for DAS, Wireless Carrier, Public Safety, and Building Operations.

3. Communication Rooms:
   a. All DAS equipment including remote units, transceivers, amplifiers, media converters, patch panels, etc. shall be installed in Intermediate Communications Rooms.

4. Backbone Distribution:
   a. The backbone shall use Single-Mode Fiber Optic Cable provided as part of this work.
   b. A fiber optic cable segment will be routed from the DAS Room to each Intermediate Comm Room and remote unit location.
   c. The Contractor shall indicate immediate and future strand quantity required for the proposed solution.
   d. All backbone cable shall be UL-Listed and meet environment conditions for where the cable is routed including plenum or risers.
   e. All exterior cable with any metallic components including conductors and/or sheath shall have UL-Listed transient surge protection devices appropriately grounded per Building Codes installed on each end of the cable and as per manufacturer’s requirements.

5. Horizontal Distribution:
   a. Horizontal cable types shall be specified by the Contractor based on the proposed solution and Manufacturer’s requirements.
   b. Horizontal cable shall be routed from the Antennas to the Intermediate Communications Rooms and remote unit.
   c. All horizontal cable and components shall be UL-Listed and plenum rated.
   d. All exterior cable with any metallic components including conductors and/or sheath shall have UL-Listed transient surge protection devices appropriately
grounded per Building Codes installed on each end of the cable and as per manufacturer’s requirements.

6. Antenna:
   a. Antennas will be connected to horizontal distribution.

7. Telecom Back-Haul:
   a. Telecommunications backhaul necessary to interface Service Providers to the PSTN will utilize backbone cable interconnecting the DAS Room to the Data Center.

C. System:
   1. The DAS shall cover all interior and exterior building areas.
   2. The interior system shall provide full coverage to all interior spaces. Refer to DAS coverage drawing in the Electrical Technology Set for additional requirements.
   3. The requirements for the exterior system require additional coordination with all Service Providers including Wireless Carriers, Public Safety, and Building Operations. The Contractor shall propose a system for consideration by Owner and Service Providers.

D. Coverage and Capacity:
   1. The DAS shall meet all coverage and capacity requirements for this facility type based on highest occupancy and facility use.
   2. The system shall be designed with the appropriate sector/zone capacity and antenna points to ensure acceptable performance.
   3. Refer to DAS Coverage Drawings included within the Electrical Technology Documents which indicate proposed coverage areas based on building area types.
   4. The following General Areas of Coverage apply to the facility:
      a. Entire building interior.
      b. Exterior areas per coordination with Owner, Owner Representative, and Wireless Carriers.
      c. Elevators, Escalators, Stairs, and Stair Towers.
      d. Public Concourses, Restrooms, Building Entrances, and Restrooms.
      e. Media and Print Press Areas.
      g. Back of House Corridors and Work Areas.
   5. Other Wireless and Interference: Considerations shall be provided for minimizing interference from other susceptible systems including but not limited to the items noted below.
      a. Assisted Listening Devices
      b. Bluetooth Devices
      c. Cordless Telephones
      d. FM Radio Transmitter
      e. Media TV Broadcast
      f. Media TV Intercoms
      g. Media Radio Broadcast
      h. Microwave Ovens
      i. Specialty Event Wireless
      j. Wireless Broadcast
      k. Wireless Microphones
      l. Wireless Telephone Headsets

E. Sectors/Zones: The DAS shall accommodate multiple sectors (or zones) to ensure high capacity requirements that are acceptable to this facility type and worst case occupancy. Exact requirements shall be coordinated by the Contractor with Owner and all Service Providers including but not limited to Wireless Carrier, Public Safety, and Building Operations.

