PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 27.

1.02 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 27 of these Specifications, and Drawings numbered with prefixes TA and TN, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.03 ABBREVIATIONS AND ACRONYMS

A. ADA Americans with Disabilities Act

B. AFF Above Finished Floor

C. AHJ Authority Having Jurisdiction

D.	ANSI	American National Standards Institute
E.	ASTM	American Society for Testing and Materials
F.	BICS	Building Industry Consulting Service International
G.	ETL	Electrical Testing Laboratories, Inc.
H.	FCC	Federal Communications Commission
I.	FM	Factory Mutual
J.	GE	Grounding Equalizer
K.	IEEE	Institute of Electrical and Electronic Engineers
L.	LED	Light Emitting Diode
M.	NEC	National Electrical Code
N.	NESC	National Electrical Safety Code
O.	NEMA	National Electrical Manufacturers Association
P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO	Unless Otherwise Noted

1.04 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.
3. As Directed - means as directed by the Contract Administrator, or his representative.
4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Architect".
8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".
9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work

necessary for proper installation and operation. Include the installation under the warranty required by this Division.

11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
13. Provide - "To furnish and install complete, and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
14. Submit - means submit to Contract Administrator for review.
15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.
    a) For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
    b) Also refer to the:
        1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations
17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".

C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue

excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
3. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.05 REFERENCE STANDARDS

A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.

E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document

including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):

1. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
2. NFPA 70 – National Electrical Code (NEC)
3. IEEE National Electrical Safety Code (NESC)
4. Americans with Disabilities Act (ADA) of 1990, as amended

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.

C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.

D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a

timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

J. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.

K. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.

L. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.

6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined whin these Specifications, provide dimensioned layouts of communications equipment locations within communications (telecom and AV) rooms, electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
3. Indicate path to allow the future removal of each large piece of equipment (including but not limited to communications racks and cabinets) without removal of nonrelated equipment or architectural elements.
4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

    a) Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer’s digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

D. Refer to Coordination requirements in specific sections for additional information.

1.08 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives. Contractor shall allow for the Design Consultant Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Design Consultant Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Design Consultant review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:

1. Pre-bid

a) Required no less than two weeks prior to the due date for the submission of bids, such as:

1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
2) Alternate personnel credentials to be reviewed for approval
3) And as required by individual sections in this Division

2. Bid

a) Required at the time of the submission of bids, such as:

1) Bid Response Forms
2) Unit Pricing (if required by sections in this Division)
3) Personnel Qualifications
4) Contractor Qualifications (Previous project references)
5) Voluntary Bid Alternates
6) And as required by individual sections in this Division

3. Pre-construction

a) Required after the award of the project to the winning bidder and prior to starting construction.
b) Submit the following items no longer than four weeks after receiving the notice to proceed:

1) Division of Labor amongst sub-contractors. Include:

a) Company Name
b) Address
c) Name of project manager for this project, including:

i) E-mail
ii) Telephone number

2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.
3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
5) Manufacturers' cut-sheets:

a) Cut-sheets are to be in the same order as in the specification sections.
b) At a minimum all cut-sheets shall contain the following:

i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance

ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page

iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.

iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.

v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

6) Samples – refer to individual sections for specific sample requirements.

a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.

c) Submit the following items sufficiently prior to installation of each respective portion of work:

1) Shop Drawings

a) Shall be furnished per the requirements of each Division 27 specification Section.

4. Project Completion

a) Required after the substantial completion but prior to final approval for completion, such as:

1) Record Drawings
2) Operation and Maintenance Data
3) Project test reports
4) Cable Databases (as applicable)
5) Warranty Certificate(s)

6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
7) And as required by individual sections in this Division

I. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

J. Refer to individual Sections for additional submittal requirements.

K. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.

L. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

M. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

N. The checking and subsequent acceptance by the Design Consultant and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Design Consultant and Contract Administrator prior to implementing any deviation.

1.09 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:

    a) Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b) Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c) Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
    d) Same warranty will be furnished for proposed substitution as for specified Work.
    e) If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f) Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.010 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. Contact the Contract Administrator for written authorization.

D. The following must be received before electronic drawing files will be sent:

1. Contract Administrator’s written authorization
2. Engineer’s release agreement form
3. Payment

1.011 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.012 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.013 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.014 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.015 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.016 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer’s standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

E. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.017 TEMPORARY FACILITIES

A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1.018 FIELD CONDITIONS

A. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

C. Use of explosives is not permitted.

D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ,

visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.03 EXISTING UTILITIES

A. Existing utility services not specifically indicated to be removed or altered shall remain as they presently exist.

B. Where existing services interfere with demolition or construction, alter or reroute such existing equipment to facilitate demolition or construction after obtaining written permission from the Contract Administrator. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.

C. Schedule and coordinate with the utility company, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.

D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.

E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.

F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.

G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.

H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.04 EXAMINATION OF SITE

A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical, communications, and Electronic Safety and Security installations, above or below ground, or other sub-surface conditions which may be encountered during the work.

Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

3.05 PERMITS AND FEES

A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.

B. Pay royalties or fees in connection with the use of patented devices and systems.

3.06 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements.

B. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment to Be Salvaged:

1. Communications Infrastructure equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Remove existing conduit and wire back to the Communications Equipment room, unless a specific extent of removal is indicated on the Drawings.

E. Communications Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

a) Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.

b) Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and “Cutting and Patching” portion of this Section in Division 27.

3.07 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".

B. Maintain all code required clearances and clearances required by manufacturers.

3.08 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".

B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.09 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.

C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.

D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
5. Other areas use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry

density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c) Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.010 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.011 PAINTING

A. Refer to Division 09 Section "Painting" for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.012 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.

C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

D. Touch up and restore damaged finishes to their original condition.

E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.013 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all equipment furnished and/or installed under this Division.

B. Check and test protective devices for specified and required application, and adjust as required.

C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

E. Refer to individual Sections for additional and specific requirements.

3.014 START-UP OF SYSTEMS

A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.

B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

C. Refer to individual Sections for additional and specific requirements.

3.015 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit results of systems tests and adjustments per each individual section.
2. Submit complete Operation and Maintenance Data.
3. Submit complete Record Drawings.
4. Perform all required training of Owner's personnel.
5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
6. Perform start-up tests of all systems.

7. Remove all temporary facilities from the site.
8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.

B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.016 EARLY OCCUPANCY

A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.

1. Refer to individual sections for additional requirements.

B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____	_____	_____
Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____	_____	_____
Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

_____	_____	_____
Contractor Acceptance Signature	Date	Company
_____	_____	_____
Owner Acceptance Signature	Date	Company
_____	_____	_____
Architect Acceptance Signature	Date	Company
_____	_____	_____
Engineer Acceptance Signature	Date	Company

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:

1. Grounding and Bonding for Communications
2. Pathways for communications systems.
    a) Cable Supports
    b) Conduit
    c) Outlet Boxes
    d) Floor Boxes and Poke Throughs
    e) Pull Boxes
    f) Cable Tray
3. Firestopping Systems
4. Access Panels
5. Identification

1.02 RELATED REQUIREMENTS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"

B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

C. Division 26 for reference regarding materials and methods for additional requirements.

D. Division 27 "General Communications Requirements"

1.03 DEFINITIONS

A. ASTM - American Society for Testing and Materials

B. AV – Audio Video

C. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

D. Common Work – all Work specified in this section.

E. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

F. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.

G. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

H. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.

I. FM – Factory Mutual

J. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

K. IMC – Intermediate Metal Conduit

L. NEMA – National Electrical Manufacturers Association

M. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

N. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.

O. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.

P. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination

plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.

Q. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is either the Project RCDD, as defined in Division 27 Section "Structured Cabling System", for Common Work for Telecommunications or the Project AVIXA CTS-I, as defined in Division 27 Section "Audio Video Systems", for Common Work for AV.

R. RMC – Rigid Metal Conduit

S. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

T. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

U. UL – Underwriters Laboratory

1.04 REFERENCE STANDARDS

A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section "General Communications Requirements".

B. Follow the additional codes, references, standards and guidelines:

1. NEMA VE 1-2017 – "Metallic Cable Tray Systems"
2. NEMA VE 2-2013 with 2016 Corrections – "Cable Tray Installation Guidelines"
3. ASTM E 814 and ANSI/UL1479 –"Fire Tests Through Penetration Firestops"
4. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
5. ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

1.05 ADMINISTRATIVE REQUIREMENTS

A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

1.06 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".

B. Bid Submittal

1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.

C. Pre-construction Submittal

1. Manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:

a) In addition to Division 27 Section "General Communications Requirements", include the following:

1) Size – including physical and loading dimensions
2) Maximum span length
3) Weight supported
4) Type
5) Fittings to be used
6) Method of attachment to structure
7) Firestop system assembly information for each system to be installed:

a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:

i) Firestop manufacturer
ii) UL system number
iii) F, T, and L Ratings
iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the

penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

8) As well as any additional information required by individual sections of this Division

2. Shop Drawings

a) Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.

1) Each pathway shall be identified by type and size on the drawings.

a) Example #1: 4" EMT
b) Example #2: 4" x 12" Cable Tray

2) Each grounding conductor shall be identified by size (and insulation):

a) Example: #3/0 insulated ground

3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.

a) Example #1 – Firestopping Sleeve:
EZ-Path Series 22, UL System W-L-3255
b) Example #2 – Backbox in Fire-Rated Wall:
Specseal Power Shield, UL System
QCSN/CLIV.R14288

4) Each pullbox and access panel shall be identified by size and height above finished floor.

a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.

b) Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.

1) Division 271000 "Structured Cabling System" and Division 274100 "Audio Video Systems" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.

D. Project Completion Submittal

1. Record Drawings:

a) The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.

1.07 QUALITY ASSURANCE

A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.

1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:

a) All applicable codes and industry standards and guidelines referenced in Division 27.
b) Being fully-coordinated with all other trades and to be installed per the Construction Documents.
c) And installed per manufacturer's direction.

B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.

1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.

C. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:

a) FM Research, approved in accordance with FM AS 4991.
b) Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.08 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.

1. Patient Care Areas
2. Offices
3. Conference Rooms
4. Consultation Rooms
5. Procedure Spaces
6. Exam Rooms
7. Teleconference Rooms

PART 2 - PARTS AND MATERIALS

2.01 GROUNDING AND BONDING FOR COMMUNICATIONS

A. Refer to drawings and Division 27 Sections "Telecommunications Equipment Room Fittings" and "Audio Video Systems" for exact grounding and bonding requirements.

2.02 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General

1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.

B. Cable Supports

1. The following manufacturers are Conditionally Approved.

a) Cooper/B-Line
b) Hilti
c) Monosystems
d) nVent Caddy
e) Panduit
f) Snake Tray
g) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Metal Hook Supports ("J-hooks")

a) Specifications

1) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.
2) Be open for easy lay-in and removal of cabling
3) Be designed so the mounting hardware is recessed to prevent cable damage

4) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
5) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
6) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
7) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed

b) Cable hooks for installation above ceilings shall be

1) B-Line series BCH21, BCH32, BCH64
2) Caddy CABLE-CAT 21 or 32 series hangers
3) Or equivalent from Conditionally Approved manufacturer

3. Fabric Saddle Supports

a) Specifications

1) Suitable for air handling spaces (plenum)
2) Adjustable strap allows for multiple support sizes to reduce inventory.

b) Cable supports for installation above ceilings shall be

1) nVent CADDY CAT 425, 425A6

C. Conduit

1. Specifications

a) Refer to Electrical Division 26 for specific product and material information.

1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

b) Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.

c) If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location

where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.

d) Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.

e) Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

f) Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

Number of Structured Cabling Outlets/Connectors	Conduit Size
Up to 4	1 inch (25.4 mm)
Up to 9	1-1/4 inch (31.8 mm)

D. Acoustical Pathway

1. Specifications

a) For use in non-rated walls only.

b) For use in place of conduit sleeves through walls of noise critical spaces.

c) Plenum Rated (to UL2043)

d) Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2. Manufacturer shall be:

a) Hilti CS-SL SA

b) Specified Technologies, Inc. - NEZ33

E. Outlet Boxes

1. Specifications

a) Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.

b) Telecommunications – for outlets shown onT or TN series drawings:

1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s).

a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
b) RANDL T-55017; or
c) Or equivalent from

i) Emerson/Appleton
ii) Thomas & Betts/Steel City
iii) Approved Substitution

2) For ceilings (flush or above accessible ceiling): *plenum-rated*, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).

a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
b) Or equivalent from

i) Emerson/Appleton
ii) Thomas & Betts/Steel City
iii) Approved Substitution

3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.

a) Single gang – RACO 695
b) Double gang – RACO 696

4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches ddep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.

a) Single gang – Thomas and Betts – IHD3-3 or equivalent

i) Or equivalent from

(1) Emerson/Appleton
(2) Hubbell/RACO
(3) Approved Substitution

b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent

i) Or equivalent from

(1) Emerson/Appleton
(2) Hubbell/RACO
(3) Approved Substitution

c) Audio Video – for outlets and boxes shown on TA series drawings:

1) Refer to box schedule on TA series drawings for size requirements.
2) Boxes specifically identified on drawings by manufacturer and model number form the basis of design. Other equivalent manufacturers will be considered, but fully-coordinate proposed alternative with Division 274100 contractor and submit substitution request.

F. Floor Boxes

1. General

a) Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
b) Floor Box Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
c) Provide a complete Floor Box Assembly.
d) UL514A listed for scrub water exclusion for all floor types.
e) The following items are not provided per this specification section:

1) Electrical receptacle(s) shall be provided per Division 26 Section “Wiring Devices” or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.

2) Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section "Communications Horizontal Cabling". Coordinate all other Assembly components to ensure compatibility.

3) Audio Video custom termination plates and connectors shall be provided per Division 27 Section "Audio Video Systems" and/or "Audio Video Systems Equipment". Coordinate all other assembly components to ensure compatibility.

G. Poke-Through Outlets (Multi-Service)

1. General

a) Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.

b) Poke-Through Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.

c) Provide a complete Poke Through Assembly.

d) Assembly shall be UL listed and UL Fire Classified, flush type, with one- to four-hour fire rating, as required by floor rating and type.

e) Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.

f) The following items are not provided per this specification section:

1) Electrical receptacle(s) shall be provided per Division 26 Section "Wiring Devices" or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.

2) Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section "Communications Horizontal Cabling". Coordinate all other Assembly components to ensure compatibility.

3) Audio Video custom termination plates and connectors shall be provided per Division 27 Section "Audio Video Systems"

and/or “Audio Video Systems Equipment”. Coordinate all other assembly components to ensure compatibility.

g) UL514A listed for scrub water exclusion for all floor types.
h) Provide with cover plate, with individual device covers, and floor flange for specific floor material for all types. Provide color as directed by the contract administrator.

H. Pull Boxes – for interior use only

1. Specifications

a) NEMA 1
b) Refer to Execution section for sizing requirements.

2. The following manufacturers are Conditionally Approved.

a) Hoffman
b) NEMA Enclosures
c) Wiegmann
d) Or Equivalent

I. Handholes – for exterior, in-grade applications only; refer to “Underground Conduit Requirements” in Part 3 for more information.

1. For use with one or two conduits, 2” diameter and smaller are installed, manufacturer shall be:

a) Quazite PG 11”x18”
b) Or Approved Equivalent

2. For all other conduit sizes and quantities, manufacturer shall be:

a) Quazite – submit part number
b) Or Approved Equivalent

J. Basket cable tray

1. The following manufacturers are Conditionally Approved.

a) Atkore/Cope
b) Bettermann Group/Chalfant
c) Chatsworth
d) Eaton/Cooper B-Line
e) Hubbell
f) Legrand/Cablofil
g) MonoSystems
h) MPHusky
i) nVent/Hoffman
j) Schneider Electric/WIBE
k) Snake Tray
l) Thomas & Betts
m) WBT LLC

n) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications

a) Cable Tray Size: Size identified on drawings indicate minimum width and depth size. Provide cable tray of sufficient size to accommodate a maximum calculated fill ratio of 50% for all Division 27 and 28 cabling, to include all cables installed plus 25% growth.

b) Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system

c) Basket cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.

1) Cable tray and accessories shall be UL Classified as an equipment ground conductor.

d) Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

e) Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.

f) Cable Tray Types:

1) Basket cable tray: a cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.

2.03 FIRESTOPPING SYSTEMS

A. General

1. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
2. The following manufacturers are Conditionally Approved.

a) Hilti
b) Specified Technologies, Inc

3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications

    a) Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
    b) Shall meet or exceed the ratings of the wall or floor that it penetrates.
    c) Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
    d) Allows the installation and removal of cables without the need to remove or add any materials.
    e) Used to seal penetrations of cables through fire rated partitions
    f) Not subject to the single manufacturer requirement

2. Manufacturer shall be:

    a) EZ-Path family of products by Specified Technologies Inc.
    b) Hilti Firestop Speed Sleeve CP 653 Series

C. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications

    a) Used to seal backboxes in fire rated partitions.
    b) Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
    c) Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

2. Manufacturer shall be:

    a) Hilti CP 617 or CFS-P PA
    b) Specified Technologies Inc., SpecSeal Power Shield
    c) Or equivalent from Conditionally Approved manufacturer.

D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications

1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
2. Specifications:

    a) Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:

a) Hilti – submit UL System documention for each floor/wall type and product cutsheets for all Hilti materials to be utilized
b) Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
c) Or equivalent from Conditionally Approved manufacturer.

2.04 ACCESS PANELS

A. Access Panels

1. Where pullboxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately-sized access panel. The following manufacturers are Conditionally Approved.

a) Activar/J.L Industries
b) Acudor Products
c) Alfab/Barco
d) Elmdor Products
e) Karp Associates, Inc.
f) Milcor
g) Nystrom Building Products
h) Williams Brothers
i) Wind-lock
j) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications:

a) Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
b) Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
c) Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:

1) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2) For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

d) Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

e) Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

3. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
4. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.05 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

A. Labels

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.

a) Brady
b) Brother
c) Dymo
d) HellermannTyton
e) Panduit
f) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Specifications:

a) Refer to additional requirements in Part 3 – Execution.
b) Refer to individual sections for additional identification requirements for specific work.

2.06 KEYS

A. Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

PART 3 - EXECUTION

3.01 PATHWAYS FOR COMMUNICATIONS

A. General

1. Refer to Electrical Division 26 for additional installation requirements.

a) Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.

2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not

less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.

4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
8. Install all communications pathways:
    a) So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
    b) So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
    c) So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
    d) So that the maximum allowable pulling tension is not exceeded.
    e) To meet the requirements of the structure and the requirements of all other Work on the Project
    f) To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
    g) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
    h) Parallel or perpendicular to building lines or column lines.
    i) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
    a) Except when supported by ladder racking within each Telecommunications room, UON.
10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and

provided for communications cabling purposes. Any deviation from this will not be accepted.

a) At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON
b) At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON

11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
13. Waterproofing

    a) Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
    b) Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

14. Cutting and Patching

    a) Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
    b) Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
    c) Patch around all openings to match adjacent construction.
    d) Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
    e) Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

f) After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

15. Mounting Heights

a) Mounting heights for equipment and devices requiring operational acess shall conform to ADA requirements.

1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

b) Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.

c) Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

16. Painting

a) Refer to Division 9 Section "Painting" for painting requirements.

b) Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

c) Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

d) Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

e) Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

f) Provide touch-up paint as required by Specification Sections in this Division.

17. Fastenings

a) Fasten equipment to building structure in accordance with the best industry practice.

b) Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:

1) Wood: Wood screws.

2) Concrete and solid masonry: Bolts and expansion shields.
3) Hollow construction: Toggle bolts.
4) Solid metal: Machine screws in tapped holes or with welded studs.
5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.

c) Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:

1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

d) Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:

1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

e) For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

f) Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

g) Bridle rings are prohibited for Division 27 cables, unless otherwise noted on drawings.

18. For large quantities of cables (greater than 50) that converge upon a common run such as at a rack, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.

19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces

B. Access to pathways and associated equipment

1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.
    a) Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
    b) Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.
3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable distribution

1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
    a) For typical new walls:
        1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.
    b) For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:
        1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
    c) See drawings for clarification
2. Provide pathways for Audio Video Systems to allow cabling to be installed in the following manner:
    a) For typical new walls:
        1) Homerun method: Conduit from outlet/box location all the way back to the AV Rack identified on the drawings.
    b) See drawings for clarification.

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
2. Adequate access shall be available where cables enter conduits
3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
4. Install conduits in the most direct route possible, running parallel to building lines
5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.
7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).
8. Flexible conduits may only be used where specifically allowed by these contract documents.

    a) Flexible conduit sections shall be less than 20 feet (6.1 m) in length.

9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.

    a) Each and any offset shall be considered a 90° bend.
    b) A pullbox is required wherever a reverse bend is installed.

11. The minimum bend radius for conduits is

    a) (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
    b) (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).

12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.
13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.

    a) Coordinate with Contractor for Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.

14. Conduits shall contain no electrical condulets (also known as LBs).

a) Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.

15. Underground Conduit Requirements

a) For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc

b) For Audio Video System cabling serving pole-mounted loudspeakers, broadcast boxes, etc.

c) Requirements

1) Refer to applicable details on drawings for illustrative requirements.

2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.

a) Only one horizontal bend is allowed, 90 degrees or less.

b) Indicate proposed routing and stub-up locations on shop drawings.

3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.

a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.

4) Approved conduit types:

a) When routed in slab-on-grade:

i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.

ii) Vertical bends shall be RMC.

b) When routed below slab-on-grade or outside the fooprint of the building:

i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.

ii) All vertical and horizontal bends shall be RMC.

16. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
17. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.

a) Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.

2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. PullBoxes

1. Pullboxes shall be placed in Conveniently Accessible locations.
2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
3. Pullboxes above an accessible ceiling shall:

a) Be aligned directly over the ceiling grid to allow access

b) Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
1" or smaller	4"	4"	2-1/8"	Not applicable
1-1/4"	6"	20"	3"	3"

1-1/2"	8"	27"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	8"

G. Cable Tray

1. Cable trays shall be installed in accordance with the applicable electrical code and standards.
2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.
6. Cable trays shall not extend over 6’ lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.

    a) The cable fill ratio for cable tray shall be 50%.
    b) The cable fill ratio for conduits shall be 40%.
    c) Example: a 4” x 12” cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4” trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4” conduits shall be provided for a 4” x 12” cable tray.

7. Cable trays and cable runways shall not be used as walkways or ladders.
8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Basket cable trays shall be supported according to manufacturer’s instruction via one of the following:

    a) Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8” (or greater) rods to structure above.

        1) Center-hung, single-rod supports are not allowed.

b) Shelf or L-brackets attached to wood or metal studs.

11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

3.02 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:

a) All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.

b) All pathways (e.g., conduit, innerduct, etc.) installed under this work.

1) Label all conduit and innerduct with "TELECOM" or "AV" according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.

a) For wall stub-up locations, label overhead only.

b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.

i) Example – "AV to AV Rack R01".

c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.

i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Confence Room 101A shall be labeled as follows:

(1) Conduit stub-up location in Telecom Room 1A – "Telecom to Conf. Rm 101A Floorbox"

(2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – "Telecom to Telecom Room 1A"

2) All pullboxes and junction boxes for Communications shall be labeled such as "TELECOM PULLBOX", "AV

JUNCTION BOX", "TV", etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.

a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie "To AV Box Q:212:01 in Control Rm 212".

c) In general, the label is to be provided and installed by whomever installed the item that is being labeled.

d) Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.03 FIRESTOPPING

A. General

1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.

    a) Assume all floors are fire-rated, unless otherwise noted.
    b) Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:

    a) Fire stop Manufacturer
    b) Installer and company
    c) Date installed
    d) UL system number with all relevant ratings indicated

4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device

1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION

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PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete-encased communications distribution pathways.

1.02 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 26 Sections “General Electrical Requirements” and "Common Work Results for Electrical” for general requirements and related documents that apply to this Section.

B. Division 27 Section “General Communications Requirements” for general requirements and related documents that apply to this Section.

C. Division 27 Section "Common Work Results for Communications” for limited scope general construction materials and methods.