F. Equipment Rooms and Communication Rooms
   1. DAS Room:
      a. The DAS Room will serve as the main distribution hub and main equipment room for DAS, Wireless Carrier, Public Safety, and Building Operations.
      b. The DAS Room will be a co-location equipment room for all Cellular Carrier equipment provided by others.
c. All DAS head-end equipment, transceivers, media converters, amplifiers, and patch panels shall be installed in cabinets and racks provided by the others as part of base project.
d. All Public Safety head-end equipment, base station equipment, repeater equipment, transceivers, media converters, amplifiers, and patch panels shall be installed in cabinets and racks provided by the others as part of base project.
e. All Building Operations head-end equipment, base station equipment, repeater equipment, transceivers, media converters, amplifiers, and patch panels shall be installed in cabinets and racks provided by the others as part of base project.
f. Electrical power including receptacles and UPS power will be provided by others as part of base project.
g. Contractor to provide all HVAC including air-conditioning that is not included in base project. This includes but is not limited to duct work and CRAC units.
   1) Contractor shall identify and coordinate the individual requirements of components and systems and provide all required equipment.
h. Contractor to provide all fire suppression equipment for DAS room and attached Main Communications and Server rooms.
   1) Fire suppression system shall be pre-action, and comply with all requirements per division 21 specifications.
i. The project has set aside a room of just over 1500 sqft. If the DAS head-end equipment requires more space than this, the contractor, Owner and Owners Representative will need to discover and approve additional space.
   1) Associated systems include HVAC, power, lighting and fire suppression. All of this equipment must fulfill all requirements of equipment in room below.
2. Intermediate Communication Rooms:
   a. Intermediate Comm Rooms are shared rooms that co-locate technology systems and distribution in the facility.
   b. Remote units, transceivers, media converters, amplifiers, and patch panels shall be installed in cabinets and racks provided by the others as part of base project.
   c. Electrical power including receptacles and UPS power will be provided by others as part of base project.
   d. HVAC including air-conditioning will be provided by others as part of base project.
      1) Contractor shall identify and coordinate the individual requirements of components and systems. Contractor shall provide any HVAC beyond that included in base project.
G. Antennas:
   1. The Contractor shall provide all antennas necessary for a complete and fully operation system.
   2. Provided below is a general list of antennas required for this project.
      a. Interior Wireless Antennas
      b. Exterior Wireless System Antennas
      c. GPS Antennas
   3. Contractor shall propose antennas recommended by Manufacturer based on the proposed solution.
   4. Antennas shall be located as necessary to provide the appropriate coverage and capacity requirements for all the wireless systems being supported and as listed in this specification.
   5. All antennas and associated locations shall be discreet.
   6. All antenna locations shall be coordinated with IT Director prior to initiating any work.
   7. Samples of each antenna type used on the project shall be submitted to the Owner and Owners Representative for approval.
H. Public Safety System: Provide all necessary head-end equipment, radio equipment, system interfaces, hardware, and distribution components to accommodate public safety two-way radio communications systems for each of the agencies listed below. The Contractor shall obtain a
copy of the appropriate current standards from each agency and ensure these requirements are fully provided for and supported in the DAS per those standards. All necessary equipment shall be included in the distributed antenna design. Separate meetings will be setup later with each agency by the Owner to review requirements for this project specifically.

1. Police Department
2. Fire Department

I. Building Operations Systems: Contractor shall provide all necessary head-end equipment, radio equipment, system interfaces, hardware, and distribution components to accommodate the Owner’s building operation two-way radio communications system. The Contractor shall confirm the Owner’s existing system and frequency assignment and ensure these requirements are fully provided for and supported in the DAS per those standards. All necessary equipment shall be included in the distributed antenna design. Separate meetings will be set up later with the Owner to review requirements for this project specifically.

J. Wireless Carrier Systems: Provide all necessary head-end equipment, system interfaces, hardware, and distribution components to accommodate all Wireless Carrier’s equipment. The Contractor shall confirm current equipment and frequency assignment utilized by the Wireless Carriers and ensure these requirements are fully provided for and supported in the DAS. All necessary equipment shall be included in the DAS design other than the Wireless Carrier’s equipment. Separate meetings will be set up later with the Owner and Wireless Carriers to review requirements for this project specifically.