D. Division 31 Sections, including “Earth Moving”.

E. Division 32 Sections, including “Turf and Grasses and “Plants”.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 27 Section “General Communications Requirements”:

1. Product data for the following products:

a) Raceways, Raceway fittings, separators, and accessories, duct-bank materials, manholes/handholes, solvent cement, sealants, tracer wire, warning tape / warning planks.

2. Shop drawings for:

a) Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.

b) Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 27 Section “General Communications Requirements”:

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

1.04 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit

B. Refer to Division 27 Section "General Communications Requirements" for additional abbreviations / definitions.

1.05 CODE, STANDARDS, AND GUIDELINES

A. The following codes and standards contain provisions that, through reference in this text, constitute provisions of document. At the time of publication the editions indicated were valid. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following standards and codes published by the following organizations, where applicable

1. Federal Communications Commission (FCC)
2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
3. National Fire Protection Association (NFPA)
4. National Electrical Code (NEC)
5. American National Standards Institute (ANSI)
6. Telecommunications Industry Association (TIA)
7. Electronics Components Industries Association (ECIA)
8. Building Industry Consulting Service International (BICSI)
9. National Electrical Contractors Association (NECA)
10. International Building Code (IBC)
11. FCC Regulations Part 68
12. NPFA-70 National Electrical Code Chapter 8 – Communications Systems
13. NFPA-71 Central Signaling Systems
14. NFPA-780 Protection of Electronic and Computer Data Processing Equipment
15. NFPA-780 Lightning Protection Code
16. NFPA-101 Life Safety Code
17. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces

18. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
19. TIA-STD-J-607 Commercial Building Bonding and Grounding requirements for Telecommunications
20. ANSI/NESC – National Electrical Safety Code

B. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following guidelines published by the following organizations, where applicable

1. BICSI Methodologies

a) BICSI Telecommunications Distribution Methods Manual
b) BICSI ITS Installation Methods Manual
c) Customer Owned Outside Plant Design Manual

C. Additional requirements for Manholes and Handholes:

1. Manholes shall be designed in compliance with the following ASTM standards:

a) ASTM C857-87 “Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures”,
b) ASTM C478 “Standard Specification for Pre-cast Reinforced Concrete Manhole Sections”,
c) ASTM C858-83 “Standard Specifications for Underground Pre-Cast Concrete Utility Structures”
d) All reinforcing steel shall conform to ASATM 432 “Standard Guide for Selection of a Leak Testing Method” and
e) ASTM 305 “Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency”.
f) ASTM C990, “Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants”
g) ASTM 432, “Standard Guide for Selection of a Leak Testing Method:
h) Test and inspect pre-cast concrete utility structures according to ASTM C 1037

2. Manholes to be designed per ACI 318-02 “Building Code Requirements for Structural Concrete”.
3. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
4. 4.Non-concrete Handholes and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

1.06 QUALITY ASSURANCE

A. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.

B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 5 years.

C. Communications and Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
2. Marked for intended use.

D. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards

E. Refer to Division 27 Section "General Communications Requirements" for additional Quality Assurance requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

B. Store pre-cast and other factory–fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.08 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, tracer wires, warning planks, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, tracer wires, warning planks, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Architect.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.02 RACEWAYS AND FITTINGS

A. Metal Conduit

1. Manufacturers:

a) AFC Cable Systems, Inc.
b) Alflex Corporation, a Southwire Company
c) Anamet Electrical, Inc.; Anaconda Metal Hose.
d) Electri-Flex Co.
e) Indalex
f) Manhattan/CDT/Cole-Flex
g) O-Z/Gedney; Unit of General Signal (Fittings)
h) Republic Raceway
i) Tyco International; Allied Tube & Conduit Div.
j) Wheatland Tube Co.
k) Or approved equivalent

2. RMC:

a) GRS: Hot-dip galvanized steel (including threads): ANSI C80.1, UL 6

B. Nonmetallic Raceway

1. Manufacturers:

a) AFC Cable Systems, Inc.
b) American International.
c) Anamet Electrical, Inc.; Anaconda Metal Hose.
d) Arnco Corp.
e) Cantex Inc.
f) Certainteed Corp.; Pipe & Plastics Group.
g) Condux International.
h) ElecSYS, Inc.
i) Electri-Flex Co.
j) Lamson & Sessions; Carlon Electrical Products.
k) Manhattan/CDT/Cole-Flex.

l) RACO; Division of Hubbell, Inc.
m) Spiralduct, Inc./AFC Cable Systems, Inc.
n) Superflex Ltd.
o) Thomas & Betts Corporation.

2. RNC: Extra-heavy Schedule 80 conduit type EPC-80-PVC, PVC: NEMA TC 2, UL 651.

a) Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.

3. RNC: Heavy Schedule 40 conduit type EPC-40-PVC, PVC: NEMA TC 2, UL 651.

a) Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.

C. Duct Accessories

1. Innerduct

a) Install size and quantity of innerduct within conduits as identified on the drawings.
b) Requirements:

1) Suitable for installation within the installed conduits
2) Sequential foot markings
3) Material shall be corrugated High Density Polyethlene (HDPE)
4) Manufacturer shall be: Duraline Corrugated, or approved equivalent

2. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
3. Underground-line warning tape / tracer wire:

a) Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1) Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2) Compounded for permanent direct-burial service.
3) Embedded continuous metallic strip or core.
4) Printed legend shall indicate type of underground line.

4. Refer to details on drawings for additional accessories.

2.03 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers:
2. Manufacturers:

    a) Carder Concrete Products.
    b) Christy Concrete Products
    c) Elmhurst-Chicago Stone Co.
    d) Oldcastle Pre-cast Group
    e) Riverton Concrete Products; a division of Cretex Companies, Inc.
    f) Utility Concrete Products, LLC
    g) Utility Vault Co.
    h) Wausau Title, Inc.
    i) Or Approved Equivalent

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
3. The cover shall have the following legend lettering molded into the cover:

    a) "COMMUNICATIONS" for Telecommunications spaces

4. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
5. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.

    a) Extension shall provide increased depth of 12 inches.
    b) Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a) Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
b) Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
c) Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

7. Duct entrances into handhole walls shall have cast end-bell or duct–terminating fittings in the wall for each entering duct.

a) Type and size shall match fittings to duct or conduit to be terminated.
b) Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable
c) Rigid steel conduits shall be hot-dipped galvanized malleable iron or steel threaded to the end if the conduit is cast in place in the wall of the manhole. .

8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
9. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12” of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4” through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.

2.04 GROUNDING

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
2. 3/4” thick, by 10’ long
3. Manufacturer shall be:

a) Copperweld Steel Company
b) ITT Weaver
c) Thomas & Betts
d) Pre-Approved equal.

B. Grounding Conductors and Connectors

1. Manufacturers:

a) Apache Grounding/Erico Inc.
b) Boggs, Inc.
c) Chance/Hubbell.

d) Copperweld Corp.
e) Dossert Corp.
f) Erico Inc.; Electrical Products Group.
g) FCI/Burndy Electrical.
h) Galvan Industries, Inc.
i) Harger Lightning Protection, Inc.
j) Hastings Fiber Glass Products, Inc.
k) Heary Brothers Lightning Protection Co.
l) Ideal Industries, Inc.
m) ILSCO.
n) Kearney/Cooper Power Systems.
o) Korns: C. C. Korns Co.; Division of Robroy Industries.
p) Lightning Master Corp.
q) Lyncole XIT Grounding.
r) O-Z/Gedney Co.; a business of the EGS Electrical Group.
s) Panduit, Inc
t) Raco, Inc.; Division of Hubbell.
u) Robbins Lightning, Inc.
v) Salisbury: W. H. Salisbury & Co.
w) Superior Grounding Systems, Inc.
x) Thomas & Betts, Electrical.
y) Or approved equivalent

2. Grounding Conductors

a) Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
b) Underground Conductors: Tinned-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.
c) Bare Copper Conductors: Comply with the following:

1) Solid Conductors: ASTM B 3.
2) Assembly of Stranded Conductors: ASTM B 8.
3) Tinned Conductors: ASTM B 33.

d) Copper Bonding Conductors: As follows:

1) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2) Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3) Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

3. Connector Products

a) Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
b) Bolted Connectors: Bolted-pressure-type connectors

1) Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

a) Company symbol and/or logo.
b) Catalog number.
c) Conductors accommodated.
d) Installation die index number or die catalog number is required.
e) Underwriters Laboratories "Listing Mark:".
f) The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).

2) Cast connectors: copper base alloy according to ASTM B 30 (latest revision).

c) Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 UNDERGROUND DUCT APPLICATION

A. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased or direct-buried duct bank, unless otherwise indicated

1. For all changes in elevation or direction, conduit shall be RMC or concrete-encased PVC.

B. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-80 PVC, encased in reinforced concrete.

3.03 UNDERGROUND ENCLOSURE INSTALLATION

A. Handholes and boxes Telephone, Communications, and Data Wiring:

1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading
5. Handholes shall be used as pull-through points only. Handholes shall not be used as splice points, unless authorized in writing by the design team.
6. Handholes shall not be used in conduit runs that have more than (3) three 4" conduits.
7. Joint use of handholes by other trades is not allowed.

B. Manholes: Pre-cast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses and "Plants".

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching".

3.05 DUCT INSTALLATION

A. Maintain a minimum trench depth to allow for the top row of conduits in the duct bank to be 36" below grade

B. Contractor shall remove all rock and debris from backfill material. Contractor shall remove all excess material from the site and compact the excavation. Unpaved areas shall be finished flush with the surrounding natural ground. Contractor shall restore damaged grassed areas.

C. Contractor shall tamp backfill material in 6" lifts with a mechanical tamp until compact density is at least equal to surrounding density

D. For concrete and driveway approaches, contractor shall replace the entire joint of the approach unless otherwise directed by the Engineer. In areas with brick sidewalks, remove only the existing brick pavers necessary to install the conduit. Replace the brick pavers within seven (7) days of their removal. Furnish new bricks of similar type necessary to restore sidewalk area to its original appearance. Any new bricks shall identically match the existing brick pavers.

E. Contractor shall backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided causing a deviation in the elevation height of the multi-duct conduit system. The purpose of the backfill is to provide a gradual change in elevation of the trench, from the bottom to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the conduit system is installed.

F. Slope: Pitch ducts a minimum slope of ½ % down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions

G. All underground conduits shall be slurry capped sealed.

H. Conduit lengths shall contain no continuous sections longer than 300 feet. If conduit lengths total more than 300 feet, pull points (manholes / handholes) shall be provided. The use of pull boxes to changes directions is prohibited, unless expressly detailed or indicated on the drawings.

I. Conduits shall have no more than 180 degrees of cumulative bends between pull points or more than 90 degrees of bends at any one point. All bends must be long, sweeping bends with a radius of not less than six times the internal diameter of conduits 50mm (2 inches) or smaller, or ten times the internal diameter of conduits larger than 50mm (2 inches). 48" sweeps are preferred.

1. For all changes in elevation or direction conduit shall change to RMC from PVC.

J. Required separation from other utilities.

1. Power up to 1KVA:

   a) 12" of well-packed earth
   b) 4" of masonry
   c) 3" of concrete

2. Gas, Oil, Water, etc.:

   a) 12" when parallel
   b) 6" when crossing

K. All conduits shall be mandrelled prior to installation of cable or (for spare conduits) prior to substantial completion; the OD of the test mandrel shall be no smaller than 80% of the conduit internal diameter.

L. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

M. Duct Entrances to Manholes and Handholes: Use end bells, spaced approximately 10-inches OC for 4-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell with out reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances
4. All ends of conduits must be reamed.
5. All conduits in the Telecommunications duct bank shall enter one end of the manhole / handhole and exit the opposite end, UON.

N. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical".

O. All conduits entering a building must be pitched to drain away from the building to avert water intrusion. To prevent conduit shearing, conduits entering through walls shall be RMC and extend to undisturbed earth, particularly where such backfill is susceptible to load bearing tension.

P. Sealing: Provide temporary closure at termination of ducts that enter buildings. After cables have been installed, seal ducts (including spare) at termination.

Q. Pulling Cord: Install 1250-lbf ½-inch (min) wide mule tape in all conduits and in all innerducts installed, including spares; all mule tape shall provide footage markers and be indexed to facilitate future identification.

R. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Spacers shall be installed / utilized per the manufacturer's standard specifications. Couplings for conduits shall be staggered at least six (6) inches. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie

entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a) Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b) If more than one pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24-inches below finished grade in areas not subject to deliberate traffic, and at least 30-inches below finished grade in deliberate traffic paths of vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
    b) Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 18 inches above all concrete–encased ducts and duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally

10. Tracer Wire: Provide an orange #6 AWG high strength copper clad steel with a high density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8-feet with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the dumber of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application if an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

S. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving".
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4-inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".
6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts, unless more restrictive separation is specified elsewhere in this section or on the drawings.
7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
    b) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Planks: Bury warning planks approximately 18 inches above all direct-buried ducts and duct banks placing them 24-inches OC. Align planks along the width and along the centerline of duct bank. Provide an

additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.

11. Tracer Wire: Provide an orange #6 AWG high strength copper clad steel with a high density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8-feet with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the dumber of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application if an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install each unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

B. Elevations:

1. Install manholes / handholes per manufacturer's instructions; lid to manhole / handhole to be flush with the surrounding terrain so that no earth, roadway or sidewalk removal is required to access the manhole / handhole interior. Contractor to provide chimney/ extensions / collars to facilitate the placement of the manholes / handholes so as to maintain the minimum distance to the surface above the highest row of conduits in the duct bank given the location of the manhole / handhole at the point of installation.
2. Manhole Roof: Install with rooftop at least 15-inches below finished grade.
3. Install handholes with bottom below the frost line, <Insert depth of frost line below grade at Project site> below grade.
4. Handhole Covers: Set surface flush with finished grade.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before

backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items n manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8-inches for manholes and 2-inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover

3.07 GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Equipment Grounding Conductors

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

2. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

D. Connections

1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

   a) Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   b) Make connections with clean, bare metal at points of contact.
   c) Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   d) Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   e) Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

2. Compression Fittings: Permanent compression-type fittings may be used for the following:

   a) Connecting conductors together.
   b) Connecting conductors to ground rods

3. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.
4. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
5. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

E. Field Quality Control

1. Testing: Perform the following field quality-control testing:

a) Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

b) Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

c) Perform point–to–point megohmmeter tests between the ground rod and all cable shields, splice cases, locate wires, and racking hardware to determine the resistance.

d) Investigate point-to-point resistance values that exceed 0.5 ohms.

1) Check for loose connections.
2) Check for absent or broken connections.
3) Check for poor quality welds.
4) Consider other reasons.

e) Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, notify Architect promptly and include recommendations and costs to reduce them.

3.08 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.09 INSTALLATION ACCEPTANCE

A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wooden test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct internal diameter.

B. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified above. Correct any deficiencies and retest as specified above.

C. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.

D. Acquire written approval from the Owner prior to backfilling any duct banks or covering manholes / hand holes

E. Provide Record Drawings indicating the exact pathway of the Telecommunications Duct bank include elevation changes and the location of all manholes/handholes. Label all manholes MH-xx and handholes HH-xx, coordinating exact labeling scheme with Owner.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. Provide a complete functioning telecommunications structured cabling system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Specification sections 271000 through 271999, and Drawings numbered with prefix TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.

C. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:

1. Quality Assurance requirements, including Contractor qualifications and advanced warranties

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 27 Section "General Communications".

C. Division 27 Section "Common Work Results for Communications".

D. Requirements of this Section apply to all Sections 271000 through 271999.

1.03 STANDARDS

A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):

1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"

2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
3. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"
4. TIA TSB 140 – "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems"
5. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure
6. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
7. ANSI/BICSI/NECA 568 – "Standard for Installing Commercial Building Telecommunications Cabling"
8. ANSI/TIA-758 – "Customer-Owned Outside Plant Telecommunications Cabling Standard"
9. ANSI/BICSI-004 "Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities"
10. ANSI/TIA-1179 – "Healthcare Facility Telecommunications Infrastructure Standard"

1.04 GUIDELINES

A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON)

1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
2. BICSI Telecommunications Distribution Methods Manual (TDMM)
3. BICSI Outside Plant Design Reference Manual (OSPDRM)

1.05 DEFINITIONS

A. BICSI - Building Industry Consulting Service International

B. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.

C. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.06 QUALITY ASSURANCE

A. Personnel Qualifications:

1. Provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee at all times. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant. Weekly inspections and approval of all work performed shall be conducted by this RCDD.
2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all submittals.
3. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
4. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
6. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.

B. Contractor qualifications:

1. Provide a list of projects (no less than 2) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

1.07 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.

1. Warranty shall be guaranteed by a single reputable manufacturer from below:

a) Belden Incorporated
b) CommScope Inc.
c) Corning Cable Systems (for Fiber portion only)
d) Hubbell
e) Legrand/Ortronics
f) Leviton
g) Panduit
h) Siemon
i) Superior Essex Cabling
j) Or Approved Substitution (submitted and accepted in the pre-bid submittal)

B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

C. Perform the remedial work promptly, upon written notice from the Architect or Owner.

D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.08 WORK INCLUDED

A. Provide labor, materials, and accessories required to provide complete, operating Telecommunications Infrastructure systems as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:

1. All horizontal cabling between the Telecommunications rooms and the outlets.
2. All backbone cabling, including cabling between the Telecommunications Entrance Facility Room and the Telecommunications rooms and designated Telecommunications equipment rooms.
3. All termination blocks, outlets/jacks, patch panels, patch cords and station cables, cabinets, equipment racks, etc., required to support, terminate and/or cross connect cabling at the main cross-connect, Telecommunication rooms and/or other designated equipment locations.
4. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and "D-rings" on backboards and equipment racks/cabinets/frames.
5. A Grounding/Bonding System, as described in these construction documents.

6. Termination, cross connect and patching of all cable pairs as indicated herein or on schedules or on drawings.
7. Testing, labeling and documentation of all cables and hardware installed under this contract.
8. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.

1.09 COORDINATION

A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.

C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.

D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.

E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch panels. Show the actual outlet/cable numbers on the as-built drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.

F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.

G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

1.010 SUBMITTALS

A. Refer to requirements in Division 27 Section "General Communications Requirements". At a minimum, include the following items:

1. Pre-bid submittal
    a) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
    b) Alternate personnel credentials to be reviewed for approval
2. Bid submittal
    a) Bid Response Forms
    b) Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:
        1) Member of staff required to be RCDD
            a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.
        2) On-site project manager
            a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.
        3) Other personnel physically installing any portion of the Communications infrastructure
            a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents
            b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.
            c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendor list as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:

i) A valid copy of each certification with the person's name and member number including the manufacturer's logo

ii) A document provided by the manufacturer describing what specific subjects the certification covers, period of time spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.

4) Contractor Qualifications (Previous project references)

5) Voluntary Bid Alternates

3. Pre-construction submittal

a) Warranty information

1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions

2) Proof that Contractor is certified with the Advanced System Warranty manufacturer

b) Resubmit Contractor and Personnel Qualification, update if necessary

c) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.

d) Manufacturers' cut-sheets, in same order as typed list and in these specifications.

1) At a minimum all cut-sheets shall contain the following:

a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance

b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo

c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.

d) For cut-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.

e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL

listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

e) Shop Drawings
f) And as required by individual sections in this Division

4. Project completion submittal

a) Preliminary Project Completion submittal requirements:

1) To be submitted:

a) After all horizontal and backbone cabling has been installed, terminated, labeled, tested, and corrected so that all cables and strands pass the Testing Requirements.
b) In conjunction with the Substantial Completion Review request.

i) Design Consultant requires a minimum of 2 weeks notice to schedule the on-site Substantial Completion Review.
ii) Substantial Completion Review shall be a minimum of 4 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.

2) Submittal shall include:

a) Scanned Work Site Prints that include horizontal and backbone cable/outlet labels that correspond to the Test Results.
b) Passing Test Results for all cables and strands, in the following formats:

i) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:

(1) Project Name
(2) Date of Preparation
(3) ID of Work Area Outlet / connector being tested
(4) Date of test
(5) Contractor's Name
(6) Media Type
(7) Make, Model, and Serial Number of test equipment used
(8) Date of last calibration
(9) Names of test crew

(10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
(11) Category or type of cable being tested
(12) Pass or Fail status

ii) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:

(1) Project Name
(2) Date of Preparation
(3) ID of Work Area Outlet / connector being tested
(4) Date of test
(5) Contractor's Name
(6) Media Type
(7) Make, Model, and Serial Number of test equipment used
(8) Date of last calibration
(9) Names of test crew
(10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
(11) Category or type of cable being tested
(12) Full Test Result Data (per Part 3 of this specification)

b) Final Project Completion submittal requirements:

1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:

a) Length of warranty period
b) Applications covered (future and present)
c) Single manufacturer responsible for fulfilling warranty
d) Who is covered
e) What is covered
f) All disclaimers, limitations, etc.
g) What, if anything, is not covered

2) Product Information

a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:

i) Product Type (as identified in these specifications)
ii) Manufacturer
iii) Model Number
iv) Quantity installed
v) Serial Number (if applicable)
vi) Manufacturer Warranty date (if longer than 1 year)

b) Manufacturer Cut Sheets / Specification Sheets
c) Operation and Maintenance Manuals – manufacturer's installation, service, and maintenance instructions.
d) Warranty certificates (for products not covered by the Advanced System Warranty)

i) If products require registration, register on the Owner's behalf.

3) As Built Drawings

a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically and saved to PDF format.
b) Include date and installing contractor's logo and contact information in the title block.
c) Mark each sheet "As Built Drawing".
d) Drawings shall include:

i) Corrected items from Substantial Completion Review punch list.
ii) Cable ID (all characters) for each work area outlet jack (so that they are searchable in the PDF version)
iii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.
iv) Project RCDD's stamp, which indicates that the project has been installed in compliance with industry standards and the contract documents.

4) Updated, complete Test Results in the following formats (to include the retesting data of any cables installed or modified after Preliminary Project Completion submittal):

a) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:

i) Project Name
ii) Date of Preparation
iii) ID of Work Area Outlet / connector being tested
iv) Date of test
v) Contractor's Name
vi) Media Type
vii) Make, Model, and Serial Number of test equipment used
viii) Date of last calibration
ix) Names of test crew
x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
xi) Category or type of cable being tested
xii) Pass or Fail status

b) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:

i) Project Name
ii) Date of Preparation
iii) ID of Work Area Outlet / connector being tested
iv) Date of test
v) Contractor's Name
vi) Media Type
vii) Make, Model, and Serial Number of test equipment used
viii) Date of last calibration
ix) Names of test crew
x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
xi) Category or type of cable being tested
xii) Full Test Result Data (per Part 3 of this specification)

B. Each structured cabling section (271000-271999) shall be submitted individually. All structured cabling section submittals (271000-271999) shall be submitted on the same date. “Piecemeal” submissions will not be reviewed.

C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:

1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pullboxes. Also show the routing of bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.

    a) Outlet locations shall be identified with jack/module type and label. Coordinate labeling scheme with Owner prior to submitting.

2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and TBC.
3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than ¼ inch = 1’-0”. They shall be prepared in the following manner:

    a) Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
    b) Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer’s required clearances.
    c) Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
    d) Indicate the operating weight of each piece of equipment.
    e) Indicate dimensions to confirm compliance with code-required clearances.
    f) Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer’s recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX or key telephone equipment, etc., if installed under this work.)
    g) Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".

D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit

concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.

1.011 SPARE PARTS

A. Furnish to the Owner the following spare parts as part of the complete Structured Cabling System:

1. Furnish one general purpose 110-style punch down tool.
2. Any custom or proprietary copper Category cable termination tool. Furnish one per Communications Room.
3. Additional Special Tools, as defined in Part 3 of this specification.

B. Have these spare parts in the Main Communications Room during Design Consultant's Site Observation Review visit; turn over to Owner before Substantial Completion.

PART 2 - PRODUCTS

2.01 110-STYLE PUNCHDOWN TOOL

A. Manufacturer shall be Panduit PDT-110 or equivalent.

2.02 COPPER TESTING EQUIPMENT

A. Augmented Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
    a) Augmented Category 6 Cable Tester
        1) Fluke
        2) Ideal
        3) Softing
        4) Viavi
2. Requirements
    a) The field tester shall be a level III-E (IIIe) or greater.
    b) The field tester shall meet the requirements of ANSI/TIA-568.

2.03 OPTICAL FIBER TESTING EQUIPMENT

A. OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
    a) Optical Time Domain Reflectometer (OTDR)
        1) Fluke

2) Ideal
3) Softing
4) Viavi

2. Requirements

a) An OTDR shall be used to provide Tier Two testing, which shall provide information regarding attenuation, connector location and insertion loss, splice location and splice loss, and any other power loss events that may have been created during installation.
b) The OTDR shall be utilized from both ends of the fiber strand to better isolate any potential problems.
c) For unterminated fiber, a "bare fiber adapter" shall be utilized.

B. OPTICAL POWER MEASUREMENT METER

a) Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

1) Optical Power Measurement Meter

a) Fluke
b) Ideal
c) Softing
d) Viavi

2. Requirements

a) An Optical Loss Test Set (OLTS) shall be used to provide Tier One testing, which shall provide information regarding link attenuation, continuity, and polarity of the installed fiber optic cable.
b) The OLTS shall be used with the appropriate adapters to allow connectivity to the optical fiber link.
c) The OLTS shall meet the launch requirements of ANSI/TIA-455-78B.

C. OPTICAL FIBER INSPECTION SCOPE (or FIBER VIEWERS)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

a) Optical Fiber Inspection Scope

1) AFL
2) EXFO
3) Fluke
4) Softing
5) Viavi

2. Requirements

a) An Optical Fiber Inspection Scope shall be utilized to examine all ends of fiber optic strands prior to splicing or termination.

b) The Optical Fiber Inspection Scope shall have a minimum of 400x magnification. If the cable and/or connectivity manufacturer requires greater magnification to meet their installation requirements, the more restrictive standard shall apply.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 IDENTIFICATION / LABELING

A. General

1. Labels or tags containing a unique cable ID designator as specified on the drawings or herein shall be placed on both ends of all cables, 6 inches (152.4 mm) from the connector and/or terminal block.
2. Label or tag all cables passing through Telecommunications rooms.
3. Subsequent to placing and terminating cables, place the appropriate cable label.
4. The administration of the Telecommunications infrastructure includes:
   a) Labels (plates, tags, etc.) to identify individual components.
   b) Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
   c) Plans or drawings to assist with visualizing the physical and/or logical locations of the components.
5. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the Telecommunications infrastructure.

B. Labeling Installation

1. Labels that are to be secured by adhesive shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.
2. Labels, plates and tags are to be installed in such a manner that they will be accessible, both physically and visually, after completion of the work. (Exception: It is understood that labels on the outlet end of station cables are generally not visible unless the face plates, bezel, module, etc., is removed or opened.)
3. Any temporary labels used during installation, cable pulling, etc. are to be removed and replaced by the permanent labels identified in Part 2 of this specification before the work will be accepted.

4. If at any time during the job the cable tag becomes illegible or removed for whatever reason during the construction period, immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense before the work will be accepted.

C. Labeling Requirements

1. Labels, plates and tags are to be installed on:

a) All Telecommunications rooms (spaces).
b) All horizontal links and their components, including:

1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all horizontal cables installed under this work.
2) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
3) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work.
4) Labeling the Telecommunications outlet housing individual connectors in the work area.

a) Labeling each connector terminating horizontal cables in these outlets.
b) Label identification within a given space (work area) shall begin at the entrance to the space and proceed in a clockwise manner around the space.

5) Any additional components required by ANSI/TIA-606

c) All components of the commercial grounding and bonding system for Telecommunications; to include but not limited to all bonding conductors, PBB and SBB's.
d) All building backbone cables and their components, including:

1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
5) Any additional components required by ANSI/TIA-606.

e) All required fire stopping systems.
f) All campus backbone cables and their components, including:

1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
5) Any additional components required by ANSI/TIA-606.

g) All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.

1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.

h) Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.

i) In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.

j) Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.

3.03 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

A. General cable testing

1. Pre-installation testing:

a) Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

b) Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.

c) Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.

d) Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

2. Post-installation testing:

a) Calibrate all testers prior to use in accordance with manufacturers' printed instructions.

b) Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.

c) Remove all defective cables from pathway systems. Do not abandon cables in place.

3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.

a) Prior to testing, submit for review and approval copies of test report forms proposed for use.

b) Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.

B. Copper cable testing

1. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.

2. Paired and multi-conductor riser metallic cables:

a) After terminating and splicing the cables. Test all cable pairs for continuity, ground fault, proper cross-connection, shorts and crossed pairs.

b) After installing cross-connects, perform end-to-end testing of each cross-connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.

c) Cable test reports: As a minimum, also provide: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.

3. Four-Pair Cables:

a) After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:

1) Augmented Category 6 F/UTP Cables

a) Wire map
b) Length
c) Insertion loss
d) Near-end crosstalk (NEXT) loss.
e) Power sum near-end crosstalk (PSNEXT)
f) Equal-level far-end crosstalk (ELFEXT)
g) Power sum equal-level far-end crosstalk (PSELFEXT)
h) Return loss
i) Propagation delay
j) Delay skew
k) Alien Crosstalk (AXTalk) – Follow manufacturer's instructions for method

4. After installing cross-connects, perform end-to-end testing of each cross-connected cable for continuity, ground fault, proper cross-connection, shorts and crossed pairs. For 100 pair or smaller cables, replace entire cable if bad pair is found. For larger pair-count cables, replace if more than 1% of pairs are bad.
5. Submit the following information regarding the cable testing: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair (if applicable), results of each test for each pair and total number of serviceable pairs in cable.
6. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and copper test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

C. Optical Fiber cable testing

1. Post-installation testing:

a) After installation of connectors, visually inspect each fiber end-face at 50X magnification. Refinish fibers with visible defects and/or striations in the core area.
b) Perform end-to-end, bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm. Conduct tests in accordance with TIA-526-14, Method B and with test instrument manufacturer's printed instructions.
c) Perform end-to-end, bi-directional attenuation (loss) test for each singlemode fiber strand at 1310 and 1550 wavelengths. Conduct tests in accordance with TIA-526-7, Method A.1 and with test instrument manufacturer's printed instructions.
d) Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is defined as the sum of: the connector losses (based on the number of mated connector pairs at the ANSI/TIA-568 maximum allowable loss of 0.75dB per mated pair) and the optical fiber loss (based on length and the ANSI/TIA-568 maximum allowable loss (3.5dB/km @ 850nm and 1.5dB/km @1300nm for multi-mode and 1.0dB/km @1300 and 1550nm for single-mode) by more than 1.0dB.
e) Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, at OTDR shall be used to: determine the true loss for each connector pair, the exact length of the fiber and to identify the presence of any core damage.

f) Faults related to fiber being connectorized shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded.

g) Where defects are found to be inherent in the fiber itself: replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.

h) Provide testing in accordance with manufacturer's requirements for a fully-warrantied cabling system(s) as required by these Contract Documents.

2. Testing jumpers used shall remain connected at the test equipment for the entire duration of testing. If at any time the jumper becomes loose or removed, for any reason, the jumper shall be reinstalled and re-referenced. This procedure shall be documented each time it is performed to indicate date, time and who performed the procedure. This log shall accompany test reports submitted.

3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.

a) Prior to testing, submit for review and approval copies of test report forms proposed for use.

b) Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.

c) Cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches, calculated maximum link loss, length or run, measured link loss for each fiber.

4. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and fiber test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

D. Acceptance

1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.

a) The Owner and Design Consultant further reserves the right to request the Contractor conduct a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results during the Substantial Completion Review. If more than 5% of these randomly tested cables do not pass, the Owner and Design Consultant reserves the right to require a re-testing of 100% of the cable plant, all without additional costs to the project.

2. For 100 pair or smaller replace entire cable if a bad pair or conductor is found. For larger pair count cables, replace if more than 1% of pairs are bad.
3. All test results are to be documented and submitted to the Architect in a timely manner, in accordance with the Submittal instructions in Part 1 of this section.

    a) Corrective procedures following the Substantial Completion Review shall be properly documented, and affected and new cables shall be retested prior to Substantial Completion.
    b) Updated complete Test Results, including retested, new and unaffected cables, shall be included in the Final Project Completion submittal.

3.04 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
2. Installation, termination, final labeling, and testing of all backbone and horizontal cabling.
3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27 “Common Work Results for Communications”), ensure all firestopping systems are installed and labeled.
4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.
5. Ensure faceplates are level, free of dust and paint, match color/style of adjacent electrical receptacle, and have blue protective film removed.
6. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.

    a) These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.

B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.

D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

3.05 SPECIAL TOOLS

A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.

B. The terms "special tools" and "small equipment items" is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars ($500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

END OF SECTION

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:

1. Bonding and Grounding (Earthing)
2. Plywood Backboard
3. Entrance Protection
4. Cabinets, Racks, Frames, and Enclosures
5. Termination Blocks and Patch Panels
6. Cable Management and Ladder Rack
7. Rack-mounted Power Equipment

B. Section does not specify fittings such as cables, cable terminations, or faceplates for structured cable system (SCS). These components are specified in the Division 27 Section "Communications Backbone Cabling" and Division 27 Section "Communications Horizontal Cabling".

C. Section does not specify fittings for audio video system(s). These components are specified in the Division 27 Section "Audio Video Systems" and "Broadcast Audio Video Systems".

1.02 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

B. Division 26 Section "Grounding and Bonding for Electrical Systems".

1.03 DEFINITIONS

A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.

B. Communications Equipment Room – This term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

C. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass

protection devices and fittings described in Article 770 “Optical Fiber Cables and Raceways” and Article 800 “Communications Circuits” of NFPA 70 “National Electrical Code”.

D. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19” or 23” inches.

E. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19” or 23” inches.

F. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.

G. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19” or 23” inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).

H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

I. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

J. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

K. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).

L. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building’s service equipment (power) ground.

1.04 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”, as well as the detailed Submittal requirements in Section “Structured Cabling System”. The following additional items shall be submitted:

B. Pre-Bid Phase:

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. "Pre-construction" submittal:

1. Shop Drawings:

a. Submit for review scaled layout drawings showing the layout of equipment racks, ground bars, wall mounted equipment and termination blocks, conduits, and ladder rack within telecom rooms. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.

2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
3. Submit manufacturers' cut sheets or catalog cut sheets for each product specified.

D. "Project Completion" submittal:

1. As-built Drawings:

a. Submit scaled layout drawings showing the layout of all equipment and pathways in telecom rooms with final identifiers if applicable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.

B. Communications equipment room fittings shall be listed by a NRTL.

1.2 WARRANTIES

A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PARTS AND MATERIALS

2.01 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:

    a) PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.
    b) TBC connecting the PBB to the main Electrical Service Ground.
    c) TBB connecting the PBB to all SBBs.
    d) All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.

2. Available Component Manufacturers:

    a) Chatsworth
    b) Cooper B-Line
    c) Erico
    d) Harger
    e) Hoffman
    f) Panduit

3. Conductor Manufacturers

    a) Shall be from the list of Component Manufacturers; or
    b) Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Primary Bonding Busbar (PBB)

1. Specifications

    a) All busbars shall have a clear cover installed to protect connections
    b) Cover shall be:

        1) Plexiglass or plastic
        2) Cover shall be printed with 3/8" lettering "PBB" using appropriate labels.
        3) Of the same manufacturer as the ground bar

    c) A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.

d) Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
e) Provide enough length for all connections with 25% growth.
f) Provided with insulators to electrically isolate busbar from mounting surface.
g) Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

a) Harger TGBIP14420TMGB
b) Chatsworth 40153-020
c) Or equivalent from Component Manufacturer

C. Secondary Bonding Busbar (SBB)

1. Specifications

a) Be a predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs
b) Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
c) Provided with insulators to electrically isolate busbar from mounting surface
d) Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

a) Harger TGBI14212TGB
b) Chatsworth # 13622-012
c) Or equivalent from Component Manufacturer

D. Ground Wire for TBB

1. Specifications

a) All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.
b) All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
c) Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
d) Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer’s name.
2) Copper Conductor Gauge.
3) UL listing.

e) Cable jacket shall be green with black lettering.
f) Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.

E. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.

1. Specifications

a) Shall be copper.
b) Insulated grounding wire with PVC insulation
c) A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
d) Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) NRTL listing information

e) Cable jacket shall be green with black lettering
f) A minimum conductor size as indicated on drawings

F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)

1. Specifications

a) Shall be copper.
b) When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
c) When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
d) Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name.
2) Copper Conductor Gauge.
3) UL listing.

e) Cable jacket shall be green with black lettering.

G. Connectors / Connections

1. Specifications

a) All connectors and connections shall utilize products that are Listed by a NRTL such as UL.

b) All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.

2. Compression Lugs

a) Specifications

1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
2) Shall include inspection port.
3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b) Manufacturer shall be:

1) Harger GECLB Series
2) Or Approved Equivalent

3. Conductor to conductor connection

a) Specifications

1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.

b) Manufacturer – Exothermic Weld

1) Erico CADWELD
2) Harger Ultraweld
3) Or Approved Equivalent

c) Manufacturer – Irreversible Compression connector

1) Burndy HYGROUND
2) Or Approved Equivalent

4. Connector for conduit to cable

a) Specifications

1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.

b) Manufacturer shall be:

1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe lamp
2) For less than 1" diameter conduits – Harger TBGC4SCS elctro tin-plated conduit bonding clamps
3) Or Approved Equivalent

5. Connector for conductor to cable tray

a) Specifications

1) For metallic cable trays that extend to the Telecommunications Room.

b) Manufacturer shall be:

1) Harger electro tin-plated cable tray bonding clamps – TBCTC
2) Or Approved Equivalent

H. Insulated Grounding Bushings

1. Specifications

a) All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
b) Shall be UL Listed for copper conductors.
c) Shall include lug for easy connection of conductor to PBB/SBB.

2. Manufacturer shall be:

a) O-Z/Gedney IBC-L
b) Or Approved Equivalent

2.02 PLYWOOD BACKBOARD

A. 4’ x 8’ sheets of 3/4” thick (minimum) A-C grade plywood be securely fastened to the supporting walls as indicated on the plans.

1. Plywood shall be installed with “A” side facing the interior of the room.
2. Plywood shall be fire-retardant with stamp visible when installed, fire-retardant and painted on all sides with two coats of white paint with the exception of the stamped area indicating that it is fire-retardant.
3. Plywood shall be mounted at 6” AFF and extend to 8’6” AFF.

2.03 TELECOMMUNICATIONS ENTRANCE PROTECTION

A. Surge Protection

1. The following manufacturers are Conditionally Approved:

a) Circa Telecom
b) Emerson Network Power
c) ITWLinx
d) TII Network Technologies
e) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. Horizontal Cable Surge Protectors – for 4-pair, Category 5e/6 horizontal cables that serve outlets exterior the footprint of the building, including, but not limited to, cables serving outlets that are mounted on roofs, exterior walls, light poles, and emergency phones/towers.

a) Requirements

1) Shall meet UL 497
2) Shall exceed TIA 568 Category 6 performance standards
3) Shall be capable of being used with POE+ applications

b) Wall-mount Protectors – for single cables, where quantity of cables in Equipment Room needing protection is 6 or less

1) Manufacturer shall be:

a) Emerson Edco CAT6-POE
b) ITWLinx SurgeGate Series CAT6-LAN

c) Rack-mount Protectors – where more than 6 cables in an Equipment Room require surge protection

1) Shall be rack-mountable in 19" wide equipment rack
2) Provide quantity of Category 6 protectors/modules required for install, plus 25% spare
3) Manufacturer shall be:

a) APC ProtectNet Chassis (PRM24) with Cat 6 Surge Modules (PNETR6)
b) Emerson Edco RM-CAT6-**POE

d) Far-end Protection: Wherever connected devices (such as cameras) do not have integral protection, provide the following at the far-end of the cable:

1) Blackbox CAT6 In-Line Surge Protector
2) Emerson CAT6-5POE-FF

2.04 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Two-Post Floor Rack

1. The following manufacturers are Conditionally Approved:

a) APC
b) B-Line
c) Chatsworth Products
d) Great Lakes
e) Hoffman
f) Middle Atlantic
g) Ortronics
h) Panduit
i) Or connectivity manufacturer carrying structured cabling warranty
j) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Requirements

a) Approximately 7’-0” in height with 45U available to mount panels/equipment.
b) Mounting rails shall be spaced 19” wide per ECA EIA/ECA-310-E. Mounting rails shall contain #12-24 tapped holes for patch panel applications. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
c) Two-post rack shall be minimum 14 gauge carbon steel construction and have a self-supporting base.
d) Finish shall be powder coat in black. Provide touch-up paint matching powder coat.
e) Minimum static load capacity: 1,000 lb
f) UL Listed
g) Secure rack to floor. Provide rack manufacturer’s rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions. Raised floor racks shall be mounted to sub or base floor with 5/8” threaded rods and steel brackets.
h) Provide 6” stand-off bracket accessory on top of rack to mount ladder rack.
i) Provide free standing relay rack accessories: rack base insulator kit, rack line-up spacer kit, rack base dust cover, equipment support bracket, equipment guard rail, and RMU Label Kit for a complete system meeting drawings and manufacturer instructions.

2.05 TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

A. General

1. All telecommunications termination blocks and patch panels shall be by the same manufacturer and covered under the same Advanced Structured Cabling System Warranty.

a) The following manufacturers are Conditionally Approved:
b) Refer to Advanced System Warranty sub-section of Division 27 “Structured Cabling System” for list of approved connectivity manufacturers
c) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

B. Rack-mount Modular - Copper Patch Panels

1. General Requirements for Patch Panels: Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
2. Patch panels shall be provided complete with all mounting hardware, jacks, retainers, wire guides, designation strips, etc.

3. Patch panels shall accept modular jacks of exactly one port, and this modular jack shall be the same type as being installed at the far-end faceplates.
4. Provide enough ports for the number of cables terminated on the patch panel, plus 25 percent spare. Provide all connector blocks', including plugs and jacks where required to fill each panel completely. Do not leave any blank openings.
5. Modular Patch Panels shall be of a metal design with snap in module frames for each individual jack.
6. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard EIA 19" racks.
7. Horizontal Cabling
    a) Four-pair Augmented Category 6 UTP cabling shall be terminated onto a four-pair Augmented Category 6 jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Augmented Category 6 standard.
8. Submit Manufacturer and part number as part of pre-construction submittals.

C. Rack-mount Optical Fiber Panels

1. Fully enclosed cable management type patch panel. Rack mountable in equipment cabinets/racks. Front and rear access (front access only for wall mounted). Complete with all necessary cable clamps, couplings and connector bulkheads.
    a) Optical fiber cables shall be terminated in cable management trays/modules.
    b) Cable management module/tray can accommodate optical fiber patch cable. Tray/module shall provide a means to avoid exceeding the cable manufacturer's minimum bending radius to protect against crimping or over bending.
    c) Cable management tray shall have labeling on the front of the tray.
    d) Optical fiber patch panels shall have a plexiglass latching front panel. Labeling and connectors shall be clearly visible with front panel open or closed.
    e) Optical fiber patch panels shall accept a variety of inter-changeable bulkheads including ST, SC, LC, FDDI as well as attenuators.
    f) Optical fiber patch panels shall provide a splice tray option.
2. Optical fiber termination method(s)
    a) Factory-terminated pigtail and with fusion splice
    b) Single-mode connectors:

1) Duplex single mode LC connectors and adapters. Color shall be blue. Suitable for use with specified single-mode optical fiber. Maximum insertion loss across mated pair: less than 0.75dB.

3. Submit Manufacturer and part number as part of pre-construction submittals.

2.06 TELECOMMUNICATIONS PATCH CABLES & CROSS-CONNECT WIRES

A. General

1. Supply all necessary patch cables and cross-connect wires as part of a complete and functioning telecommunications system to support voice, data, audio-video, security, and other miscellaneous systems.
2. The manufacturer of patch cables shall be the same as the telecommunications connectivity, unless otherwise specified.
3. All patch cables shall be factory-terminated and tested.

B. Fiber Optic Patch Cords

1. Singlemode

a) Connectors shall be LC on both ends.
b) Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:

1) Total quantity shall be 100% of the terminated ports, in the following lengths:

a) All shall be 7’-0”

c) Manufacturer shall be:

1) Same as fiber connectivity manufacturer
2) Submit product cutsheet for review

2.07 TELECOMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

A. Ladder Rack (Cable Runway)

1. Color: black
2. Rung Spacing: 9”
3. Width: 18”
4. UL Listed as an equipment grounding conductor
5. Provide ladder rack components such as e-bend, outside radius bend, and corner bracket for a complete system meeting drawings and manufacturer instructions.
6. Provide ladder rack supports such as wall angle support kit, triangular support bracket, center support kit, threaded rod, I-beam clamp, threaded ceiling kit, cabinet elevation kit, foot kit, rack mounting plate, rack elevation kit for a complete system meeting drawings and manufacturer instructions.

7. Provide ladder rack accessories such as cross member radius drop, end caps, and dividers for a complete system meeting drawings and manufacturer instructions.
8. The following manufacturers are Conditionally Approved:

    a) B-Line
    b) Chatsworth Products
    c) nVent/Hoffman
    d) Middle Atlantic
    e) Or connectivity manufacturer carrying structured cabling warranty
    f) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

B. Vertical Cable Managers

1. Manufacturer shall be the same as equipment racks and cabinets, unless otherwise noted.
2. Color: black
3. Size: as specified on drawings, or a minimum of 6" wide by 6" deep, whichever is greater.
4. The following manufacturers are Conditionally Approved:

    a) B-Line
    b) Chatsworth Products
    c) Ortronics
    d) Panduit
    e) Or connectivity manufacturer carrying structured cabling warranty
    f) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

C. Horizontal Cable Management

1. Manufacturer shall be the same as copper connectivity manufacturer.
2. Color: black
3. Size: 1RU or 2RU, as shown on the drawings.
4. The following manufacturers are Conditionally Approved:

    a) Belden
    b) Hubbell
    c) Leviton
    d) Ortronics
    e) Panduit
    f) Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 GROUNDING AND BONDING INSTALLATION

A. General:

1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. "Daisy chaining" of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color
    a) Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
    b) Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
6. Follow additional installation requirements from NECA/BICSI 607-2011 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings".

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (if applicable) to the PBB. Conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the SBB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):

    a) An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

3.03 TELECOMMUNICATIONS ENTRANCE PROTECTION INSTALLATION

A. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8.

1. Exception: Service providers will provide and install primary protectors on service entrance cabling.

B. Install grounding wire as straight as possible from terminal to Grounding Bar.

C. UON, mount all protection devices on wall surface in a manner sufficient to support the weight, and to sustain incidental contact.

D. Protector housings shall stack vertically.

E. Grounding and Bonding of Entrance Conduits

1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.
2. Bonding conductors shall be connected to the appropriate bus bars as specified in this Section and in accordance with NEC chapter 8.
3. Connect the grounding conductor from the protection devices directly to the PBB/SBB as specified in this Section and in accordance with the NEC and the manufacturers' recommendations.
4. Verify grounding means exist at each end of the circuit as required by the NEC. If no grounding means exists then provide all connections required by the NEC.

3.04 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES INSTALLATION

A. Wall cabinets, racks, frames, and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).

B. Tags/labels shall be placed on each equipment rack, cabinet and frame in accordance with specification Division 27 Section ""Common Work Results for Communications"

3.05 CABLE LADDER RACKING

A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568C & 569, NFPA 70 (National Electrical Code), NEMA VE2, and applicable local codes.

B. Install cable ladder racking level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

C. Install cable ladder racking where indicated in the drawings and as required by these Specifications

D. Corner clamp brackets shall be used to join sections of cable ladder rack that are perpendicular to each other.

E. Cable ladder rack stringers shall be attached to plywood backboards with angle brackets and "J" bolts.

F. End supports and stringer junction brackets shall be used to attach vertical cable ladder segments to the floor.

G. Stringer junction brackets shall be used to attach end to end horizontal cable ladder rack segments.

H. Open ended stringer segments shall be closed with corner clamps and end bars.

I. Mounting plates and "J" bolts shall be used to attach the cable ladder racking to the relay racks or equipment cabinets.