3.3 INSTALLATION

A. General:

1. This Section describes the installation locations for the products and materials, as well as methods associated with the DAS and wireless installation portions of the Project. These Specifications, along with the drawings shall be followed during the course of the installation.
2. The Contractor shall examine areas and conditions under which DAS infrastructure is to be installed. Notify Owner and Owners Representative in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
3. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
4. The Contractor shall be responsible for furnishing all materials as specified herein and as indicated on the drawings for a complete DAS.
5. The Contractor shall verify space requirements and locations before starting cable installations and terminations. Inappropriate conditions shall be immediately reported to Construction Manager, Owner and Owner’s Representative prior to initiating installation.
6. All DAS and communications infrastructure shall be installed in an aesthetically pleasing fashion. All surface raceway in new buildings must be approved by the Owner and Owner’s Representative.
7. All communications infrastructure shall be installed for optimal performance.
8. All DAS and communications infrastructure shall be installed to allow for easy additions, moves, and other changes in the future.
9. The Contractor will create a mock up program including the installation of a complete kit of each public location of the AP, radio and enclosure, fully painted and secured for sign off. Refer to Submittal Requirements outlined in Section 1.14 for requirements.
10. Final labeling scheme for all DAS and communications components shall be coordinated with the Owner and Engineer during the shop drawings process, prior to initiating work. Labeling scheme shall include but not be limited to communications rooms, cabinets, racks, cable terminal blocks and patch panels, antennas, outlets, cables, etc.
11. Construction within communication rooms must be substantially complete before the installation of the DAS and communications cabling. This includes, but is not limited to, the installation of plywood backboard, cable tray or ladder rack, electrical outlets, light fixtures, sprinklers and ductwork. All walls shall also be painted before the installation.
12. All components noted in this section and drawings shall be provided and completely set up and installed. This includes but is not limited to Cable, Terminations, and Cable Managers.

13. The Contractor is required to coordinate their efforts with the other trades and subcontractor who may be working within the same vicinity to avoid conflict and lost time.

14. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.

15. Where applicable, the Contractor shall verify existing cable fill in riser conduits before installation of additional cables so as not to exceed 40% cable fill. Contractor will be responsible for installation of additional riser conduit, where additional cables to be added will exceed the 40% cable fill.

16. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, and Owner’s Representative prior to initiating installation. All mis-installed components will be removed and replaced with new, appropriate components at the Contractor’s expense. No additional cost will be submitted to Owner.

17. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.

18. Communication rooms must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of fiber optic cables. The door to the communication rooms must be installed and closed during termination.

B. Raceway Installation: The following procedures shall apply to raceway installation:

1. Provide floor to floor distribution with concrete floor sleeves or conduits as noted on the drawings, and as required by Architectural Design.

2. Provide protective cable bushings on all conduits immediately after installation.

3. Use only electrical 45° or 90° conduit elbows with long bend radii. Refer to manufacturer and industry standard requirements for minimum bend radii.

4. Do not place more than two 90° sweeps or exceed 100 ft. between pull boxes without providing a pull box.

5. Contractor shall provide horizontal conduits as necessary. Cable fill in conduits shall not exceed 40% cable fill.

6. Conduits shall be installed with pull strings. Do not exceed manufacturer’s recommended pulling tensions.

7. Fire seal all raceway penetration and openings to maintain fire rating after communications cables are installed.

8. Provide labels on all communications pull-boxes and junction-boxes.

9. Identify conduits at cable tray end by architectural room number.

C. Cable Installation: The following procedures shall apply to cable installation:

1. All distribution cable, backbone cable, horizontal cable, radiating cable, and antenna cable must be plenum rated.

2. All DAS and communications cables routed within communications rooms shall be bundled and combed to provide a neat and organized appearance. This includes horizontal and vertical cables routed on cable tray, d-rings, vertical cable managers, equipment rack cable managers, etc. Cables shall be bundled using only manufacturer and industry approved wire ties with tensions that do not deform and damage cable resulting in loss of transmission or performance. Any bundles and combing methods used shall not exceed manufacturer or industry standard recommendations for that cable type.