J. Runway should be supported every 5 feet on center with 1/2 inch diameter threaded rod with slotted hanger clamps, or applicable support brackets or attachments. All wall brackets shall be attached to plywood backboard.

K. A support shall also be placed within 24 in. on each side of any connection to a fitting.

3.06 CABLE MANAGEMENT AT EQUIPMENT RACKS AND CABINETS

A. Install cable organizers and/or cable channel on equipment racks and within cabinets at locations as described in the Specifications and/or indicated on the Drawings.

3.07 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS

A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.

B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

C. Equipment racks, cabinets and distribution frames shall be assembled and installed as per the manufacturers' printed instructions.

END OF SECTION

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PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. Provide a complete intra-building (premises) backbone cabling system in accordance with these Contract Documents. Including but not limited to, the following:

1. Optical Fiber Cables
2. Splices (where required by these Contract Documents)
3. Necessary installation and supporting hardware.

1.02 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section “General Communications Requirements”

B. Division 27 “Common Work Results for Communications”

C. Division 27 “Structured Cabling System”

D. Division 27 Section “Telecommunications Equipment Room Fittings”

1.03 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.04 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568, when tested according to test procedures of this standard.

1.05 CODES, REFERENCES, AND STANDARDS

A. Follow all applicable codes, references, and standards listed in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

1.06 GUIDELINES

A. Follow all applicable guidelines listed in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

1.07 QUALITY ASSURANCE

A. Refer to Division 27 Section “Structured Cabling System” for Quality Assurance requirements.

1.08 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”, as well as the detailed Submittal requirements in Section “Structured Cabling System”. The following additional items shall be submitted:

B. Pre-Bid Phase:

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. “Pre-construction” submittal:

1. Shop Drawings:

a) Submit for review scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and proposed cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.

2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
3. Submit manufacturers’ cut sheets or catalog cut sheets for:

a) Each of the cables specified:

1) Cut sheets shall include the following information at a minimum:

a) Manufacturers name and logo
b) Cable outside diameter
c) Number of conductors/strands in each cable and binder group

d) Gauge or strand thickness
e) Minimum transmission performance rating
f) Cable jacket material and rating
g) Maximum pulling tension
h) Jacket/Sheath color
i) Individual conductor or strand insulation colors
j) Minimum bend radius

i) During installation and post installation.
ii) As well as any additional information required by individual sections of this Division.

D. "Project Completion" submittal:

1. As-built Drawings:

a) Submit scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and final cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.09 WARRANTIES

A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS AND MATERIALS

2.01 SINGLE MODE OPTICAL FIBER CABLE

A. Requirements

1. See Division 27 and backbone (riser) diagram(s) on the Drawings for required fiber counts.
2. Cable shall meet the transformation performance and physical specifications of ANSI/TIA-568.
3. Cable jacket marking: Shall be legible and shall contain the following information:

a) Manufacturer's name and trade mark
b) Fiber size
c) Fiber Grade
d) UL listing (Shall be suitable for the application)
e) Sequential length markings

4. Cable jacket color shall be:

a) YELLOW for single-mode fiber optic cables

5. Low water peak fiber construction
6. Dispersion shifted fiber optic construction
7. Maximum allowable attenuation (db/km) is 1.0 at 1310nm and 1.0 at 1550nm.
8. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in "wet" locations

B. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in "wet" locations

1. Cable shall have an overall armor of steel or aluminum

a) Cable jacket shall be plenum (OFNP | OFCP) rated.
b) Intra-building; cables that remain within the envelope/footprint of the building that are installed within pathways defined to be in "wet" locations
c) Manufacturer shall be:

1) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

C. Intra-building; cables that remain within the envelope/footprint of the building that are installed within pathways defined to be in "wet" locations

1. Cable shall have an overall armor of steel or aluminum

a) Cable jacket shall be outside plant only cable and suitable for installation in such environments.
b) Cable jacket rating shall be consistent with manufacturer's requirements to be covered under warranty specified.
c) Manufacturer shall be:

1) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.02 SPLICES (SPLICE CASES)

A. In general, optical fiber cables are not to be spliced except where indicated otherwise in the Drawings and Specifications.

1. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for splicing requirements integral to rack-mounted enclosures.

B. Where splicing is indicated in the Drawings and Specifications, multi-mode and single-mode optical fiber cable splicing shall be fusion spliced. Provide splice case with trays to accommodate all fiber strands that enter case.

C. Multi-mode and single-mode optical fiber cables shall be spliced at points indicated on the Drawings.

1. End caps with hole configurations to meet cable sheath diameters without filters.
2. Plugs for all unused end cap holes.
3. Trays shall be used to hold all splices.
4. Optical fiber cables shall be labeled between 6" and 12" from their entry to the splice case.

D. Maximum allowable loss for splices is 0.3 db.

E. Manufacturer shall be:

1. Preformed Line Products – Coyote Fiber Optic Closures series
2. Or approved equivalent

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 CABLE INSTALLATION

A. General:

1. Place all backbone cabling in accordance with these specifications, on the Drawings and as indicated on any cable schedules.
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
    a) There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
    b) There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/cable ladder system. Refer to the Telecommunications floor plan and detail drawings for the layout of the conduits, cable tray and cable ladder.
    a) Backbone cables in which no portion of the cable jacket will be exposed when routed in a plenum or other air handling space, shall be riser rated (CMR, MPR, OFNR, or OFCR). Cables suitable for use in air plenums or other air handling spaces, and which meet the electrical/transmission specifications, are also acceptable for riser applications.

b) Backbone cables in which any portion of the cable jacket will be exposed when routed in an air plenum or other air handling space shall be plenum (CMP, MPP, OFNP, or OFCP) rated.
c) Backbone cables installed in "wet" locations as defined by the NEC or in these construction documents shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
d) Backbone cables routed vertically within a Telecommunications Room shall be supported by velcro-attachment every 18" to vertically-mounted ladder rack or D-rings.

4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

   a) Except when supported by ladder racking or D-rings within each Telecommunications room, UON.

5. All backbone cables running on ladder racking within all Telecommunications rooms throughout the building shall be neatly placed and secured to the horizontal and vertical ladder racking with cable lacing twine or nylon wire ties at intervals not to exceed every third rung plus all locations where the cable changes direction.
6. At the same time backbone cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
7. Do not install kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Where distance allows all backbone cables shall be provided with slack/service loops at each end of the cable. Each slack/service loop shall be:

   a) A minimum of (10) feet in length, UNO
   b) Configured in a loosely formed figure eight configuration (ie. not coiled)

9. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
10. Comply with all referenced standards and guidelines
11. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the

performance or physical characteristics of the cable jacket or insulation over time.

12. Where backbone cabling has a shield or metallic member, the shield or metallic member shall be bonded to the TMGB/TGB in accordance with ANSI/TIA-607 and BICSI/NECA 607-2011.

B. Outside plant cable installation: for cables placed in "wet locations". These locations include but are not limited to; pathways that extend outside the envelope of the building such as aerial entrances, direct buried cables, underground conduits, conduits embedded in, or routed below a ground floor slab, etc.

1. Unlisted cables shall transition to an indoor rated cable within 50' of the entrance point as required the NEC.

   a) This 50' allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)

2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling spaces nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.

   a) These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50' of the transition point to indoor rated cabling in accordance with the NEC.
5. Cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings".

3.03 OPTICAL FIBER CABLE INSTALLATION

A. General:

1. Place all optical fiber backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
2. Splices between optical fiber cables are permitted only at those locations indicated on the Drawings.
3. Splices between riser rated optical fiber cables and factory connectorized pigtails are permitted, but not required at each fiber termination location indicated on the Drawings. Pre-terminated riser cables meeting the material specifications may be utilized.

4. Comply with all referenced standards and guidelines.

B. Pre-installation testing:

1. Optical fiber cables: Perform visible light continuity check on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.

C. Optical Fiber Backbone Cables:

1. Place between the optical fiber Main Distribution Frame (MDF) and the Telecommunications rooms as noted in the cable schedules and the Drawings.
2. Optical fiber cable is to be installed within inner duct at all locations where it is within nominal 4-inch conduit (not including short conduit sleeves.)
3. Support optical fiber riser cables with suitable support grips. After being supported, the optical fiber cables will be routed over to the optical fiber patch panel in that particular Telecommunications room.

3.04 OPTICAL FIBER MAIN DISTRIBUTION FRAME

A. Optical fiber cables shall be routed to the Fiber MDF from each of the Telecommunications Rooms via conduits, trays and riser sleeves. See the Drawings.

B. Optical fiber cables shall enter the Fiber Distribution Frame from the top of the frame and then routed to the connector and splice modules/shelves.

3.05 CABLE IDENTIFICATION

A. Label all backbone cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.

B. Cables shall be labeled within 6” at each end and within each pullbox.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or equivalent

3.06 CABLE TERMINATIONS

A. Terminate all backbone cabling specified in accordance with Division 27 Section “Communications Equipment Room Fittings”, No cables shall contain unterminated elements UON.

3.07 CABLE TESTING

A. Refer to Division 27 Section “Structured Cabling System” for testing requirements.

3.08 ACCEPTANCE

A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or strand is found.

END OF SECTION

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PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. Provide a complete Category 6A horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents.

B. This section specifies the following:

1. Horizontal Copper Cable
2. Copper Connectivity
    a) Faceplates
    b) Surface Box
    c) Jacks/plugs/inserts
3. Power Over Ethernet Extenders

1.02 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"

B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.

C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.

D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.

E. Category 6 and fiber cabling and connectivity for Audio Video Systems (as required by the TA drawings) are specified in Division 27 Section "Telecommunications Requirements for Audio Video Systems".

1.03 CODES, STANDARDS, AND GUIDELINES

A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:

1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
2. IEEE NESC - "National Electrical Safety Code"

3. ANSI/BICSI 005 – "Electronic Safety and Security System Design and Implementation Best Practices"
4. ANSI/NECA/BICSI-607 – "Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings"
5. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
6. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
7. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
8. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
9. BICSI – "Telecommunications Distribution Methods Manual"
10. BICSI – "Information Technology Systems Installation Methods Manual"
11. IEEE 142 – "Recommended Practice for Grounding of Industrial and Commercial Power Systems" (Green Book)
12. IEEE 1100 – "Recommended Practice for Powering and Grounding Electronic Equipment" (Emerald Book)

1. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"

13. TIA-TSB-140 – "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems"

1.04 DEFINITIONS

A. Advanced System Warranty – refer to Division 27 Section "Structured Cabling System".

B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.

D. Horizontal Cabling

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

a) Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
b) Bridged taps and splices shall not be installed in the horizontal cabling
c) Splitters shall not be installed as part of the optical fiber cabling

2. A work area is approximately 100 sqft (9.3 sqm), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
3. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meter). This maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) in the horizontal cross-connect.
4. Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.

E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

1.05 QUALITY ASSURANCE

A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.

B. All testing equipment used shall have the latest version of software and/or firmware installed prior to testing any cabling. Testing equipment shall also undergo all manufacturers' required and recommended routine maintenance.

1.06 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements"

B. Pre-bid submittal

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Pre-construction submittal

1. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)
2. Submit manufacturers' cut sheets or catalog cut sheets for:

    a) Each of the cables specified. Cut sheets shall include the following information at a minimum:

        1) Manufacturers name and logo
        2) Cable outside diameter
        3) Number of conductors/strands in each cable and binder group
        4) Gauge or strand thickness
        5) Minimum transmission performance rating
        6) Cable jacket material and rating
        7) Maximum pulling tension
        8) Jacket/Sheath color
        9) Individual conductor or strand insulation colors
        10) Minimum bend radius

            a) During installation and post installation.
            b) As well as any additional information required by individual sections of this Division.

    b) Faceplates and modules. Cut sheets shall include the following information at a minimum:

        1) Manufacturers name and logo
        2) Material type
        3) Performance rating
        4) Physical Dimensions
        5) Color

    c) Product information of test equipment to be used for the testing of cabling.

    d) Provide documentation indicating manufacturer required and recommended maintenance and calibration services and intervals at which these services shall be performed.

        1) Provide documentation indicating the dates at which all testing units have undergone these services. For services required on a daily or pre-test basis provide documentation on the procedures the contractor will undergo for performing such services.

3. Shop Drawings

    a) Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system

number identified), furniture feed points, and fiber optic termination panels are to be installed.

b) Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks to be installed (including those to accommodate 25% growth).

c) Each individual outlet on the drawings shall have proposed outlet identification indicated.

d) Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.

4. Testing

a) Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.

b) Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals for all parameters shall be from printed manufacturers' cut-sheets or other manufacturers' printed material.

c) Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.

5. Sample warranty information as indicated herein and elsewhere in this Division.

D. Project completion submittal

1. As-built Drawings

a) Submit scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels have been installed.

b) Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks installed (including those to accommodate 25% growth).

c) Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.

2. After approval by the Owner, submit the test results in computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.

3. Advanced Structured Cabling System Warranty Certificate

1.07 WARRANTIES

A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS AND MATERIALS

2.01 HORIZONTAL (WORK AREA) COPPER CABLE

A. Horizontal cables for dry environments

1. Requirements

a) Unshielded Twisted Pair (UTP)
b) Minimum performance specifications: Cable shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
c) Four pairs of 22-24 AWG solid copper conductors
d) Cable jacket color(s) shall be

1) Blue for general data cabling
2) Yellow for security cabling
3) White for wireless access point cabling

e) Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) Pair Count
4) UL and CSA listing
5) Manufacturer's trade mark
6) Category rating
7) Sequential distance markings, in one foot increments

f) Individually insulated conductors under a common sheath
g) Plenum (CMP or MPP) rated.

2. Manufacturer shall be:

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Horizontal cables for Wet Locations (as defined in Division 27 Section "Structured Cable System")

1. Requirements

a) Suitable to be in contact with standing water
b) Cable construction shall be consistent with manufacturer's requirements to be covered under warranty specified in Division 27 Section "General Communications Requirements".

c) Minimum performance specifications: Cable shall meet requirements for Augmented Category 6 of ANSI/TIA-568.

d) Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) Pair Count
4) UL and CSA listing
5) Manufacturer's trade mark
6) Category rating
7) Sequential distance markings, in one foot increments

2. Product shall be:

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.02 FACEPLATES FOR COPPER CONNECTIVITY

A. Single-gang faceplate:

1. Requirements

a) High impact nylon with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
b) Color shall match electrical, U.O.N. by owner
c) Single gang, U.O.N

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Double-gang faceplate:

1. Requirements

a) High impact nylon with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
b) Color shall match electrical, U.O.N. by owner
c) Double gang, U.O.N

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

C. Weatherproof faceplate:

1. Requirements

a) Water resistant faceplate (to IP56 rating, or equivalent) with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
b) With in-use cover

2. Product shall be:

a) Panduit Mini-Com Water Resistant Faceplate with integral cover.
b) Hubbell RW57300 (Or Approved Equivalent) with decora-insert and jacks from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements).

D. Surface mount box

1. Requirements

a) With number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
b) Mount into backbox, U.O.N

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.03 COPPER CONNECTIVITY

A. Modular jacks

1. Requirements

a) Outlets shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
b) All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
c) Outlet hardware shall be UL listed.
d) One port
e) Color shall match electrical, U.O.N. by owner

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Field termination plugs

1. Requirements

a) Outlets shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
b) All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
c) UL Listed: UL 2043 (plenum)

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

C. Blank inserts

1. Requirements

a) Provide blank modules to fill any unused openings in faceplates
b) Color shall match other jack colors

2. Product shall be

a) Submit product data from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.04 POWER OVER ETHERNET EXTENDER

A. General:

1. Shall be utilized where noted on drawings and for any work area outlets that requires a Category 6 connection, where the cable distance exceeds 295 feet.
2. The Power over Ethernet (PoE) extender system shall provide the capability to upgrade a channel of a standard Ethernet switch to deliver PoE (IEEE 802.3af), PoE+ (IEEE 802.3at), or HPoE (non-standard) over a composite fiber/power cable.
3. The system shall utilize an external power injector at the source end.
4. The system shall provide power that is compliant with the requirements of a Class 2 Power Source per NFPA 70 or CSA C22.1 and be listed as such.
5. The system shall be comprised of a power injector and converter that generates and injects DC power and converts electrical signals to optical signals in the head end room, a receiver that converts the optical signals back to electrical signals and acts as a power supply for Power Over Ethernet at the work area outlets, and a composite cable for both fiber optic and copper power elements.

B. Media Converters - Power Source Devices

1. Shall be capable of being mounted on a horizontal or vertical surface or rack-mount bracket or chassis. Chassis modules shall take power from a common power supply.
2. The operating temperature range shall be 0°C to 40°C (32°F to 104°F).
3. The Power over Ethernet capabilities shall be:

a) Input voltage range 100 – 240 VAC.
b) Complies with the universal IEEE 802.3at PoE endpoint standard, supplying PoE to class 0, 1, 2 and 3 devices or PoE+ to class 0, 1, 2, 3 and 4 devices.

4. Product shall be

a) Berk-Tek One Reach
b) Commscope Powered Fiber

C. Media Converters – Work Area Outlet Devices

1. Shall accept power from power source equipment at head end.
2. Shall be available in 1 and 2 port modules.
3. Remotes shall be placed in enclosures/boxes suitable for the environment such as NEMA Type 1 (indoors, typical) or NEMA Type 3R (outdoors, typical).
4. The operating temperature shall be -40°C to 50°C (-40°F to 122°F).
5. Product shall be

a) Berk-Tek One Reach
b) Commscope Powered Fiber

D. Hybrid Optical Fiber/Copper Cable

1. The cable shall be a composite, containing single-mode fibers and solid copper conductors of size 12 AWG.
2. Outdoor rated.
3. Product shall be

a) Berk-Tek One Reach
b) Commscope Powered Fiber

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 CABLE INSTALLATION

A. General

1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.

a) There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
b) There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.

1) Horizontal cabling shall be terminated in a Telecommunications room that is on the same floor as the

area (outlet) being served in accordance with ANSI/TIA-568.

2) No horizontal Category cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.

3) Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.

3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.

   a) All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON

   b) Horizontal cables installed in "wet" locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.

4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.

   a) Except when supported by ladder racking within each Telecommunications room, UON.

5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
7. Comply with all referenced standards and guidelines.
8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:

   a) A minimum of 8 feet (2.44 meter) in length, UNO

b) Configured in a loosely formed figure eight configuration (i.e. not coiled)

10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.

B. Outside plant cable installation: for cables placed in "wet locations" or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)

1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.

a) This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)

2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.

a) These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
5. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings"

C. Horizontal (work area) Cables:

1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.

2. Install all horizontal cables in accordance with Division 27 Section "Common Work Results for Communications" and as indicated on the drawings.

3.03 CABLE & WIRE INSTALLATION

A. General:

1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.

B. Station Cables:

1. Install station cabling, outlets and jacks as detailed in the horizontal cable placement schedules and the Drawings. The typical configuration for outlets shall be two unshielded twisted pair (UTP) cables of 4-pairs each, unless otherwise noted on the drawings or the Horizontal Cable Placement Schedules.

C. Cables located in "wet" locations

1. Provide all required entrance protection in accordance with Division 27 "Communications Equipment Room Fittings".
2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section "Communications Horizontal Cabling"
3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution. Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.

    a) Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.

D. Elevator Phone Cables:

1. Install elevator phone cables to support communications to each individual elevator cab. These cables will be run from each elevator's respective elevator equipment room to the nearest Telecommunications room as shown on the Drawings. Leave 15 feet (4.47 m) of coiled slack in the elevator equipment room junction box for eventual termination by the elevator contractor.

3.04 CONNECTOR INSTALLATION

A. Furnish and install all cable connectors as shown on the Drawings.

B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.

C. The provision and termination of connectors from each cable shall be done as follows:

1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

D. Copper Connector Installation

1. Terminate all four pairs of each cable on one outlet jack.
2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
3. The provision and termination of connectors for each cable shall be done as follows:

a) Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
b) All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

3.05 FLOORBOX LOCATIONS

A. Refer to Division 27 "Common Work Results for Communications" for size, type, and specifications.

1. Provide appropriate mounting brackets (as required), faceplates, modular jacks, inserts, mounting frames and cabling required to fully populate and provide a fully functional system.

B. For slab-on-grade floorbox locations, coordinate with the Common Work contractor to extend underground or in-slab conduit all of the way to the serving Telecommunications Room. If that is not practical, coordinate with Common Work contractor on stub-up location and overhead enclosure size/location to transition OSP (wet-rated) cable to plenum-rated cable.

1. Note underground conduit routing and overhead transition point locations on pre-construction shop drawings and Record Drawings.

3.06 FACEPLATE INSTALLATION

A. Furnish and install all faceplates in locations as shown on the Drawings.

3.07 CABLE IDENTIFICATION

A. Label all horizontal cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.

1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.

B. Cables shall be labeled within 6" at each end.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or equivalent

3.08 CABLE TERMINATIONS

A. Terminate all horizontal cables in accordance with Division 27 Section "Communications Equipment Room Fittings". No cables shall contain unterminated elements UON.

3.09 CABLE TESTING

A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.010 ACCEPTANCE

A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found.

END OF SECTION

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PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

A. These specifications and the associated TA series drawings describe the audio-video (AV) systems (hereafter referred to as the "Technical System") requirements to be furnished and installed as a portion of the project scope of work.

B. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.

C. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.

D. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project's Architect, Structural Engineer, and Design Consultant.

E. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.

1. Provide related low-voltage "on/off" AC power control system wiring, low-voltage "on/off" control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:

1. Division 27 Section "General Communications Requirements"
2. Division 27 Section "Common Work Results for Communications"

B. This section is a parent section to all sections numbered 274101 through 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.

1.03 EXAMINATION OF SITE

A. This project is a new facility.

B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work.

C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in their proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.04 MATERIAL AND WORKMANSHIP

A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.

B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.

C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.05 ORDINANCE AND CODES

A. Comply with all applicable national and local codes and ordinances and obtain all required permits.

B. Contractor shall be responsible for any and all violations within the scope of this work.

1.06 DEFINITIONS

A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.

B. Suspension System – A unique assembly of rated hardware elements and accessories required for overhead installation (and attachment to building structure) of loudspeakers and other technical system components. Elements of a suspension system may include: wire rope, shackles, eyebolts, chain, beam clamps, strut channel, etc.

1.07 QUALITY ASSURANCE

A. Contractor General Qualifications:

1. Compliance with the requirements of Division 1.
2. Licensed to perform work of this type in the project jurisdiction.
3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.
4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
5. Active membership in the National Systems Contractors Association (NSCA).
6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
    a) AVIXA APEX certification.
7. Fully staffed and equipped maintenance and repair facility.
8. Factory-authorized dealer for the major components specified.

B. Contractor Personnel Qualifications:

1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager and shall attend all scheduled project meetings.
    a) Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.
    b) Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
    c) Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

d) Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network-based AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary testing of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

e) Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.

C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

1.08 SUBMITTALS

A. Refer to requirements in Division 27 Section "General Communications Requirements".

B. Include the following items specifically as it relates to AV:

1. Submittal #1: AV System Product Data (Pre-Construction). A separate product data submittal is required for each specification section, i.e., 274100, 274116, etc.

   a) Equipment List (1A)
   b) Manufacturers' cut sheets (1B)
   c) Product Substitutions (1C)
   d) Project Implementation Schedule (1D)

2. Submittal #2: AV System Shop Drawings (Pre-Construction)

   a) AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section "Common Work Results for Communications". Indicate locations of all devices and equipment.
   b) Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.

c) AV Control System (2C) - AV control system panel/screen layouts suitable for the Owner's Representative to understand the operation and flow (submitted no less than five months prior to system first use).

d) DSP Signal Flow (2D) - DSP signal flow configuration (submitted no less than three months prior to system first use).

3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)

a) Structural Details (3A)

1) No Suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.

2) For Suspended equipment provide detailed, dimensioned drawings of each Suspension hardware assembly. Also indicate location relative to structure, location relative to other component(s) (Technical System or otherwise), configuration of suspended components, attachment to structure, suspension method, and calculations.

a) Calculations shall include weights of Technical System equipment including suspension hardware, and details of all suspension hardware including: manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.