3. Install cables concealed in accessible ceilings. Install cables according to manufacturer’s recommended installation practices using approved hangers at a maximum spacing of every 48-inches (1.2m).

4. Do not lay cable on suspended tile ceiling, ductwork, piping, conduit, or other building equipment.
5. Do not route radiating coaxial cable through metallic conduit or sleeve through a wall or partition. Transition to a non-radiating coax or jumper to pass through metal conduit or concrete.

6. Mount radiating coaxial cable a continuous minimum distance of 2-inches (50mm) off any surface.

7. In order to minimize loss of RF signal due to shadowing, generally route radiating coaxial cable below the installed height of other infrastructure if within 2-feet (.7m) of HVAC ductwork, metal pipes, sprinklers, pull boxes, unistrut, cable tray, or other cabling.

8. Contractor shall train cables to the termination points with no excess where cable is installed within enclosures.

9. Cable bends shall not be less than that recommended by the manufacturer of the cable. Do not exceed manufacturer's minimum bending radii and other cable requirements.

    Provided below are some examples but all requirements shall be verified.
    a. The minimum installed bend radius of ½-inch radiating coax is 5-inches (125mm).
    b. The minimum routing bend radius of ½-inch radiating coax is 10-inches (250mm).
    c. If cable (non-radiating coaxial cable) is to be installed in conduit, the bend radii of the conduits must be greater than 10-inches.
    d. If conduit bend radius is less than 10-inches, the coaxial cable must be terminated (connectorized) prior to pulling through conduit and a jumper must be used for routing through conduit.

10. The contractor shall not install any cable in conduits that does not have the appropriate protect bushings on conduit ends. All mis-installed cable will be removed, bushings installed, and new cable re-installed at the Contractor’s expense. No additional cost will be submitted to Owner.

11. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

12. Do not splice cable between termination, tap, junction points, or between damaged cable segments.

13. Any exposed cables shall be installed parallel to building lines. Follow surface contours and support the cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables. All exposed cable routing shall be coordinated with the Owner and Owner’s Representative prior to installation.

14. All cables shall be installed in conduit when routed exposed at public areas. Contractor shall verify identify certain cables types that may not be possible due to size and/or flexibility. Contractor shall coordinate these instances for approval with Owner and Owner’s Representative prior to installation.

15. Provide a minimum 8'-0" and maximum 10'-0" of slack at the Communications room. Loop shall be contained on the horizontal cable tray or ladder rack.

16. Care shall be taken so as not to damage cable during the installation process and that the manufacturer’s and industry standard’s pull tension specification is not exceeded.

17. Within communications rooms, cables shall be snugly wrapped using Velcro reusable cable ties, a minimum of every 3'-0" for cable organization. Velcro ties shall be tightened so as not to deform cable jackets and thus affect cable performance. Plastic cable tie wraps shall not be used.

18. Provide independent signal circuit grounding recommended by manufacturer.

19. Under no circumstances shall the cable be painted, treated, or covered with other material unless approved by manufacturer.

D. Antenna Installation: The following procedures shall apply to antenna installation:

1. All antennas and associated locations shall be discreet. Antennas shall be concealed wherever possible using stealth technology to ensure installation maintains high architectural form critical to the high-end finish of this project.

2. All antenna locations shall be coordinated with Owner’s Representative prior to initiating any work.

3. Install antennas per manufacturer’s requirements.
4. Contractor shall install antennas with all necessary supports to ensure safe installation and support to prevent falling.
5. Antennas shall be rated accordingly and as applicable for the installation type, location, condition, and application supported.

E. Equipment Installation: The following procedures shall apply to equipment installation:
1. Install surge suppressors where ac-power-operated devices are not protected against voltage transients by integral surge suppressors specified in UL1449. Install surge suppressors at the devices' power-line terminals. Comply with Division 26 Section "Transient Voltage Suppression."
2. Mount electronic equipment in the types of cabinets recommended by manufacturer. Group related items in methodical sequence.
3. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space.
4. Interface DAS equipment with all base station equipment as required during installation period of DAS.
5. Label all equipment and interfaces.