3) Prior to submission, these drawings must be approved and signed/sealed by a structural engineer licensed for the location of the project. The following guidelines are applicable:

a) Contractors participating in the Suspension of Technical System components shall conform to industry best practice standards as set forth in:

i) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14); and

ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and

iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).

b) All Suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).

b) Equipment Rack Shop Drawings (3B) - Equipment rack front elevation for each rack showing equipment, panel layout, and electrical circuiting.

c) Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.

d) Millwork Shop Drawings (3D) - Sound console and mobile cart millwork details, and related equipment and panel layout (submitted no less than three months prior to the installation of other millwork).

4. Submittal #4: AV System Test Results (Prior to Substantial Completion)

a) Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.

5. Project Closeout

a) Refer to Division 27 Section "General Communications Requirements" and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.

6. Refer to child sections for additional requirements.

1.09 SUBSTITUTIONS

A. Refer to Division 27 Section "General Communications Requirements".

1.010 ELECTRONIC FILE SHARING

A. Refer to Division 27 Section "General Communications Requirements" for information on obtaining electronic versions of the construction drawings.

1.011 PROTECTION OF WORK

A. Protect all work, materials, and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner's Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.

B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminates. Clean

all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.

1.012 TEMPORARY TECHNICAL SYSTEM

A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.013 WARRANTY

A. Warrant all work executed under this contract, including all in-shop and onsite material, parts, and labor, for a period of twelve months after the date of final acceptance.

1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.

B. The warranty services are limited to normal business hours unless additional agreements are made between the Owner's Representative and the contractor.

C. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.

D. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.

E. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

F. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner's Representative and Design Consultant.

G. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise designated, provide all of one type of equipment from one manufacturer. For example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.

B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by substituted equipment.

C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.

D. All equipment shall be new and of professional quality.

E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.

F. Each software programmable device furnished (i.e., digital signal processor, control system, etc.) shall include most recent software and appropriate computer interface (wired cable or wireless). Cable, software, source (uncompiled) code and all related aspects of all software-controlled equipment shall become the property of the Owner and will be furnished as a portion of the Operation & Maintenance (O&M) Data manuals (see Operation & Maintenance Manuals near the end of Part 3).

G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.02 DATA PATCH PANELS & ACCESSORIES

A. Data Patch Panels are acceptable for use in Ethernet, audio network, AVLAN, and digital multimedia network applications as required to provide a complete technical system.

2.03 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

A. Where applicable, touch screen control interfaces shall follow the guidelines outlined in the “Dashboard for Controls” documents created on behalf of AVIXA International. Reference the Design Guide, Design Reference, and Integrators Guide for this project. Documents are available for download on the AVIXA web site.

B. Contractor shall be responsible for complete configuration of the control system features including touch screen layouts, button configuration, colors, appearance, operation, and coordination with systems external to the Technical System.

C. Participate in planning meeting(s) (web/phone) with Design Consultant and Owner's Representative to review programming concepts and requirements before commencement of work.

D. Panel layout and navigational flow concepts shall be developed during planning meeting(s) with Design Consultant and Owner's Representative.

E. Refer to submittal requirements for additional information.

F. This specification describes the initial programming concepts and requirements. Account for one (1) distinct change for revisions requested by the Owner's Representative after the system is substantially complete.

G. Touch screen and keypad overall user interfaces shall comply with the following minimum requirements:

1. A common theme shall be employed and used with consistency throughout the layouts. Theme shall be discussed with the Owner's Representative. The Owner's standard theme template shall be used if available.
2. Where Owner logos or colors are used, Owner branding guidelines shall be followed. Trademarks shall be used appropriately. Official graphical representations (logos, word marks, logotypes, etc.) may not be altered. Owner colors shall utilize official and exact color (Pantone, CMYK, RGB, hex, etc.) as provided by the Owner, visual matching is not allowed. Content shall be obtained from an official and authorized source, e.g., the use of content from Google images is not appropriate. Owner branding is encouraged where appropriate; however, proper use and compliance remains the responsibility of the Contractor.
3. The use of a password hierarchy shall be employed as directed by the Owner's Representative as they deem appropriate.
4. Power ON/OFF sequence shall control all applicable devices. Sequence time shall be the required time for all controlled devices to cycle. Where applicable, projector lamp warm-up and cool-down period shall be taken into account. Shutdown shall utilize two-step verification.
5. Animated activity indicators (spinning ring, progress bar, etc.) shall be utilized to provide visual feedback while the system is processing tasks in the background. This will prohibit multiple button presses by the user and show feedback that the control system is processing the request. Relevant text shall be utilized where appropriate, e.g., "Please wait while the system shuts down."
6. Source selection shall be available for all devices. Sources shall be laid out and grouped in a logical manner.

7. Button presses shall show instant visual feedback that they have been engaged and shall accurately reflect the response received from the device being controlled.
8. Current system status shall be always visible and be consistent across all adjoined screens. Buttons shall show current status (engaged or disengaged) via color, illumination, outline, greyscale, etc. as relevant. Sliders and level indicators shall show current and true system status (i.e., show true level based on system feedback, not status based on last touch screen input) via color, knob location, percentage, etc. as relevant.
9. Volume control of wired microphones, wireless microphones, and/or AV system program volume levels shall be discrete and shall be properly interfaced with the DSP (where applicable).
10. Where applicable, show the current operation mode. For example, in the case where two rooms combine/separate, the word "Combined" or "Separated" shall be displayed on each applicable screen.

2.04 CABLE - BULK

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

B. Product must be procured from the original cable manufacturer.

C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.

D. Where cable is run exposed (such as in ceiling plenums, cable trays, chases, or below accessible floors):

1. Verify which locations do and do not require plenum-rated cable.
2. Furnish the appropriate cable type.
3. Obtain written authorization from the Architect (or the Architect's designated Engineer) in this regard.

E. Category cabling:

1. Refer to Division 27 Section "Structured Cabling System" for product information and additional installation requirements.

F. Twisted Pair – Shielded: Twisted pair, shielded 22 AWG cable; interior rated 2 conductor cable with drain wire suitable for microphone, line, or production intercom level circuits:

1. Communications plenum rated cable (CMP) is suitable for use in all environments including environmental air plenums as defined per NEC Article 800.
    a) The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 800, local codes, and the connected equipment manufacturer's listed requirements.
    b) Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut sheets.
2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
3. 22 AWG/CMP: 22 AWG Communications Plenum rated bare copper conductor cable:
    a) Belden 9451P or 6500FC; or
    b) Clark Wire SPA22GSP; or
    c) Gepco IP222AL or 61801HS; or
    d) West Penn 25291B.
4. 22 AWG/CMR: 22 AWG Communications Riser rated bare copper conductor cable:
    a) Belden 8451 or 9451 or 5500FE; or
    b) Clark Wire SPA22GS; or
    c) Gepco IR222AL or 61801 or 61801EZ; or
    d) West Penn 291 or 452.
5. 22 AWG/CMP/MC: 22 AWG Communications Plenum rated bare copper multi-conductor cable, individually shielded pairs, color coded (not for interconnection within equipment racks):
    a) 4 pair:
        1) Clark Wire 22EPS4P; or
        2) Gepco 6604HS.
    b) 3 pair:
        1) Belden 6542PA.
    c) 2 pair:
        1) Belden 6541PA or 9451DP.
6. 22 AWG/CMR/MC: 22 AWG Communications Riser rated bare copper multi-conductor cable, individually shielded pairs, color coded (not for interconnection within equipment racks):
    a) 4 pair:
        1) Belden 1815R; or
        2) Clark Wire 704; or

3) Gepco GA61804GFC.

b) 3 pair:

1) Belden 8777; or
2) West Penn D431.

c) 2 pair:

1) Belden 9451D; or
2) Clark Wire RS22G2; or
3) Gepco D61801EZGF; or
4) West Penn 77510.

G. Twisted Pair – Unshielded: Twisted pair, 2-conductor interior installation loudspeaker cable:

1. Class 3 remote-control, signaling, and power-limited plenum rated cable (CL3P) is suitable for use in all environments including environmental air plenums as defined per NEC Article 725.

a) The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 725, local codes, and the connected equipment manufacturer's listed requirements.
b) Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut sheets.
c) Wire gauge shall not be reduced to gain a higher cable rating.

2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
3. ** AWG/CL3P: As listed AWG Class 3 Plenum rated bare copper conductor cable:

a) Belden 1862A or 6200UE (16 AWG), 6300UE (18 AWG); or
b) Gepco IP122BA19 (12 AWG), IP142BA19 (14 AWG), IP162BA19 (16 AWG), IP182BA7 (18 AWG); or
c) West Penn 25210 (10 AWG), 25227B (12 AWG), 25226B (14 AWG), 25225B (16 AWG), 25224B (18 AWG).

4. ** AWG/CL2P: As listed AWG Class 2 Plenum rated bare copper conductor cable:

a) Belden 6T00UP (10 AWG), 1860A or 6000UE (12 AWG), 1861A or 6100UE (14 AWG), 1863A (18 AWG); or
b) Clark Wire CW1202P (12 AWG), CW1402P (14 AWG), CW1602P (16 AWG), CW1802P (18 AWG).

5. ** AWG/CL3R: As listed AWG Class 3 Riser rated bare copper conductor cable:

a) Belden 5000UE (12 AWG), 5100UE (14 AWG), 5200UE (16 AWG), 5300UE (18 AWG); or
b) Clark Wire CW1202HS (12 AWG), CW1402HS (14 AWG); or
c) Gepco IR122BA19 (12 AWG), IR142BA19 (14 AWG), IR162BA19 (16 AWG), IR182BA7 (18 AWG); or
d) West Penn 227 (12 AWG), 226 (14 AWG), 225 (16 AWG), 224 (18 AWG).

6. ** AWG/CL2R: As listed AWG Class 2 Riser rated bare copper conductor cable:

a) Clark Wire CW1202 (12 AWG), CW1402 (14 AWG), CW1602 (16 AWG), CW1802 (18 AWG).

7. ** AWG/CL3: As listed AWG Class 3 rated bare copper conductor cable:

a) Belden 1313A (10 AWG), 1311A (12 AWG), 1309A (14 AWG), 1307A (16 AWG); or
b) Gepco 122HBW (12 AWG), 142HBW (14 AWG).

8. ** AWG/CL2: As listed AWG Class 2 rated bare copper conductor cable:

a) Belden 5T00UP (10 AWG); or
b) West Penn HA210 (10 AWG).

H. Single conductor – Unshielded: Single conductor, unshielded cable:

1. LS Cable, loudspeaker cable for use when conduit size is limited:

a) THHN or THWN single conductor stranded copper. Utilize the maximum available color range.

I. RG-58: Single 50-ohm coax, RG-58/U radio frequency cable:

1. RG-58/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

a) Belden 7806R; or
b) Clark Wire CV5058; or
c) West Penn 812.

2. RG-58/P: Plenum rated cable:

a) Belden 82240 or 88240; or
b) Clark Wire CV5058P; or
c) West Penn 25812.

J. RG-8: Single 50-ohm coax, RG-8X and RG-8/U radio frequency cable:

1. RG-8X/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

a) Belden 7808R or 9258; or
b) Clark Wire CV5008X; or
c) Gepco V5020; or

d) West Penn 807.

2. RG-8X/P: Plenum rated cable:

a) West Penn 25810.

3. RG-8/U/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

a) Belden 9913; or
b) Clark Wire RF50LL; or
c) West Penn 810.

4. RG-8/U/P: Plenum rated cable:

a) Belden 89913; or
b) Clark Wire RF50LLP; or
c) West Penn 25812.

K. RG-213: Single 50-ohm coax, RG-213/U radio frequency cable:

1. RG-213/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

a) Belden 8267; or
b) Clark Wire CV50213.

L. Control cable, power and control in one jacket, one unshielded 18 WG pair, one shielded 22 AWG pair:

1. Control cable - NP, not plenum rated:

a) Belden 1502R or Gepco 18/22AXL; or
b) Clark Wire ULK2218; or
c) Crestron CRESNET-NP; or
d) West Penn 77350.

2. Control cable - P, plenum rated:

a) Belden 1502P or Gepco 18/22AXLP; or
b) Clark Wire ULK2218P; or
c) Crestron CRESNET-P; or
d) West Penn D25350.

M. RS-232: Low capacitance computer cable for EIA RS-232/422, 24 AWG, 4-conductor, shielded, minimum conductor-to-conductor capacitance: 22pF/ft, PVC jacket:

1. RS-232/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

a) Belden 8102; or
b) Clark Wire SMP2404.

2. RS-232/P: Plenum rated cable:

a) Belden 88102; or
b) Clark Wire SMP2404P.

2.05 CABLES – FACTORY TERMINATED – INSTALLED

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.

B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass through conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.

C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section "Audio Video Systems Equipment" and are required to be furnished in addition to those required for system installation.

D. All cable assemblies must be factory tested and certified.

E. Category cabling:

1. Refer to Division 27 Section "Structured Cabling System" for product information and additional installation requirements.

F. DisplayPort, version 1.1a or higher, Acceptable lengths: 1'-25':

1. Clark Wire DP Series (3', 6', 10', 15'); or
2. Comprehensive DisplayPort Standard Series (3', 6', 10', 15', 25'); or
3. Extron DisplayPort M-M Series (3', 6', 12', 25'); or
4. Approved Equal.

G. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1'-25':

1. Belden HD-800 Series (2', 4', 8', 25'); or
2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
3. Perfect Path 800 Series (2', 4', 8', 16', 25'); or
4. Approved Equal.

H. HDMI Fiber Optic Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 25'-328':

1. Celerity UFO Series (35', 40', 50', 60', 80', 100', 160', 200', 300'); or
2. Liberty DL-HDM-M-***M Series (8m, 10m, 15m, 23m, 30m, 50m, 60m, 100m); or
3. Cables To Go RapidRun Optical Series (25', 35', 50', 65', 80', 100', 125', 150', 175', 200'); or

4. Approved Equal.

I. USB, Type B male (device = square) to Type A male (computer = flat) or Type A male to Type A male USB 2.0 compliant, Acceptable lengths: 1'-25':

1. Comprehensive; or
2. Extron; or
3. Approved Equal.

2.06 CONNECTORS

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

B. 1/8" TRS Cable Connector, 1/8" (3.5mm) three-conductor mini-plugs which have a metal barrel and solder lugs:

1. Amphenol KS3P; or
2. Canare F-12; or
3. Neutrik NTP3RC; or
4. Switchcraft 35HDNN plug.

C. Locking LS Cable Connector, twist-lock cable mount male loudspeaker connector, minimum 2-two conductors. Coordinate connector with associated intended panel mount connector, including those on loudspeakers:

1. Amphenol SP-2-FN (two conductor); or
2. Neutrik speakON NL2FC (two conductor); or
3. Amphenol SP-4-FN (four conductor); or
4. Neutrik speakON NL4FC (four conductor); or
5. Neutrik speakON NL8FC (eight conductor).

D. Locking LS Panel Receptacle, twist-lock chassis mount female loudspeaker connector, minimum two conductors. Coordinate receptacle with associated intended cable connector:

1. Amphenol SP-2-MD (two conductor); or
2. Neutrik speakON NL2MP (two conductor); or
3. Amphenol SP-4-MD (four conductor); or
4. Neutrik speakON NL4MP. Male connector (four conductor); or
5. Neutrik speakON NL8MPR-BAG (eight conductor)

E. RJ45 Panel (Faceplate) Connector-6, data connector rated for shielded Category 6 cable:

1. Neutrik etherCON NE8FDY-C6* with SCDX cover

*Division 27 "Telecommunications Requirements for Audio Video Systems" Contractor shall terminate cable onto etherCON connector installed in custom faceplate.

F. BNC Cable Connector, 75-ohm BNC, compression fitting for coaxial cable furnished:

1. Liberty CM-RG-BNC series; or
2. West Penn CN-CS-BNC and CN-FS-BNC series.

G. BNC Panel Connector, 75-ohm BNC, pass-through, D-style mounting:

1. Neutrik NBB75DFI; or
2. Approved Equal.

H. Terminal Block Terminations

1. Utilize as applicable and only as allowed per Part 3.
2. Acceptable mounting methods include:
    a) For small quantities in AV Closets: Mount DIN rail within rear of AV equipment rack. Utilize as preferred method wherever feasible and provide a compatible DIN rail rack mount kit.
    b) For large quantities in AV Closets: Mount DIN rail(s) to plywood backing on wall. Utilize wall mounting DIN rail brackets.
        1) Microphone level cable shall be mounted within an enclosure.
    c) For field locations: Provide a minimum NEMA 1 rated enclosure and locate DIN rail(s) within enclosure. Ensure enclosure is properly labeled and identified on as-builts.
3. Captive Screw Terminal Block: modular terminal blocks for mounting on DIN rails:
    a) Entrelec (TE) Screw Clamp series; or
    b) Legrand Viking 3 series; or
    c) Approved equal.
4. Terminal Block DIN Mounting Rails: DIN rails for mounting of terminal blocks:
    a) Crestron DIN-EN series; or
    b) Hoffman DIN Rail LMK series; or
    c) Middle Atlantic FWD-DIN1H; or
    d) Approved equal.

2.07 EQUIPMENT RACKS

A. Furnish complete equipment racks including all top, bottom, and sides as necessary.

B. Furnish all necessary accessories including ganging hardware, blank plates (to fill all unoccupied space), vent panels (as applicable), shelves, security covers, mounting screws, trim kits, lacing bars, cable management, leveling feet, casters, etc. to provide a complete solution which complies with “best practice” guidelines.

1. Full-solution accessories are not detailed in this specification. They shall be provided as needed and shall be approved by the manufacturer for use with the intended rack series (i.e., Middle Atlantic casters must be used with a Middle Atlantic rack).

C. Furnish all required components for a complete thermal management solution within each location to ensure enclosure interior temperature does not exceed manufacturer's recommended operating temperatures.

1. Rack fans shall be quiet, such as the Middle Atlantic QFAN.
2. Thermostatic fan control shall be utilized where available.

D. Equipment racks and all associated blank panels located in equipment rooms shall be factory finished semi-gloss black. Equipment racks and associated blank panels located in control booths or other visible locations shall be factory-finished color as selected by the Architect.

E. Furnish locking storage drawers, hinged security covers, and racks with locking doors all keyed alike. Furnish four keys total.

F. Equipment rack specification indicates the system basis of design. Verify equipment layout, rack size, and number of equipment racks required for equipment furnished. "**" in part number denotes rack height.

G. Wall Rack:

1. Sectional – S, wall-mount rack with separate back plane and rack sections, height as required, shallow minimum 22" depth:

a) Middle Atlantic Products DWR-**-22 series; or
b) Approved equal

H. Credenza Rack, full millwork kit with built-in rack:

1. Middle Atlantic CFR-**-16 series; or
2. Approved equal

I. Above Ceiling Rack, 4RU, 25lb capacity, for 2' x 2' suspended ceilings, with smart AC and fan:

1. FSR CB-224S.

2.08 EQUIPMENT RACK ACCESSORIES

A. The following equipment rack accessories shall be provided as indicated on the rack elevations or within this section.

B. Equipment rack accessories located in equipment rooms shall be factory finished semi-gloss black. Equipment rack accessories located in control booths or other visible locations shall be factory-finished color as selected by the Architect.

C. Logo rack panel, single vertical rack space, labeled with contact information for the contractor and Design Consultant. Panel specified is custom and already has the information for the Design Consultant; the contractor shall coordinate their logo/information with the panel manufacturer (shop drawing required). One required to be installed at the top of each bank of equipment racks:

1. Liberty AV Solutions model HEI-RHIM-TEMPLATE.

D. Storage drawer, specification indicates the system basis of design. "**" in part number denotes (RU) height as indicated in rack elevations.

1. Locking rack drawer keyed to match rack rear door, approximately 16" deep, color to match adjacent rack-mounting panels:

   a) Atlas Sound SD**-14 with optional SD-LOCK installed; or
   b) Middle Atlantic D**-LK; or
   c) Chief SDR-**-L.

2. Rack drawer, approximately 16" deep, color to match adjacent rack-mounting panels:

   a) Atlas Sound SD**-14; or
   b) Middle Atlantic D**; or
   c) Chief SDR-**.

E. Rack Shelf:

1. 1RU, utility rack shelf, 3.5" high, approximately 10" deep, color to match adjacent rack-mounting panels:

   a) Atlas Sound SH1-10; or
   b) Lowell 1556-USV110; or
   c) Middle Atlantic UTR1.

2. 2RU, utility rack shelf, 3.5" high, approximately 16" deep, color to match adjacent rack-mounting panels:

   a) Atlas Sound SH2-15; or
   b) Lowell 1556-USV110; or
   c) Middle Atlantic U2.

3. Pull-out shelf, requires rear rack rails, approximately 1.75" high (1RU), color to match equipment rack:

   a) Atlas Sound VTD1-16; or
   b) Lowell 1191-SLS; or
   c) Middle Atlantic SS.

2.09 AC POWER

A. General

1. A complete AC power connection solution for each equipment rack and cabinet is required.
2. Provide spare NEMA 5-15R or 5-20R outlets (single duplex receptacle) for temporary equipment (beyond that required for connected equipment, rack fan, etc.). These outlets shall be fed from an un-switched "Normal" power circuit.
    a) For racks 16 RU or less: two spare outlets (minimum)
    b) For racks greater than 16 RU: four spare outlets (minimum)
3. All power strips shall maintain integrity of system grounding requirements.
4. All equipment shall be connected such that maximum rated performance can be obtained without exceeding the AC circuit load capacity.
5. Coordinate with Electrical drawings and Division 26 specifications. Where outlets are provided under this section as a portion of power strips or power distribution units, receptacle types and colors shall match the supplied AC power circuit.
6. Comply with all NEC requirements, including separation of loads classified as Life Safety from Normal loads via an independent Vertical / Horizontal Power Strip, PDU, and/or UPS.

B. PS/V: Vertical Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum fourteen NEMA 5-15R outlets, mount to rear of rack interior (furnish where provided electrical receptacle quantities do not meet system requirements):

1. APC AP7530 with 40170-6INCH L5-20P adaptor; or
2. Eaton EPBZ97; or
3. Middle Atlantic PD-2420SC-NS; or
4. Tripp Lite PDUV20 with included L5-20P adaptor; or
5. Approved equal.

C. PS/H: Horizontal Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum eight rear-facing NEMA 5-15R outlets, single rack space (furnish where provided electrical receptacle quantities do not meet system requirements):

1. APC AP9563; or
2. Eaton EPBZ85; or
3. Middle Atlantic PD-920R-NS; or
4. Tripp Lite PDU 1220; or
5. Approved equal.

D. Power Distribution Unit (PDS):

1. SS – 1RU: power distribution unit, surge suppression, single rack space, 20A power distribution with non-MOV based surge suppression, minimum of eight receptacles:

a) Furman P-8 PRO SERIES II; or
b) SurgeX SX-1120-RT.

2. SS/IP – 1RU: power distribution unit, surge suppression, IP controllable, single rack space, 20A power distribution with non-MOV based surge suppression, minimum of eight receptacles:

a) SurgeX SX-AX20.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 PREPARATION

A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.

B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.

1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.03 INSTALLATION

A. General

1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.
3. Install any floor-mounted receptacles so that release buttons (for both receptacles and cable connectors) are easily accessible when cable connectors are installed.
4. Blank panels and/or vent panels shall be installed in unused rack spaces. Ensure that air flow within the rack is maintained (i.e., cool air can enter the rack and hot air can exit the rack).
5. Equipment racks and other exposed equipment shall be kept covered and protected from airborne contaminates. Clean all equipment racks and the interior rack floor, prior to system final acceptance activities.

6. For racks installed in credenzas, fasten carpet tiles or low friction sliders to the bottom of the rack to protect the finish of the furniture.
7. Where the design location requires products, materials, or equipment to be visible to the public, manufacturers logos shall be removed if possible. Unless otherwise directed, neatly remove or logos.
8. AC power switches located on the front panel of equipment mounted in racks shall be covered by a security cover or utilize front panel lockout features. Exclusions from this list are items requiring user interface such as tuners and wireless microphone receivers.
9. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.

B. Suspended Systems

1. General

a) Contractor shall provide Suspension system, including connection to structure, for all suspended components including but not limited to: loudspeakers, video projectors, flat panel displays, televisions, projection screens, etc.

b) Suspension system design shall be created by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer licensed in the location of the project per submittal requirements in Part 1 of this document.

c) Contractor shall include a safety cable or other backup support mechanism.

d) Suspension systems and installation shall conform to industry best practice standards as set forth in:

1) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14)

e) Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.

f) Field verify conditions for compliance with the approved suspension plan prior to installation, placement of equipment orders, or material fabrication. Coordinate with other trades as necessary.

2. Loudspeakers

a) Install loudspeakers so there are no obstructions to loudspeakers' coverage pattern.

b) Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.

c) Paint loudspeaker and/or grille assembly (at discretion of Architect or Design Consultant) color as selected by the Architect. Use primer

per manufacturer's recommendations. Do not paint loudspeaker cones or high frequency diaphragms. Materials and labor provided by Contractor.

d) Provide access to loudspeakers during installation, testing, and final acceptance activities to allow for modifications to location or installation. Access includes all necessary resources required to obtain direct physical contact to loudspeakers (front and rear), including: scaffolding, motorized lift, etc.

C. Video

1. Coordinate structural backing required for wall mounted flat panel displays/televisions prior to the installation of drywall or other wall materials.

D. Grounding

1. Comply with NEC and BICSI grounding requirements.
2. Each equipment rack within a row of racks and each row of racks within a room shall be electrically bonded to each other. Bonding shall be via copper ground bus. Any bolts shall fasten to unpainted sheet metal.

E. Equipment Power Control

1. Low voltage "ON/OFF" control of system equipment shall be provided via the control system.
2. Operation of the following components is required, at a minimum:
   a) Power amplifiers as indicated in Part 2 requirements
   b) Components equipped with power state control
3. Make all low-voltage connections as required to provide a complete and working control system.
4. Refer to electrical drawings for AC power information.
5. Coordinate with Electrical Contractor as necessary to verify proper circuit assignment and sequencing order.

3.04 RACK BUILDING, CABLE MANAGEMENT AND TERMINATION

A. Employ techniques to fulfill AVIXA F502.01:2019 "Rack Building for Audiovisual Systems" as a minimum standard with the additional requirements as described in this paragraph.

1. Reference below for additional requirements and stipulations related to zip tie utilization.

B. General

1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.

2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.
3. Terminate cables with sufficient service loop to allow at least two re-terminations without having to open a cable bundle or pathway.
4. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.
5. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to “Conduit/Circuit Group Divisions” and “Conduit Routing and Separation” schedules for additional information.
6. All solder connections shall be made with soldering iron and rosin core solder. All solder connections shall be checked for "cold" solder joints.
7. If equipment is removed or replaced for service, ensure the proper cable termination points are apparent when the equipment is re-installed.
8. Use Velcro tie wraps (hook and loop) for all category, coaxial, or fiber cables and additionally as practical for other types of cables. Do not use zip ties on any category, coaxial, or fiber cables and limit use where possible otherwise.
9. Do not tighten cable wraps so the cable is deformed. Zip ties should never be used in locations prone to damage due to cable sagging.

C. Equipment Racks

1. Utilize Velcro cable wraps (hook and loop) for dressing cables within the rack(s). Cable wraps shall be hand tightened and spaced at various inconsistent distance intervals. The use of zip ties is not allowed inside equipment racks.
2. Install rack-mounted equipment manufactured without IEC removable power cords so the power cords are dressed using removable fasteners such as Velcro and there are no obstructions to the item being pulled out from the front of the rack. Avoid coiled or bundled cable loops.
3. For rack-mounted equipment manufactured with IEC removable power cords, provide power cord assemblies of the minimum length needed to accomplish connection to the PDU. Avoid excess power cabling including coiled or bundled cable.
4. Factory terminated cable assemblies are only permitted for use within racks, between devices external to racks, as portable equipment, or for use in conduit as specifically noted as follows: Permitted for rack inter-connect when racks are in close proximity (same room) and may pass through conduit if necessary, in this situation. Cable assemblies shall be the minimum length needed to accomplish the connection.
5. Install rack equipment to enable repair or replacement without hindrance. If there are obstructions prohibiting the disconnection of terminations on the back side of the technical equipment, there must be sufficient cabling to

permit the equipment to be pulled from the front allowing for easy disconnection and reconnection.

D. Paralleling and Extension Connections

1. Circuits shall not be joined by butt-splice, solder-splice, wire nut, or similar.
2. Circuits requiring parallel connection as indicated on signal flows shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
    a) Approved connections include DIN mounted terminal blocks as specified in Part 2.
    b) Field splicing techniques such as wire nuts, “twist and solder”, etc. are not allowed.
    c) Any circuit requiring parallel connection shall be permanently labelled on every cable as defined herein.
    d) Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
3. Circuits requiring extension (non-data) due to field conditions such as excessive conduit bends, etc., shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
    a) Extension of circuits is to be avoided if at all possible.
    b) Contact the Design Consultant via documented project communication. Inform the Design Consultant of the circumstances regarding the desired extension. Contractor and Design Consultant will coordinate to determine the most appropriate course of action.
    c) Approved connections include DIN mounted terminal blocks as specified in Part 2.
    d) Any circuit requiring extension shall be permanently labelled on every cable as defined herein.
    e) Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
4. Document each parallel connection and extension on the field drawings and transfer same to the final record drawings.

E. Telecommunications Cabling

1. Refer to Division 27 Section “Structured Cabling System” for all work associated with data-related cabling including Category cabling.

F. Microphone/Line Level Audio

1. Audio circuit termination shall observe the methods set forth in “Sound System Interconnection” RaneNote 110, © 2011 by Rane Corporation. This reference document may be obtained at: https://www.ranecommercial.com/legacy/library.html
2. Key methods include, but are not limited to the following:

a) All audio circuits shall be balanced two-wire circuits, with a separate grounding shield conductor, unless noted otherwise. All circuits shall have either the red or white wires as the "high" or “+” side of the line and connect to pin 2 of microphone-type XLR audio connectors and the tip of 3-conductor phone connectors. The black wire of the two-wire circuit shall be the "low" or “-“ side of the line and connect to pin 3 of microphone connectors and the ring of 3-conductor phone connectors. The shield conductor shall connect to pin 1 of microphone connectors or to the sleeve of phone connectors.

b) Shield conductors shall be connected at each end of each wire to the pin 1 of each XLR, shield connection for each electronic device, etc. No shield wires shall be left unconnected except where noted on the drawings, nor shall any shield come in contact with conduit, pull boxes, or other building steel. Audio line-level circuit shield wires shall be grounded to rack sheet metal only via rack-mounted equipment. Shields shall be electrically isolated in multi-conductor cables. Shields for audio line-level circuits connected to audio transformers shall be connected to transformer electro-static shields and case ground.

c) In the case of an unbalanced source feeding into a balanced input and the cable run is short (i.e., less than fifteen feet), connect the signal connection of the unbalanced connector to the “high” side of the balanced input. Connect the “ground” connection of the unbalanced line to the “low” side of the balanced connector. Connect the cable shield to the shield connection of the balanced input but do not connect it to the unbalanced connector. If the cable run is longer than fifteen feet, balance the line at the unbalanced source using specified balancing devices.

d) In the case of a balanced source feeding into an unbalanced input and the cable run is short (i.e., less than fifteen feet), connect the “high” side of the balanced output to the signal input of the unbalanced connection. Connect the “shield” of the balanced connection to the “ground” of the unbalanced connection. Leave the “low” side of the balanced output floating.

G. Loudspeaker Level Audio

1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.

H. Video

1. Compression fittings shall be used for all BNC connector terminations.
2. Neatly dress all cables behind a flat panel display/television. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables nor visible.

3. For fixed projector or pole mounted flat panel display installations, signal cables shall be routed within the mounted pipe. Signal cables shall not be tied to the outside of the pipe. Provide cabling of appropriate distance to minimize excess cable at device. Bundle excess cable above the ceiling, not at the device.

3.05 LABELING

A. Adhere to AVIXA F501.01:2015 “Cable Labeling for Audiovisual Systems” as a minimum standard with additional requirements as described in this paragraph.

B. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.

C. Adhere to the labeling standard across all platforms, including within the DSP programming.

D. Refer to general notes, the signal flows, and panel and plate details for expected labeling scheme of system equipment and components. Comply with any specific color coding as described.

E. All equipment in equipment racks shall be labeled front and rear for ease of identification. Labels shall be of a contrasting color with that of equipment color to promote visibility.

F. Install permanent labeling on the front of each equipment rack in a row of racks identifying the rack designation (number).

G. Within each rack and at other remote locations for technical system equipment, label all associated AC power receptacles reflecting the appropriate circuit breaker. Ensure that the circuit breakers are labeled as to the rack or remote equipment location.

H. Document the labeling standard for inclusion in the Operation and Maintenance Data.

I. Document all labels for the Record Drawings.

J. Pre-approved labelling systems include:

1. Brother P-touch EDGE with HGeS2***PK labels; or
2. Brady Equipment Identification Labels.

3.06 SYSTEM CONFIGURATION

A. Coordination

1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.

B. Software

1. Furnish, install, and configure the most recent approved, non-beta, software for each device or system.
2. Provide software as identified in other areas of these specifications or on the drawings.
3. Provide software not specifically identified but required to allow for system operation and/or to allow for more efficient system configuration, setup, and operation.

C. Firmware

1. Ensure the firmware for each device is the most recent manufacturer approved version and is installed and operational.

D. Operating Systems

1. Gain approval of the operating system version and type from the Owner's IT representative and associated equipment manufacturer(s).
2. Ensure the operating system for each device is the most recent, installed, and fully operational.
3. Ensure the latest security patches are installed.

E. Network Configuration

1. Secure the entire network, documenting all passwords. Comply with the Owner's IT representative's requirements with respect to password selection and network security implementation.

F. Network Documentation

1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

3.07 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.

B. Adhere to ANSI/Infocomm 10:2013 "Audiovisual Systems Performance Verification" as a minimum standard with additional requirements as described in this paragraph.

C. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.

D. General

1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.
3. Ensure that all equipment is on the jobsite and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.
4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, system inputs and outputs, intercom system, video routing, video distribution, operational controls, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
6. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

E. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.
    a) Systems requiring testing via approved devices will be identified below.
    b) Required test devices will be listed in related sections.
    c) Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.
    d) Provide original results from testing equipment (as applicable).
2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.
3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

F. Audio System

1. Electronics

a) Test all system audio electronic components for uniform frequency response from input to power amplifier output:

1) Supply pink noise to a single system input which engages most of the system electronics. For example, connect pink noise to a microphone receptacle on the stage for a Performing Arts facility.
2) With all signal processing bypassed (equalization band pass filters, crossovers, dynamics, etc.), independently route the signal through audio console, DSP, and any other system processing components to an amplifier output.
3) With speaker load disconnected, measure the signal response of the selected amplifier output (to obtain viable measurement results, ensure output level is set to match the ability of the measurement device to display accurate information. This can be accomplished via attenuation of signal or insertion of a speaker level to line level attenuator).
4) Verify the measured response is uniform and matches the reference input signal within ±1dB from 30 Hz to 18 kHz.
5) Required test equipment - Signal Generation:

a) Terrasonde/Sencore Audio-Toolbox; or
b) Japan Audio Society CD-1 test compact disc
c) NTI Minirator MR-PRO

6) Required test equipment – Measurement Device:

a) Rational Acoustics SMAART system v7 or later; or
b) NTI Audio XL2 Analyzer; or
c) Studio Six Digital Audio Tools RTA or FFT Module, with

i) Studio Six Digital iAudioInterface 2

b) Repeat measurement for each amplifier output channel.

2. Loudspeaker Impedance

a) Measure and record the impedance of all loudspeaker circuits at the output of each amplifier. During this process, also check each loudspeaker circuit for shorts to ground.
b) Required test equipment:

a) Dayton Audio DATS; or
b) NTI Minirator MR-PRO; or
c) Sennheiser ZP-3; or
d) Terrasonde/Sencore Audio Toolbox

2) Unacceptable measurement devices for loudspeaker impedance include the following:

a) Digital Multimeter (DMM); or
b) TOA ZM-104; or

c) TOA ZM-104A

3. Loudspeaker Band Pass/Amplifier Assignment Confirmation

a) For full range loudspeakers, apply full spectrum pink noise at sufficient level in order to:

1) Verify subjectively that each loudspeaker is emitting full spectrum signal (both woofer and tweeter/horn are operating)
2) Confirm each loudspeaker is connected to the proper amplifier chassis and output channel.
3) Verify proper phase of each loudspeaker.
4) Required test equipment

a) Galaxy Audio CPTS Cricket Polarity Tester; or
b) NTI Audio MR-PRO generator with XL2 Analyzer; or
c) Studio Six Digital Audio Tools Speaker Polarity Module; with

i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
ii) Studio Six Digital iPrecisionMic; or
iii) Studio Six Digital iTestMic; or

d) Studio Six Digital Speaker Pop; with

i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
ii) Studio Six Digital iPrecisionMic; or
iii) Studio Six Digital iTestMic

b) For loudspeakers with multiple band pass sections (bi-amp, tri-amp, etc.), apply appropriately band-limited pink noise at sufficient level to each device or band pass (i.e., high frequency section, mid frequency section, low frequency section):

1) Verify subjectively that each loudspeaker is emitting appropriately band-passed spectrum signal.
2) Confirm each band pass is connected to the proper amplifier chassis and output channel.
3) Verify phase of each band pass
4) Required test equipment

a) Galaxy Audio CPTS Cricket Polarity Tester; or
b) NTI Audio MR-PRO generator with XL2 Analyzer; or
c) Studio Six Digital Audio Tools Speaker Polarity Module; with

i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or

ii) Studio Six Digital iPrecisionMic; or
iii) Studio Six Digital iTestMic; or

d) Studio Six Digital Speaker Pop; with

i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
ii) Studio Six Digital iPrecisionMic; or
iii) Studio Six Digital iTestMic

4. Loudspeaker Rattle

a) Verify each loudspeaker is connected to the respective power amplifier and test each loudspeaker throughout its usable frequency range using 1/3-octave bands of pink noise to ensure loudspeaker and related building systems do not rattle.
b) Required 1/3-octave band pink noise sources and test equipment include:

1) Terrasonde/Sencore Audio-Toolbox; or
2) Japan Audio Society CD-1 test compact disc
3) NTI Minirator MR-PRO

5. Loudspeakers Uniformity of Coverage

a) Perform audio system verification per ANSI/AVIXA 1M-2009 for all loudspeakers. Document per guidelines set forth in the standard.

6. Loudspeakers Equalization

a) Perform sound system equalization to optimize system performance for the intended uses.
b) Every loudspeaker shall be equalized.
c) Required test equipment:

1) Calibrated Type 1 or Type 2 microphones shall be used
2) Studio Six Digital Audio Tools for the classrooms, meeting rooms, conference rooms gymnasium, lobby; with

a) Studio Six Digital iPrecisionMic; or
b) Studio Six Digital iTestMic; or

3) SmaartLive (most current non-beta version) with SmaartLive approved:

a) Appropriate laptop
b) Microphone interface

4) EASRA (most current non-beta version) with EASRA approved:

a) Appropriate laptop
b) Microphone interface

7. Microphone/Line Level

a) Verify that all microphone and line level cabling and connectors are installed with Pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure proper polarity.

b) Verify that all microphone connectors, extension cables, and microphones are wired properly and in polarity.

c) Required test equipment:

1) Alphaton ACT-100 Remote Tester; or
2) NTI Minirator MR-PRO with Cable Test Adapter
3) A microphone is NOT an acceptable measurement device for cable tests.

8. Wireless Microphones

a) Setup and configure each wireless microphone system using the software provided by the manufacturer of the wireless microphone system. The following tasks are required:

1) Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform an RF spectrum sweep.
2) Perform frequency coordination with Owner. Take into account any existing wireless microphone system(s).
3) Calculate spare RF channels (based on 5% of the total wireless system channels).
4) Perform frequency assignment of all transmitters/receivers per the results of the frequency coordination and RF spectrum sweep.
5) Verify all receivers are set to maximum line level audio output.
6) Set all handheld wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
7) Set all body pack wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
8) Using subjective listening, adjust the body pack settings to match the audio level of the handheld transmitters.
9) Walk the entire performance coverage area using speech as the program material to verify signal performance. Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform a QOS test.
10) Document wireless microphone frequency assignments including coordinated spare channels.

9. Assistive Listening System

a) Setup and configure the assistive listening system. Verify proper input signal level.

b) Walk the entire coverage area using speech as the program material to verify signal performance.
c) Set all receivers to match the selected transmit channel(s).

G. Video System

1. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:

a. Hall Research PGA-VHD; or
   a) Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
   b) Murideo Fresco Field Test Suite; or
b. Quantum Data QD780C; or
c. Purelink HDG 2.0; or

2. Setup and calibrate each visual display using current edition of Spears & Munsil High-Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.
3. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:

d. Datacolor Spyder5ELITE Display Calibration; or
   a) SpectraCal CalMAN Ultimate software (most recent version) running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.
      1) Supported Meters: as recommended by SpectraCal
      2) Supported Pattern Sources: as recommended by SpectraCal; or
e. X-Rite ColorMunki Display

H. Control System

1. Verify performance of the Control System including the operation of all control features.

I. Adjustment

1. Repair or replace any defects or malfunctions found prior to the commencement of final acceptance activities by the Design Consultant.

J. Testing Documentation Submittal

1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:
    a) Results of the tests detailed herein; and
    b) Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner Representative direction or the Testing and Adjustment process. Scans of current field set are acceptable for this submittal; and
    c) Digital photographs or explanation of reasoning for failed test results due to reasons such as site conditions, constraints, equipment availability, equipment failure, direction required from design team or Owner's Representative, etc.; and
    d) Written notice to the Design Consultant that the system(s) are ready for final acceptance.
2. Include the final approved Testing Documentation package in the Operation and Maintenance Data package.
3. Modify the Record Drawings to include any changes as a result of the adjustment process.

K. Contact the Design Consultant should problems or concerns arise during the testing activities.

L. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to scheduling of final acceptance. The Consultant cannot visit the site or begin the acceptance phase until the submittal has been approved.

M. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.

3.08 FINAL ACCEPTANCE

A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:
1. Random verification of contractor tests
2. System check-out
3. Tailoring of the technical system's frequency response to the facility's acoustical environment (where required)
4. Observation of video system to verify proper image display
5. Function and operability of the control system.

B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately two (2) eight-hour days. Additional time may be required due to Addenda or Change Orders (if any) which modify the

scope of work. The supervisor shall provide personal assistance during these activities. This duration does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.

C. At the discretion of the Design Consultant, the Contractor shall participate in the control and adjustment of computer-controlled systems including but not limited to the following systems: Main control, DSP, wireless microphone, amplifier, active loudspeaker, etc.

D. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.

E. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.

F. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.

3.09 OPERATION AND MAINTENANCE DATA

A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section "General Communications Requirements".

B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner's Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.

C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.

D. As applicable, save full digital version to the system computer.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the equipment for the audio-video (AV) system (hereafter referred to as the "Technical System").

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:

1. Division 27 "Audio Video Systems".

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Division 27 Section "Audio Video Systems" for general product requirements.

B. All components of the technical system equipment shall be provided and installed by a qualified contractor as outlined in Division 27 Section "Audio Video Systems".

C. All electronic audio devices shall have electronic or transformer balanced inputs and outputs except for specific program source equipment and mixing console inputs and/or outputs. If an electronic device specified or furnished has an unbalanced input and/or output, make provisions to balance said input/output (i.e., active signal balancing device as approved) unless other arrangements have been agreed upon with the Design Consultant.

2.02 COMMON EQUIPMENT

A. Refer to Division 27 Section "Audio Video Systems" for common equipment and components.

2.03 MICROPHONES - INSTALLED

A. Microphone – Suspended: permanently installed, with factory installed cable of sufficient length to reach the ceiling without splices. Store excess cable inside the ceiling box to permit future height adjustment, if required:

1. ClearOne Ceiling Microphone Array; or
2. Approved equal.

2.04 SOUND MASKING / PAGING

A. Furnish sound masking system capable of performing paging functions.

B. Sound Masking Control Module: Integrated amplifier, sound masking generator, controller, and third-octave band equalizer; audio distribution through Dante audio network; Ethernet connectivity;

1. Biamp Qt X D Series; or
2. Approved equal.

C. Sound Masking Power Supply:

1. Biamp QT PS-AE-3; or
2. Approved equal.

D. Sound Masking Power Injector:

1. Biamp QT PI-AE

E. Sound Masking / Paging Ceiling Flush Mounted Speakers: simultaneous sound masking and paging signal capable:

1. Biamp Qt Active Emitter; or
2. Approved equal.

F. Paging Station: Desktop, PoE+, audio distribution through Dante network:

1. Biamp NPX G1100; or
2. Approved equal.

2.05 ROOM SCHEDULING SYSTEM

A. Furnish room scheduling system compatible with MS Exchange, Office 365, Google Calendar, 25 Live, EMS, NFS, and Ad Astra.

B. No annual subscription or maintenance fees

C. After system is configured install the configuration software on owner computer. Coordinate with owner.

D. Room Scheduling Panel: 10” diagonal screen, gorilla glass, supports two factor authentication (OAuth) for Microsoft 365, encrypted communication between panel and calendar server, multi-colored lights to indicate status of room, PoE:

1. Extron TLS 1025M;
2. No substitutions allowed.

2.06 WIRELESS MICROPHONE SYSTEMS

A. Furnish complete UHF diversity wireless microphone system(s) including the following components (select components from one manufacturer listed below):

B. Wireless Microphone Receiver: furnish single, or dual models with rack mount kits as required to achieve the number of receiver channels as shown on the drawings:

1. Shure SLXD4 (single channel), or SLXD4D (dual channel) digital wireless receiver with included rack mount kit; or
2. Approved equal.

C. Wireless Beltpack Transmitter: furnish beltpack transmitter with lapel microphone (quantity one per receiver required):

1. Shure SLXD1 with lapel microphone; or
2. Approved equal.

D. Wireless Handheld Transmitter – Dynamic (quantity one per receiver required):

1. Shure SLXD2/B58; or
2. Approved equal.

E. Wireless In-Line RF Amp: RF amplifier powered from wireless microphone receiver or antenna distribution amplifier:

1. Shure UA834 line amplifier; or
2. Approved equal.

F. Wireless Remote Antenna: omnidirectional ½-wave remote mounted antenna:

1. Shure UA8 Omni-directional Antenna; or
2. Approved equal.

G. Wireless rechargeable battery system:

1. Shure SBC203 dual charger with power supply (quantity to support charging of all wireless microphones simultaneously; or
2. Approved equal.

H. Provide all connections and components necessary for proper operation of the wireless systems described above.

I. Coordinate the selection of transmitter/receiver frequencies to be free of interference from outside sources or interference between wireless systems. Select the frequency from an unused channel per FCC regulations Part 74, subpart H.

J. Label each receiver/transmitter combination as coordinated with the Owner's Representative. See Labeling and Placards section in this specification for additional labeling requirements.