F. Long Term Wireless Carrier Interface
1. Contractor shall coordinate and supervise the installation of Cellular Carrier Equipment and interfaces to the DAS.

G. System Management and Monitoring Software Installation: The following procedures shall apply to system management and monitoring software installation:
1. Install software on Owner provided computers.
2. Coordinate computer and data network requirements with Owner’s IT Group. This should include MAC and IP addressing, VLAN assignment, bandwidth requirements, class of service (CoS), VPN requirements, etc.
3. The system management and monitoring software shall be fully set up, programmed, and configured including but not limited to the following:
   a. Date and Time.
   b. Networked DAS end points including but not limited to antenna points, remote units, base head-end equipment, etc.
   c. Graphical user interface (GUI) including facility maps indicating interactive icons for all equipment locations and antenna points.
   d. Web portals, user access, and VPN.
   e. Administrator accounts, passwords, and security levels.
   f. User accounts, passwords, and security levels.
   g. Device thresholds, status, alarm points, alerts, and notification.
   h. Remote diagnostics.
   i. System Inventory.
   j. Event reporting protocol.
   k. System logs including status, performance, alarms, history, and others.
   l. Maintenance log, schedules, and notification.

3.4 COORDINATION
A. Design Coordination: All components proposed by the Contractor shall be coordinated with the Owner and Manager. Provided below is a general list of major items that shall be documented in a table and coordinated. The list provided below is to be used as an example and is not intended to be all inclusive or to limit items required to be reviewed and coordinated.
1. Equipment Type and Physical Size.
2. Rack Units required per location.
3. Electrical Power (voltage, amp, loads, and receptacle types)
4. HVAC (heat dissipation and equipment operating temperature range)
5. Antenna Types and Locations
6. Backbone Distribution (fiber strand allocation)

B. RF and Wireless Coordination:
1. The Contractor shall perform an onsite RF and wireless study prior to starting work. This information shall be submitted in hard copy documents.
2. The Contractor shall obtain a copy of the Owner’s current RF strategy and frequency assignment. This information shall be reviewed in detail to identify any interfering and/or potentially interfering sources.

3. The Contractor shall review and coordinate the onsite study, Owner’s current RF strategy and frequency assignment, and proposed DAS design. The Contractor shall make recommendations to the Owner and adjust the proposed design accordingly to ensure no interfering sources or overlap of frequency assignment.

4. The Contractor shall perform an on-site RF and wireless study after completing system installation. This information shall be submitted in hard copy documents. The results of this test shall be reviewed by the Contractor and Manufacturer to confirm system compliance with coverage, capacity, and performance requirements.

5. All documents submitted by Contractor including product data, submittals, as-built, test results, drawings, reports, etc. shall be provided in electronic (pdf) and paper format.

6. The Contractor will coordinate all Public Safety frequencies, preferred manufacturer make/model, antennas, equipment, power conditions and locations with IJ Rosenblum, irosenblum@paconvention.com.

7. Refer to submittal requirements as outlined in Section 1.4.

C. Installation Coordination: The Contractor shall field coordinate all work with Construction Manager and other Sub-Contractors and Trades as necessary to minimize conflicts.

D. Schedule: The Contractor shall coordinate the project schedule with the Construction Manager including but not limited to the following:
   1. RFP Response
   2. Submittals
   3. Construction and Phasing
   4. Installation
   5. Substantial Completion
   6. Final Completion
   7. System Acceptance

3.5 IDENTIFICATION
A. The following procedures shall apply to system labeling:
B. General Label Requirements:
   1. The labeling scheme shall be provided by the Contractor and coordinated with the Owner and Owner’s Representative prior to initiating any work. A sample scheme shall be submitted for approval.
   2. Mechanically print and install all labels.
   3. Format: Select font size to be readable and to fit all information required without overlap of text.
   4. Use all capital letters.
   5. All labels shall be consistent font type, size, and color throughout project.
   6. Labels shall be white with black text.
   7. Clean all surfaces prior to attachment of any label. Follow manufacturer’s recommendations for cleaning and affixing labels.
   8. Method: Brady cable labels appropriately sized or approved equivalent.
C. Cable:
   1. Label Location: Within 4 inches (100 mm) of each termination.
   2. Near-End Label Information: “Cable No. XXX and Comm Room ZZZ -DAS Cable. Do not disturb,” where XXX and ZZZ are actual room numbers assigned. Room numbers shall be coordinated with Owner and Owner’s Representative.
   3. Far-End Label Information: “Cable No. XXX and Room ZZZ -DAS Cable. Do not disturb,” where XXX and ZZZ are actual room numbers assigned. Room numbers shall be coordinated with Owner and Owner’s Representative.
   4. Radiating Cable: In addition to end labels, any radiating coaxial cables shall be labeled “Radiating Coaxial Cable.”
D. Equipment:
   1. Label all equipment, components, cabinets, and enclosures.
   2. Label Information: Equipment No. and Type (or Short Description).
3.6 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Contractor shall engage a factory-authorized service representative to inspect field-assembled components and equipment installation, and supervise pre-testing, testing, and adjusting of equipment.

B. Inspection: Contractor shall verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

C. Pre-testing: Contractor shall align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved.

D. Operational Tests: Contractor shall perform operational system tests to verify that system complies with Specifications. Operational tests shall include all modes of system operation. Equipment shall be tested for proper operation in all functional modes.

E. Test Schedule: Contractor shall schedule tests after Operational testing has successfully been completed and system has been in normal functional operation for at least 14 days. Contractor shall provide a minimum of 10 days notice of the test schedule.

F. Qualitative and Quantitative Performance Tests: Contractor shall verify for each major frequency band identified by Owner that signal coverage area, signal coverage levels, and signal coverage consistency are compliant with Specifications. Testing shall be conducted using calibrated “walk-test” receivers.

G. Test Results: Contractor shall record test results and publish them in electronic and hard copies for distribution to Owner.

H. Re-Test: Contractor shall correct all deficiencies identified by tests and observations, and retest until specified requirements are met.

I. Commissioning:
   1. Contractor shall create and submit a detailed checklist for commissioning system equipment and components. The list shall be submitted for Owner review. System commissioning shall be completed by the Contractor prior to system acceptance by Owner. A formal report shall be generated that includes sign-off and notes of all items.
   2. System commission shall include the following categories.
      a. Validate Procured Components
      b. Physical Installation and Location
      c. Equipment Connectivity and Inter-Connectivity
      d. Support Systems Functioning (HVAC, electrical, and UPS)
      e. System Setup and Operation
      f. Wireless Surveys
      g. Testing

J. Contractor shall provide onsite support for each major event for the first 120 days following the final installation. A major event shall be any event with an attendance exceeding 15,000 attendees.

3.7 CLEANING

A. Contractor shall clean installed items using methods and materials recommended by manufacturer.

B. Contractor shall clean system components, including antennas and supports, electronic equipment, and distribution components.

3.8 RECORD DOCUMENTATION

A. Record documentation shall be submitted to the Owner by the Contractor at the completion of the DAS installation. The contractor shall submit all information necessary to operate and maintain the system including but not limited to the following:
   1. As-Built Documents
   2. Operations and Maintenance Manuals
   3. Maintenance Schedule
   4. Maintenance Company Contact Information
   5. Troubleshooting Guide
   6. Product Data and Manufacturer Cut-Sheets
   7. Warranty Information and Contact
   8. Manufacturer’s Product and Installation Certificate
9. Log (troubleshooting, replacement, expansion, and replacements)
10. Labeling Scheme
11. Spare Parts Lists

B. Contractor shall maintain current record documents at the construction site.
C. All documents submitted by Contractor including product data, submittals, as-built, test results, drawings, reports, etc. shall be provided in electronic (pdf) and paper format.
D. Refer to submittal requirements as outlined in Section 1.4.

END OF SECTION