2.07 PROGRAM SOURCE EQUIPMENT

A. Document Camera – Ceiling: single chip ceiling mounted document camera with the following features: native resolution of 1,920x1,080, 30 fps, 12x optical zoom, high depth of focus, built-in light, HDMI output, Ethernet port for control:

1. Wolfvision VZ-C6;
2. No substitutions allowed.

B. PTZ (pan-tilt-zoom) Camera: 3,840x2,160 resolution or better at 30 fps or better, 20x optical zoom, automatic framing, face tracking, horizontal angle of view of 4 degrees to 60 degrees, vertical angle of view of 2 degrees to 34 degrees, HDMI output:

1. ClearOne UNITE 260 Pro Camera; or
2. Approved equal.

C. USB Webcam: USB 3.0 camera with 3,840x2,160 resolution or better at 30 fps or better, 15x zoom, automatic framing, automatic camera:

1. Logitech Rally Camera; or
2. Approved equal.

D. USB Integrated Sound Bar/Microphone/Webcam: integrated USB 2.0 webcam with speakers and beamforming microphones, mounted to flat panel display, 5X zoom, auto framing:

1. Logitech MeetUp; or
2. Approved equal.

E. USB Integrated Sound Bar/Microphone/Webcam: integrated USB 2.0 webcam with speakers and beamforming microphones, mounted to flat panel display, 4X digital zoom, auto framing:

1. Logitech Rally Bar Mini; or
2. Approved equal.

F. USB Integrated Sound Bar/Microphone/Webcam: integrated USB 2.0 webcam with speakers and beamforming microphones, mounted to flat panel display, 5x optical zoom, auto framing:

1. Logitech Rally Bar; or
2. Approved equal.

2.08 USB EQUIPMENT

A. USB Hub: three port USB 3.0, four port USB 2.0 hub, HDMI input:

1. ClearOne Versa USB Hub; or
2. Approved equal.

B. USB-over-Twisted Pair Extender: USB 2.0, 165 feet distance:

1. Hall Technologies U22-160-DP transmitter/receiver pair; or
2. Approved equal.

2.09 ANNOTATION AND COLLABORATION EQUIPMENT

A. Wireless Presentation / Collaboration Unit: output resolution of 3,840x2,160 at 30 fps; 1,920x1,080 at 60 fps; wireless mirroring via AirPlay, Miracast, Chromecast and data network; GIF, JPEG, BMP, and PNG image file format compatible; PDF, Word, PowerPoint, Excel, Text, and HTML document file compatible; MP3, WMA, MKA, OGA, and OGG audio file compatible, AVI, WMV, MOV, MP4, DivX, MKV, M4V, and OGV video file compatible; simultaneous display of up to four devices; Google Drive, Dropbox, Box, Jianguoyun, OneDrive, WebDAV cloud service compatible; Microsoft 365 integration (with optional feature pack); Microsoft 365 and Google Calendar compatible; touch control; whiteboard and annotation; Zoom, Teams, and WebRTC web conferencing compatible (with optional feature pack); integrated web browser; four USB 3.0 ports; Ethernet port; single HDMI output:

1. Wolfvision Cynap Pure Pro;
2. No substitutions allowed.

B. Wireless Presentation / Collaboration Unit: output resolution of 3,840x2,160 at 60 fps; 1,920x1,080 at 60 fps; wireless mirroring via AirPlay, Miracast, Chromecast and data network; content streaming for up to 40 devices; GIF, JPEG, BMP, and PNG image file format compatible; PDF, Word, PowerPoint, Excel, Text, and HTML document file compatible; MP3, WMA, MKA, OGA, and OGG audio file compatible, AVI, WMV, MOV, MP4, DivX, MKV, M4V, and OGV video file compatible; simultaneous display of up to four devices; dual screen functionality; unicast and multicast data network streaming; Wowza, YouTubeLive, and Facebook webcasting compatible; video recording at up to 1,920x1,080 at 30 fps; Panopto lecture capture compatible; Google Drive, Dropbox, Box, Jianguoyun, OneDrive, WebDAV cloud service compatible; Microsoft 365 integration; Microsoft 365 and Google Calendar compatible; touch control; whiteboard and annotation; Zoom, Teams, and WebRTC web conferencing compatible; integrated web browser; six USB 3.0 ports; dual Ethernet ports; two HDMI inputs; two HDMI outputs; one line-level input; one line-level output:

1. Wolfvision Cynap Pro;
2. No substitutions allowed.

C. Wireless Presentation / Collaboration Unit: output resolution of 3,840x2,160 at 30 fps; 1,920x1,080 at 60 fps; wireless mirroring via AirPlay, Miracast, Chromecast and data network; content streaming for up to 40 devices; GIF, JPEG, BMP, and PNG image file format compatible; PDF, Word, PowerPoint, Excel, Text, and HTML document file compatible; MP3, WMA, MKA, OGA, and OGG audio file compatible, AVI, WMV, MOV, MP4, DivX, MKV, M4V, and OGV video file

compatible; simultaneous display of up to four devices; Wowza, YouTubeLive, and Facebook webcasting compatible (with optional feature pack); video recording at up to 1,920x1,080 at 30 fps (with optional feature pack); Panopto lecture capture compatible (with optional feature pack); Google Drive, Dropbox, Box, Jianguoyun, OneDrive, WebDAV cloud service compatible; Microsoft 365 integration; Microsoft 365 and Google Calendar compatible; touch control; whiteboard and annotation; Zoom, Teams, and WebRTC web conferencing compatible; integrated web browser; four USB 3.0 ports; dual Ethernet ports; one HDMI input; one HDMI output; one line-level input; one line-level output:

1. Wolfvision Cynap Core Pro;
2. No substitutions allowed.

D. Interactive LCD Display: see "DISPLAY – INTERACTIVE LCD FLAT PANEL" in this Section.

2.010 DIGITAL SIGNAL PROCESSING (DSP)

A. The Contractor shall create all schematics for the DSP and submit as a shop drawing. Refer to Submittals section for additional information.

B. Provide one computer with mouse and system features as recommended and approved by the manufacturer of the DSP system for use during final acceptance.

1. If a permanent computer is not configured for technical system usage, furnish a wireless 802.11ac router and laptop computer configured to allow for wireless control of the DSP during system final acceptance. This equipment shall remain on site until final acceptance activities have been completed. Retain ownership of the router and laptop computer.

C. Password protection shall be included. One password shall be provided to allow operator access to select functions. Another password shall be provided for technical staff to access all aspects of the software.

D. DSP programming of Fire Alarm connection

1. General

a) Sound system operation in relation to fire alarm system is subject to NFPA, local building codes, and the local Authority Having Jurisdiction.

b) Sound system mute for fire alarm audible notification shall be provided for all assembly areas, locations with systems capable of prolonged operation in excess of 100dBA, and all facility background music systems.

c) Coordinate with the fire alarm contractor and local authority having jurisdiction.

2. Sound system shunt initiation signal

a) Fire alarm system connection shall be via DSP contact closure in location as indicated on signal flows.
b) Upon fire alarm activation, and subsequent reception of shunt signal from the fire alarm system via normally open contact closure to the DSP, all sound system audio shall mute.
c) DSP shall be programmed to mute audio sources until the alarm is cleared, upon which normal operation shall resume. Activation of shunt signal may include General Alarm, keying of the fire alarm microphone, or initiation of preprogrammed severe weather (or the like) announcement.
d) DSP programming shall include clear visible status of alarm state for troubleshooting purposes.

3. Refer to signal flows and coordinate connections with Fire Alarm System Contractor to ensure compatibility with connections to Fire Alarm System. The following components may be required, dependent on system configurations:

a) Loudspeaker Level to Line Level Transformer: 25V, 70V, or 100V loudspeaker level input, unbalanced line level output, selectable input voltage, for connection from loudspeaker level fire alarm connection to line level DSP input:

1) RDL TX-70A.

b) Logic Controlled Relay – Momentary: momentary latching logic-controlled relay, contact closure output, for connection from DSP GPIO to fire alarm relay module when DSP GPIO does not have native contact closure outputs:

1) RDL ST-LCR1.]

E. Furnish all components for a fully functioning digital signal processing system.

F. DSP system basis of design is shown on the signal flows:

1. Extron DMP Plus C Series; or
2. Approved equal.

2.011 POWER AMPLIFIERS

A. Power amplifiers in this section shall be by one manufacturer.

B. All power amplifier inputs shall be either balanced analog inputs or digital network.

C. Power amplifiers are listed by series, with the basis of design model shown on the signal flows. Deviation from the basis of design to an approved substitute shall be allowed as follows:

1. Power rating for high impedance (70V) operation shall meet or exceed the basis of design load requirement on the channel. Load shall be calculated

based on total power (addition of all loudspeaker tap values) as indicated on the signal flows.

2. Power rating for low impedance operation shall meet or exceed the basis of design load requirement on the channel. Load shall be as indicated on the signal flows.
3. Channel count per chassis shall produce the most efficient solution of maximum channels vs appropriate power rating.
4. Proposed substitute should take into account:
    a) alterations of audio network requirements, as applicable. Alterations may include the need for additional network infrastructure, including network switches.
    b) alterations of audio system requirements, as applicable. Alterations may include the need for additional digital signal processing infrastructure.
    c) standby/sleep mode functionality. Alterations may include the need for additional network infrastructure or control system infrastructure.
    d) all other parameters, including but not limited to rack requirements and environmental considerations (AC power, thermal dissipation, weight, etc.).

D. Power Amplifier:

1. Non Sound Masking / Paging Amplifiers:
    a) Extron XTRA Series; or
    b) Approved equal.

2.012 LOUDSPEAKERS – INSTALLED

A. General loudspeaker requirements:

1. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
2. Utilize the most recent manufacturer-recommended DSP settings if available.

B. Non-Sound Masking / Paging Ceiling Pendant Speakers:

1. Extron SF 3PT for 3” driver applications; or
2. Approved equal.

C. Non-Sound Masking / Paging Ceiling Flush Mounted Speakers:

1. Extron SF 26CT; or
2. Approved equal.

2.013 ASSISTIVE LISTENING SYSTEM - FM 72MHZ

A. The transmitter shall be installed in the audio equipment racks and the transmitting antenna shall be remotely mounted/suspended at the location shown on the drawings. The antenna shall be installed in a vertical orientation.

B. Select interference-free frequencies, subject to revision (as approved) to avoid interference.

C. The Assistive Listening System (ALS) shall include all hardware as required to provide a fully-functional system. The contractor shall engage the design services of the ALS manufacturer.

D. ALS Transmitter 72MHz: transmitter, rack mount, operates in the 72MHz band:

1. Listen Technologies LT-800-072-1 with LA-326 rack mount kit; or
2. Approved equal.

E. ALS Dipole Antenna 72MHz: antenna, coax or dipole, tuned for operation in the 72MHz band. Contractor shall select the cable connecting the transmitter to the antenna based on input from the ALS manufacturer:

1. Listen Technologies LA-122 (telescoping dipole); or
2. Approved equal.

F. ALS Receiver 1CH-72MHz: beltpack style receiver, tuned for operation in the 72MHz band (quantity as required to comply with ADA requirements [calculated per seating capacity of each system space]):

1. Listen Technologies LR-400-072 with LA-362 NiMH batteries or LR-4200-072 (iDSP) with LA-365 Li^+ battery; or
2. Approved equal.

G. ALS Ear Speaker: single ear speaker (one required for each receiver furnished):

1. Listen Technologies LA-401; or
2. Approved equal.

H. ALS Neckloop: neck loop for use with T-coil equipped hearing aids (quantity as required to comply with ADA requirements [calculated per seating capacity of each system space]):

1. Listen Technologies LA-166 or LA-430 (iDSP); or
2. Approved equal.

I. ALS Charger: charging case (one charging slot required for each receiver furnished):

1. Listen Technologies LA-317 4-Slot Charging/Carrying Case or LA-423 4-Port (iDSP) USB Charger; or
2. Listen Technologies LA-322, 8-slot Charging/Carrying Case; or

3. Listen Technologies LA-311 16-Slot or LA-380 12-Slot (iDSP) Charging/Carrying Case; or
4. Approved equal.

J. ALS Signage: signage notifying occupants that the assistive listening system is available. Mount signage as directed by the Owner's Representative (one required for each entrance to each applicable room):

1. Listen Technologies LA-304; or
2. Approved equal.

2.014 DISTRIBUTION AMPLIFIER

A. HDMI 1x4: HDMI distribution amplifier with one input, four HDMI-over-shielded twisted pair cable outputs, compatible with specified digital twisted pair components:

1. Extron DTP HD DA 4K 330; or
2. Approved equal.

2.015 DIGITAL TWISTED PAIR TRANSPORT

A. Twisted Pair audio and video products shall all be supplied from the same manufacturer through the signal chain (i.e. transmitter – switch/distribution amplifier – receiver).

B. HDMI over STP: single input - single output, sends HDMI and control over shielded twisted pair cable. Transmits 1080p/60 at 4:2:2 or 4:4:4 chroma sampling, specified as a pair (transmitter and receiver):

1. Extron DTP Series; or
2. Approved equal.

2.016 VIDEO DISPLAY EQUIPMENT – PROJECTORS

A. Projector lens recommendations are based on conditions anticipated during the design phase. Site conditions may differ from the design documents. The Contractor shall be responsible for field verifying the screen size/location, projector mounting location, throw distance, lens shift capability and selection of the appropriate lens. Projectors shall be installed perpendicular to their objective screen or projection surface. Image alignment shall be via projector placement and lens shift only. Digital keystone correction is not acceptable. Digital manipulation of the image size is not an acceptable alternative to incorrect lens selection. Incorrect selection of the projector lens or incorrect installation of the projector in relation to the projection surface will not be an acceptable request for a change order.

B. All projectors specified in this section shall have the following features or options included, unless noted otherwise for specific projectors:

1. Capable of minimum native resolution no less than 1920x1200

2. HDMI input
3. Control via LAN or RS-232
4. Include or provide lens capable of meeting site conditions as described above

C. Three chip LCD, laser diode light source, minimum of 16,000 ANSI lumens:

1. Panasonic PT-MZ16KL with 1.35-2.10:1 zoom lens; or

a) Approved equal.

2.017 FLAT PANEL DISPLAYS - GENERAL

A. Flat panels in this section shall be LCD.

B. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:

1. Display response time of 10ms or less
2. LED backlighting
3. VESA mounting compatible

C. LCD flat panel basis of design models are listed in the drawing schedules. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.

D. Deviation from the basis of design to a proposed substitute will be allowed as follows:

1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but without any connections are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.

a) Example connections include but are not limited to:

1) HDMI (HDCP compatible),
2) RJ45 LAN,
3) RS232 control via DB9 connector, and
4) USB.

2. Contractor shall be responsible that the proposed substitute meets or exceeds the basis of design and will:

a) have an equivalent aspect ratio.
b) meet the capabilities of any built-in speakers.
c) physically fit in the location with sufficient space for ventilation and servicing.
d) have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)

e) utilize the same touch sensing technology (resistive, capacitive, etc.)
f) be compatible with the display mount.
g) be the same image size and equal or higher resolution.
h) have an equivalent manufacturer's warranty.

3. Contractor shall submit details, including shop drawings where applicable, for each proposed substitute which include information relating to the above.

2.018 PROJECTOR MOUNTS & ACCESSORIES

A. Unless noted otherwise, provide the appropriate mount for each projector furnished. Mount color as selected by Architect. Match mount to the projector and the mounting surface.

B. Full assembly (projector, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural support shall be provided. No mounts shall fasten directly to the roof deck.

C. Shop drawing required. Refer to submittal requirements.

D. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.

E. Projector Mount - Pole: video projector mount, fully adjustable, sized for projector as required:

1. Chief RPAU; or
2. Chief VCMU (Heavy Duty Universal), or
3. Peerless PRG Series; or
4. Premier Mounts PDS-PLUS-W S; or
5. Approved equal.

2.019 FLAT PANEL DISPLAY/TELEVISION MOUNTS

A. Unless noted otherwise, provide the appropriate mount for each display furnished. Mount color as selected by Architect. Match mount to the display and the mounting surface.

B. Full assembly (display, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural backing/support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.

C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.

D. Mounts shall be selected and installed to ensure the full display/mount assembly meets all ADA requirements, including Protrusion Limits into Circulation Paths of no more than 4" (as defined by the ADA Accessibility Guidelines). Additional considerations may include:

1. The use of thin mounts in lieu of standard depth display mounts to reduce mounting depth.
2. Where wall standoffs are utilized, ensure overall depth is no greater than 4".
3. The use of "right angle" plugs or terminations may be required to maintain minimum cable bend radius.
4. The use of recessed back boxes may be required to accommodate plugs or terminations and any display mounted equipment.
5. The use of recessed back boxes with thin profile articulating mounts may be utilized in lieu of thin mounts.

E. Flat Panel Mount – Wall – Tilt: tilt wall mount, fully adjustable, lockable, sized for display as required:

1. Chief FUSION *TM Series (OD for outdoor series); or
2. Peerless ST Series (EPT for outdoor series); or
3. Premier Mounts P****T Series (-EX for outdoor series).

F. Flat Panel Mount – Wall – Tilt Thin: tilt wall mount, low profile, fully adjustable, lockable, sized for display as required:

1. Chief FUSION *TT; or
2. Peerless Ultra Slim SUT Series; or
3. Premier Mounts Low-Profile P****T Series (-EX for outdoor series).

G. Flat Panel Mount – Wall – Articulating: articulating arm wall mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required:

1. Chief TS***T Series (OD for outdoor series); or
2. Peerless SA Series (ESA for outdoor series); or
3. Premier Mounts AM Series.

H. Flat Panel Mount – Wall – Articulating ADA: articulating arm wall mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required; with recessed back box for retain mount within wall cavity, maximum depth of mount at face of wall no greater than 0.5":

1. Chief RIW Series mount with PAC501B in-wall back box; or
2. RP Visuals Wallmate Series; or
3. Approved equal.

I. Flat Panel Mount – Ceiling - Pole: ceiling mounts one display from 1.5" pipe, fully adjustable, locking, sized for display as required:

1. Chief FUSION CM Series; or
2. Peerless PLCM Series (ECMU for outdoor series); or

3. Premier Mounts CTM Series.

J. The maximum allowable lateral movement of a ceiling pole mounted display assembly shall not exceed one inch at the bottom of the display. Where these conditions cannot be met by the standard installation requirements, the following components are approved where necessary to facilitate compliance with this guideline.

1. Where pole length creates excessive "shaking" of the display under normal operating conditions due to structural deflections, the following components may be utilized to mitigate the issue.
2. Mitigation methods do not alleviate the Contractor's responsibility for proper rigid support methods to prevent these concerns.

K. Flat Panel Mount Accessory – Lateral Bracing – Wall: Provides additional lateral support to flat panel displays or other equipment suspended by NPT pipe assemblies. For use in close proximity to wall or other structural element. Minimum two (2) assemblies required per installation. Install per Anvil International Seismic-10.13, pg. 5.

1. Anvil International Q Brace Clamp, P/N: fig.770; with
    a) Anvil International Sway Brace Swivel Attachment, P/N: fig.770; or
2. Approved equal.

L. Flat Panel Mount Accessory – Lateral Bracing – Cable: Provides additional lateral support to flat panel displays or other equipment suspended by NPT pipe assemblies. For use when primary support pipe is not in close proximity to wall or other structural element.

1. Display Devices Pole Stabilizing Kit; or
2. Approved equal.]

2.020 FRONT PROJECTION SCREENS – INSTALLED

A. All projection screens specified in this section shall have the following features or options included, unless noted otherwise for specific screens:

1. Black backing on screen surface
2. Extra drop to allow for bottom of screen image to reach 48" AFF
    a) Screen fabric shall be fully deployed when at the specified height
3. Motorized screen
4. Externally mounted electrical junction box / low voltage control interface

B. Refer to drawing schedules for exact screen size required per screen. Size listed as: (height in inches)-(width in inches). Deviance from basis of design size allowed +/-2".

C. Coordinate final mounting position with appropriate parties. Ensure screen is mounted such that screen drop is not impeded by wall mounted devices, including any electrical devices or marker boards and trays. Screen drop shall not impact wall during deployment.

D. Projection Screen: motorized, tab-tensioned, ceiling mounted projection screen. Image viewing area as listed on drawings (H" x W"):

1. Da-Lite Wireline Advantage; or
2. Approved equal.

2.021 A/V CONTROL SYSTEM – EQUIPMENT

A. Program the system to provide acceptable operation by the Design Consultant and/or Owner's Representative.

B. Select equipment that can be fully controlled by the control system furnished.

C. All systems shall be accessible remotely via the Owner's LAN as directed by the Owner's Representative.

D. All control equipment necessary shall be furnished to provide a complete operating system:

1. Button Controller – Six Button
    a) Extron NBP 100;
    b) No substitutions allowed.
2. Volume Control – Rotary volume knob, mute button
    a) Extron ACP VC1 D;
    b) No substitutions allowed.
3. Control System - Processor
    a) Extron IPCP PRO 250;
    b) Extron IPCP PRO 350;
    c) No substitutions allowed.

2.022 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

A. Refer to Division 27 Section "Audio Video Systems" for general programming requirements with the following revisions and additions:

1. No additional requirements.
2.

2.023 STANDBY EQUIPMENT

A. The following equipment shall be on-hand at the time of system final acceptance and system first-use for possible replacement of defective equipment or for field

conditions noted. Maintain ownership of this standby equipment. However, if any item of this standby equipment is used to replace defective equipment, the installed item of standby equipment becomes Owner's property. Assume ownership of the defective equipment:

1. Power Amplifier (one of each type required).
2. Loudspeaker (four of each type required).
3. Backup software for programmable devices.
4. Laptop computer for all programmable devices.

B. Allowances for overnight shipping shall be included and utilized if any component is required for Owner's initial operation, first-use, or as directed by either the Owner's Representative or the Design Consultant prior to Substantial Completion.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS

A. Refer to Division 27 Section "Audio Video Systems" for common requirements.

3.02 LABELING

A. Refer to Division 27 Section "Audio Video Systems" for labeling requirements.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of work for this system includes providing assembled, fully functional system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, accessories, system programming etc. as necessary in these specifications and integrating system with related two-way communication system at Areas of Refuge locations. The two-way communication system shall be IP-based.

B. System Description:

1. Call Stations: Located at each designated area as indicated on drawings, unless otherwise directed by authorities having jurisdiction.
2. Master Control Station: New; located as indicated on drawings, unless otherwise directed by authorities having jurisdiction.
3. Provide secondary control station(s) located as indicated on drawings.
4. System battery backup is required;
    a) Capacity: 24 hours standby
5. Timed automatic connection to designated constantly attended monitoring location
6. Minimum Number of Zones Supported: As required for call stations/zones indicated, with minimum 400 percent spare capacity;

C. System Operation:

1. When a call for assistance is initiated at call station:
    a) Provide audible and visual notification at call station to confirm that call has been placed.
    b) Provide audible and visual notification at control station(s) that call has been placed and annunciate the location of the call station/zone that initiated a call.
    c) Maintain visual notification of each call location at control station(s) until manually reset by control station operator.
    d) Maintain audible notification at control station(s) that call(s) have been placed until call is acknowledged by control station operator.
    e) Maintain visual notification at call station until manually reset by control station operator.
2. When a call for assistance is acknowledged at control station:
    a) Provide visual notification at control station that call has been acknowledged.
    b) Provide visual notification at call station that call has been received.

c) Establish two-way voice communication between call station and control station.

3. When a call has not been acknowledged during a programmed time delay to allow for local response, automatically initiate call to listed remote monitoring station under contract with facility; and establish two-way voice communication.

1.02 QUALITY ASSURANCE

A. Contractor will be an authorized reseller of the equipment and hardware included in their bid package. Where manufacturer's warranties are required, Contractor will be authorized by manufacturer to warrant the system.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company engaged in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company with minimum three years documented experience with similar area of refuge/rescue assistance systems and providing contract maintenance service as a regular part of their business manufacturer's authorized installer.

1. Contract maintenance office located within 200 miles of project site.

E. Maintenance Contractor Qualifications: Same entity as installer

F. Products: Listed, classified, and labeled as suitable for the purpose intended.

G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

H. Products provided shall meet FCC regulatory requirements for electromagnetic emissions.

I. Provide products listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose intended.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for area of refuge/rescue assistance system components.

2. Coordinate the work with other installers to provide communication lines required for control station timed automatic connection to designated constantly attended monitoring location.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install call stations and control station(s) until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams.

D. Design Data: Include standby battery calculations.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

G. Manufacturer's certification that products meet or exceed specified requirements.

H. Field quality control test reports.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

K. Maintenance contracts.

L. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

M. Maintenance Manuals and Record Drawings

1. Accurately record installation information including device location, serial number, model number, port labels, configuration, software/firmware revision, date of installation, test results, installer/technician, and project manager's approval. Provide in written and electronic format.

1.05 RELATED SECTIONS

A. Division 26 Section "Raceways and Boxes for Electrical Systems" for rough-in requirements

1.06 REFERENCES

A. Comply with AHJ requirements

1. Americans with Disabilities Act

a) 2010 ADA standards for Accessible Design

2. National Fire Protection Agency

a) NFPA 70 – National Electrical Code
b) NFPA 72 – National Fire Alarm and Signaling Code
c) NFPA 101 – Life Safety Code

3. International Code Council

a) (IBC) International Building Code

PART 2 - PRODUCTS

2.01 GENERAL

A. The following manufacturers are "Conditionally Approved". "Conditionally Approved" means that the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.

1. Code Blue
2. Cornell Communications
3. Housing Devices Inc.
4. Rath Microtech
5. Space Age Electronics, Inc.
6. Talk-a-Phone
7. Viking Electronics

B. Source Limitations: Furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 CALL STATION(S)

A. Requirements

1. Vandal resistant, with tamper proof hardware.
2. Suitable for the environment where installed.
3. Finish: Painted steel or stainless steel
4. Mounting: Flush-mounted;
5. Provides means to initiate call for assistance.
6. Provides for distinct audible and visual notification to confirm that call has been placed and for distinct visual notification that call has been acknowledged.
7. Following initial call for assistance, provides for hands-free two-way communication with control station(s).
8. Illuminating LED's for low light viewing.
9. Cast metal raised letter and Braille signage for ADA compliance

2.03 MASTER CONTROL STATION(S)

1. Vandal resistant, with tamper proof hardware.
2. Suitable for the environment where installed.
3. Mounting: Flush-mounted;
4. Provides visual notification that system is operational.
5. Provides for distinct audible and visual notification of calls with annunciation of call station/zone locations.
6. Provides for two-way communication with selected call stations.
7. Provides for supervision of system wiring and provides distinct audible and visual notification of faults.
8. Audible Notification Sound Level: Not less than 90 dB
9. Strobe activates when emergency call is first detected and remains active for duration of call.
10. 2-way internal communication via handset.
11. Illuminating LED's for low light viewing.

B. Accessories

1. Provide components as indicated or as required for a complete operating system.
2. Wiring: Provide manufacturer's recommended cables as indicated or as required for connections between system components, and in accordance with wiring methods indicated.

    a) IP-Based low voltage wire

        1) UL listed 2-hour Circuit Integrity (CI) Cable.
        2) S/UTP Category 6

3) IP-Based Systems are limited to 100 meters.

3. Signage:

a) Illuminated Signs: Complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

b) Self-Powered Illuminated Signs: Upon interruption of normal power source, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

c) Call Station Instruction Signs: Raised character and Braille instructions complying with ADA Standards.

d) Product(s):

1) Photoluminescent Call Station Instruction Signs
2) Non-illuminated Directional Signage

PART 3 - EXECUTION

3.01 GENERAL

A. Unless otherwise stated, where installation requirements identified in drawings and specifications conflict with the manufacturer's recommendations, the more restrictive standard shall apply.

B. Bring to the attention of the Owner and Engineer conflicts between manufacturer's instructions and Construction Documents.

C. Provide parts, components, labor and installation as authorized, described, and recommended by the manufacturer.

D. Provide signage at each emergency phone.

E. Program command unit and emergency phones:

1. Verify programming instructions with Owner prior to programming the system.
2. Program each Emergency Phone with location identifier message.
3. When activated, Emergency Phone shall locally call the Command Unit.
4. If the Command Unit does not answer or is busy, program the Emergency Phone to call remote number to emergency personnel (receive phone number from Owner). If no one answers the remote number, have it re-ring the local phone and continue this cycle until either the local or remote phone answers the call.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

3.03 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

3.04 INSTALLATION

A. All wire shall be installed in conduit and concealed in structure. Wire shall not be spliced.

B. Contractor shall be responsible for all testing of all devices for complete functionality. Malfunctioning or non-functioning devices shall be replaced by the Contractor.

C. Separate wires 20” (50 cm) away from any AC wiring, fluorescent lights, dimmer switches. etc.

D. Contractor shall include service for 60-day period for adjustment of the system in their bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Provide a complete functioning Neutral-Host Distributed Antenna System (DAS) capable of supporting Public Safety Networks (PSN) and Wireless Service Providers (WSP) for Cellular Telephones and/or Facilities Radio System. Each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. This specification section, and relevant information found on drawings numbered with prefix TN generally describe these systems, but the scope includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 27 Section "General Communications Requirements".

C. Division 27 Section "Communications Backbone Cabling" is the parent section of this specification section.

1.03 REGULATORY REQUIREMENTS

A. Products provided shall meet FCC regulatory requirements for electromagnetic Emissions.

B. Provide products listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose intended.

1.04 SUBMITTALS

A. Submittal Requirements with Bid Response:

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

a) Optical fiber cable and hardware
b) Coverage antennas or access points
c) Coaxial cable and connectors (if used)
d) Splitters, combiners, and couplers (if used)
e) All active components included in the proposal

2. Shop Drawings: Submit the following items:

a) Proposed riser and horizontal cabling diagram
b) RF link budget (If DAS included)
c) Overlay of system components on floor plans
d) Bill of materials (BOM)

3. Statement of Work (SOW): Submit sample SOW
4. Acceptance Test Plan (ATP): Submit sample ATP
5. Recommended Spares
6. Warranty Documents:

a) Submit for all manufactured components specified in this section
b) Submit contractor's system warranty
c) Submit manufacturer's extended warranty

7. Submittal Requirements Prior to Start of Construction

a) Final RF link budget (If DAS included)
b) Overlay of system components on floor plans
c) Drawings for donor antenna and grounding (if used)
d) RF propagation modeling for all bands and carriers on the system (If DAS included)
e) Bill of materials (BOM)
f) Maintenance service contract
g) Statement of Work (SOW): The contractor shall submit an SOW that has been accepted by the customer or customer's designated representative.
h) Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.

8. Submittal Requirements at Close Out

a) Drawings: Submit as-built drawings indicating:

1) Cable routing, splitters, couplers, and coverage antenna locations
2) Active component locations, layout, and configuration

b) Test Reports: For WSP DAS, submit an accepted ATP report confirming the requirements of each respective WSP has been met. (If DAS included)
c) Retransmission Agreements provided by respective WSP if required (If DAS included)

d) Field Reports: Submit optical test results for all fiber runs including field terminations
e) Operation and Maintenance Data: Submit hardware and software manuals for all active components
f) Warranty Documents
    1) Submit for all manufactured components specified in this section
    2) Submit contractor's system warranty
    3) Submit manufacturer's extended warranty

1.05 QUALITY ASSURANCE

A. Qualifications

1. Contractor or subcontractor shall have a minimum of four years full-time experience executing work of similar scope and complexity.
2. Contractor or subcontractor shall have deployed a minimum of 10 networks.
3. Contractor or subcontractor shall have the ability to remotely monitor DAS networks (if DAS included).
4. Contractor or subcontractor shall have the ability to provide comprehensive system maintenance.
5. Contractor or subcontractor project managers must be Project Management Institute (PMI) - certified.
6. Contractor or subcontractor shall provide an on-site construction foreman to oversee the installation.
7. Contractor or subcontractor shall provide a project manager to oversee the deployment.
8. Contractor or subcontractor must have a registered communications distribution designer (RCDD) on staff.

1.06 CERTIFICATIONS

A. The manufacturer(s) of the active components shall maintain a formal authorized and certified value-added reseller program, which consists of routine quality audits of the participating value-added resellers. The list of authorized value-added resellers shall be published, and the contractor or subcontractor shall be listed in the manufacturer's publication of value-added resellers.

B. Contractor or subcontractor(s) shall provide manufacturer certification that their personnel have been trained on the passive and active components being installed.

C. Contractor or subcontractor shall be an authorized and certified value-added reseller for the proposed manufacturer of passive and active components.

1.07 WARRANTY

A. Manufacturer Warranty

1. Splitters, Couplers, and Coverage Antennas: Five-year limited warranty from date of system acceptance
2. Coaxial Cable and Connectors: 10-year limited warranty from date of system acceptance
3. Fiber Optic Cable: 25-year limited warranty from date of system acceptance
4. Active Components: One-year limited warranty from date of system installation or 15 months from date of shipment

B. Contractor Warranty: Contractor shall warrant the system performance for one year.

1.08 MAINTENANCE

A. The contractor shall provide an optional annual maintenance service contract to include:

1. 24/7 year-round remote monitoring
2. Remote diagnostics and repair
3. 24/7 year-round technician dispatch (on-site within 24 hours)
4. Annual preventive maintenance
5. Service provider coordination
6. Equipment warranty management

1.09 CODES, STANDARDS AND CERTIFICATIONS

A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractor's Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements. Equipment and cabling installation shall comply with the following standard s. All publications must be of the latest issue and addenda:

1. NFPA 70 - 2020 National Electrical Code (NEC®)
2. 2012 International Fire Code
3. NFPA 72 2013 – National Fire Alarm and Signaling Code
4. Federal Communications Commission (FCC) - Title 47 of the Code of Federal Regulations, Part 90.
5. Federal Communications Commission (FCC) Rules, Parts 15 and 22
6. ANSI/TIA-568-C.O: Generic Telecommunications Cabling for Customer Premises (February 2009)
7. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (February 2009)
8. ANSI/TIA-568-C.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standards (April 201 0)

9. ANSI/ TIA-568-C. 3: Optical Fiber Cabling Components Standards (June 2008)
10. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces (May 2009)
11. ANSI/TIA-606-A: The Administration Standard for the Telecommunications Infrastructure of Commercial Building (November 2008)
12. ANSI/ TIA-J-STD-607 -D: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
13. BICSI Information Transport Systems Installation Methods Manual, Current Edition
14. BICSI Telecommunications Distribution Methods Manual, Current Edition

B. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.

1.010 ABBREVIATIONS AND ACRONYMS

A. ACG: Automatic Gain Control

B. AHJ: Authority Having Jurisdiction

C. ATP: Acceptance Test Plan

D. AWS: Advanced Wireless Service

E. BDA: Bi-Direction Amplifier

F. BOM: Bill-of-Material

G. BRS: Broadband Radio Service

H. BTS: Base Transceiver Station

I. CDMA: Code Division Multiple Access

J. C/N: Carrier-to-Noise Ratio

K. CWDM: Coarse Wave Division Multiplexing

L. DAS: Distributed Antenna System

M. DWDM: Dense Wave Division Multiplexing

N. EBS: Educational Broadband Service

O. ESMR: Enhanced Specialized Mobile Radio

P. FCC: Federal Communications Commission

Q. GUI: Graphical User Interface

R. iDEN: Integrated Enhanced Digital Network

S. LMR: Land Mobile Radio

T. LTE: Long Term Evolution

U. MTBF: Mean Time Between Failure

V. NFPA: National Fire Protection Association

W. NMS: Network Management System

X. PCS: Personal Communications System

Y. PSN: Public Safety Network

Z. RoF: Radio-over-Fiber

AA. RoHS: Restriction of Hazardous Substances

BB. RSL: Received Signal Level

CC. SISO: Single-Input, Single-Output

DD. SMR: Specialized Mobile Radio

EE. SMS: Short Message Service

FF. SNIR: Signal-to-Noise Interference Ratio

GG. SNMP: Simple Network Management Protocol

HH. SOW: Statement of Work

II. VSWR: Voltage Standing Wave Ratio

JJ. WSP: Wireless Service Provider

1.011 WORK INCLUDED

A. Converged fiber optic transport infrastructure: Product shall support the delivery of multiple disparate services including but not limited to carrier-grade cellular signals in the 700/800/CELL/PCS/AWS, AWS3 2.5 GHz and Wireless Communications Service (WCS) bands in both SISO and MIMO configurations, Gigabit Ethernet, technologies requiring simplex or duplex single-mode fiber, and NEC Class 2-

compliant DC power directly to active access points/antenna units or mid-power remote units via readily available Corning ActiFi™ composite optical fiber/copper cable.

B. Product shall allow for discrete individual remote access unit (RAU) or mid-power remote (MRU) addressability and segregation or aggregation via common headend control software/firmware. All individual RAU and/or MRU shall support NEC Class 2 remote DC power via composite fiber/copper cables and shall be able to support at a minimum LTE (SISO/MIMO), ESMR, CELL, PCS, AWS (SISO/MIMO), and WCS. RAU shall be plenum rated (UL 2043) and shall also allow for below-, in-, and above-ceiling tile mounting. RAU shall have external antenna ports to allow for the addition of external antennas when required. MRU shall support both indoor and outdoor mounting locations; outdoor mounting options are available by leveraging the Purcell FLX2412 or FLX2416 GR-487-rated enclosure to protect the MRU from the outdoor environment while maintaining full serviceability and upgradability of the unit.

C. Passive cabling infrastructure, with the exception of connections to external antenna ports on RAU and jumpers/connections to headend equipment, shall be single-mode fiber for all riser connections and composite fiber/copper cabling in the horizontal.

D. RAUs shall be stand-alone DC-powered units that may be mounted horizontally on ceiling surfaces or in- or above-ceiling tiles via mounting brackets. Units may also be wall-mounted with the use of external antennas. RAU shall have the following features:

1. Operational Temperature: 0° to +50□C (32° to 122□F)
    a) Wall-mount installations: 45□C (113□F)
2. Supported Services
    a) SISO: CELL/ESMR, PCS, AWS, AWS3 , 700 LTE
    b) MIMO: AWS/700 LTE (with expansion module)
3. Interface Connections:
    a) Two LC APC single-mode fiber connectors
    b) Two DC power input ports; main and secondary
    c) Two QMA RF ports; for external cavity filter (in/out) use
    d) LTE and CELL filters
    e) One external antenna
    f) One RJ45 MGMT (local) connection
4. Built-in Antenna (when supplied)
    a) Omnidirectional (15 degrees down from horizon)
    b) Must provide QMA port for optional broadband external antenna
5. Management

a) Web-based management via centralized control system
b) Port available to access headend or any RAU on network

6. Physical Characteristics

a) Mounting: Horizontal mount above or below acoustic ceiling, wall mount
b) Dimensions, without external antenna (H x W x D): 3.6 x 12.9 x 10.4 in (90 x 327 x 264 mm)
c) Dimensions, with external antenna (H x W x D): 6.1 x 13.1 x 13.1 in (154 x 334 x 334 mm)
d) Maximum Weight: 14.39 lb (6.5 kg)
e) Maximum Weight of external antenna: 3.7 lbs (1.7 kg)

E. MRU shall be stand-alone AC- or DC-powered units capable of both indoor and outdoor installation depending on the configuration. Units shall have a number of hot-swappable plug-and-play features and integrate into a central headend with other similar components. The MRU shall have the following features:

1. Required Features

a) Shall support multiple frequency bands including 700, ESMR, 800/CELL, PCS, AWS, AWS3, WCS via plug-in hot- swappable modules, and 2.5 GHz via external input ports.

1) Bands shall be deployed via modules and allow for future field upgrade without need to power down system.
2) System shall support any combination of bands

b) Shall support multiple power input modes including AC, DC Class 1 and DC Class 2 via field-swappable module.
c) Fan assembly shall be hot-swappable and field-installable
d) System shall integrate a management port that allows field service personnel access to the entire management platform including equipment located remotely from the MRU
e) System shall allow for real-time reconfiguration of RF services including re-provisioning of multisector deployments without need for physical jumper or wiring changes
f) System shall support up to 2 W RF output per module for bands greater than 1 GHz and 1 W for bands less than 1 GHz.
g) System shall support external dry contact alarm inputs at the remote for monitoring adjacent units or outdoor enclosures.
h) System shall be capable of being deployed in outdoor environments via use of external cabinet specified by the equipment manufacturer.

1) Configuration shall include built in alarms for door security as well as cabinet internal temperature

2. Operational Environment

a) Operating Temperature: -40° to +65°C (-40° to 149°F)
b) Storage Temperature: -30° to 85°C (-22° to 185°F)

1) NEBS Rating: GR-63, GR-1089 (standard enclosure) and GR-487 (outdoor enclosure)

c) Physical Characteristics

1) Mounting: 19-in rack (maximum 6U per unit) or wall mount (optional, with additional bracket)
2) Dimensions: 10.5 x 17.5 x 15.75 in
3) Weight (fully loaded): 70.55 lbs

d) AC Power

1) 100-240 VAC 50-60 Hz
2) 5 A maximum
3) 360 W maximum power consumption
4) Require fewer than six 100 W pairs to power the unit
5) Cabling shall accommodate a minimum of 64 W

e) DC Class 1 Power

1) 48 VDC (40-60 VDC range)
2) 9 A maximum
3) 330 W maximum power consumption

f) DC Class 2 Power

1) 24/48 VDC (20-60 VDC range)
2) 1.75 A maximum per pair (multiple pairs required)
3) Power amplifiers require 50 W per pair
4) 330 W maximum power consumption

3. The system shall also provide when using RAU via either add-on or stand-alone module a minimum of two 10/100/1000BASE-T (802.3/802.3ab/802.3u) 802.3at/af-compatible optical Ethernet duplex LC APC ports.
4. The headend interface to the wireless service providers shall provide a flexible platform that provides up to 48 interface points per set of four shelves for any number of WSPs and their services. Headend shall allow for flexible configuration and allocation of these connected services via software configurations without the need to change physical jumper locations.
5. The headend interface shall include an optical interface that provides one-for-one connection points for every RAU and/or MRU connected to the system. The optical interface shall be expandable in quantities of three so as to support up to 144 RAU per headend. The optical interface unit shall allow for flexible software configuration of each set of three RAUs to support all or a subset of the services connected to the headend interface.
6. The headend interface shall have an option that allows the various components that make up the headend to be distributed across multiple locations up to 12.75 miles apart via one single-mode fiber link. This remote capability shall have the following features:

a) Must allow multiple RF sources from multiple different locations to be fed into the system
b) Must support up to three different RF layers/sectors across all of the interlinked systems
c) Must allow for transparent management of the system at any of the remote headend locations including any of the connected RAU or MRU
d) Must provide a port for parallel transport of dense wavelength division multiplexing (DWDM) (100 GHz ITU grid) or coarse wavelength division multiplexing (CWDM) optical signals such as 10 or 1 GbE or FC between remote headend locations
e) Main: DWDM -1550.12 nm, CWDM 1550 nm
f) Remote: DWDM 1530.33 nm, CWDM 1530 nm
g) Must allow for either star or mesh Layer 1 topology and must allow for up to one level of cascading

7. The headend interface shall include the following characteristics:

a) Provide UL, DL, and/or duplex QMA connections to up to 48 WSP services and accept composite input levels from 0 to 37 dBm
b) Shall provide a control system that contains the Web-based system management software

1) Interface shall be Web-based.
2) Connections to the interface may be made via local Ethernet, LAN connection, or via remote connection via physical or wireless connection to a RAU connected to the system.

c) The system shall be powered via 100-220 VAC and be able to have a redundant power supply. Maximum power per chassis shall be 200 W.
d) System shall be 19-in rack-mountable, and each chassis shall occupy no more than 4U.
e) The optical interfaces shall be via angled MTP ® connectors.
f) Optical loss budget per fiber shall be 5 dB or better.
g) The overall system performance including headend and antenna units:

RF Parameters per Service (RAU)

Supported Services

	Frequency Range (MHz)		
Services	Band	Uplink (UL)	Downlink (DL)
LTE	700 MHz	698-716 777-787	728-746 746-756
CDMA/WCDMA[2]/ TDMA/GSM/LTE[1]	ESMR800/CELL 850	817-824/824-849	862-869/869-894

CDMA/WCDMA[2]/TDMA/GSM/LTE[1]	PCS 1900	1850-1915	1930-1995
WCDMA[**]/LTE[*]	AWS 2100	1710-1780	2110-2180

[*]WCDMA service is based on 3GPP standards, LTE service may deployed in the future due to Frequencies re-farming planned by the Carriers as well

[**]WCDMA service is based on 3GPP2 CDMA2000 standards.

RF Parameters per Service

Service/Band	LTE 700 MHz		ESMR800/ CELL850 MHz		PCS 1900 MHz		AWS+AWS3 2100 MHz	
RF Parameter	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**
Frequency Range (MHz)	728-746 746-756	698-716 777-787	862-869/ 869-894	817-824/ 824-849	1930- 1995	1850- 1915	2110- 2180	1710- 1780
Max Output Power Per Antenna Port (dBm)	15		15		20		20	
Max Input Power (dBm)	0 to 37		-10 to 37/ 0 to 37		0 to 37		0 to 37	
Typical Antenna Gain (dBi)	0		0.5		3		2.5	
Horizontal Polarization Omni @ 34-45 Degree	-2 to 0		-2 to 0		-1 to 1		-1 to 1	
UL Gain (dB)		-19 to 15		-19 to 15		-19 to 15		-19 to 15
Input IP3 (dBm) AGC OFF Typical		-5		-5		-5		-5
Input IP3 (dBm) AGC ON Typical		5		5		5		5
SFDR[*] (dB)		60		64		64		60
Max Intermod Distortion [dBm]	-13		-13		-13		-13	
UL NF[**](dB)		12		12		12		12
Gain Flatness/Ripple (dB)	±2.0		±2.0		±2.0		±2.0	

* SFDR calculated with bandwidth of 1.23 MHz for the CELL and PCS and with 5 MHz for the LTE and AWS

**Typical for single remote access unit

RF Parameters per Service (MRU)

Supported Services

	Frequency Range (MHz)		
Technology	**Service/Band**	**Uplink (UL)**	**Downlink (DL)**
LTE	700 MHz Lower ABC 700 MHz Upper C	698-716 777-787	728-746 746-756
CDMA/LTE	ESMR 800	817-824	862- 869
CDMA/GSM/LTE/UMTS	CELL 850	824-849	869-894

UMTS/LTE	AWS + AWS-3	1710-1778	2110-2180
CDMA/LTE/GSM/UMTS	PCS + G 1900	1850-1915	1930-1995
LTE	WCS	2305-2315	2350-2360
LTE	BRS/EBS	2496 - 2690	

RF Parameters per Service

Service/Band	LTE 700 MHz		ESMR800/ CELL850 MHz		AWS 1700 MHz		AWS1/3*** 1700 MHz		PCS 1900 MHz		WCS 2300 MHz	
RF Parameter	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**	**DL**	**UL**
Frequency Range (MHz)	728-746 746-756	698-716 777-787	862-869/ 869-894	817-824/ 824-849	2110-2155	1710-1755	2110-2180	1710-1778	1930-1995	1850-1915	2350 - 2360	2305 - 2315
Max Output Power Per Antenna Port (dBm)	30		30		34		34		33		33	
Input Power (dBm)	0 - 37		0 - 37			0 - 37		0-37	0 - 37		0 - 37	
UL Gain Range (dB)		-19 to 15		-19 to 15		-19 to 15		-19 to 15		-19 to 15		-19 to 15
SFDR* (dB)		60		64		60		60		64		60
Maximum Intermod Distortion (dBm)	≤ -13		≤ -13		≤ -13		≤ -13		≤ -13		≤ -13	
UL NF**(dB)		12		12		12		12		12		12
Gain Flatness/Ripple (dB)	±2.0		±2.0		±2.0		±2.0		±2.0		±2.0	

* SFDR calculated with bandwidth of 1.23 MHz for the CELL and PCS and with 5 MHz for the LTE, AWS and WCS.
**Typical for single remote unit
***AWS1/3 supported only with MRU-PAM-A17E

F. Omnidirectional Coverage: Omnidirectional coverage antennas shall feature a multiband design, accommodating multiple frequency bands in a single small antenna.

1. MIMO antennas shall have specifications that meet or exceed below:

Antenna Type	Small Form Factor MIMO In-Building Antenna
Diameter	8.19"(208mm)
Height	2.83"(72mm)
Weight	0.95 lbs (430g)
Catalog Number	02121261-05542U

Frequency Band(MHz)	698-894	894-960	1710-2180	2180-2700	698-894	894-960	1710-2180	2180-2700
Input	2x N-Type or 4.1/9.5 MiniDIN Connector (Female) with pigtail cable (12"/30cm length)							
Horizontal Beamwith	Omni (360°)							
Impedance	50 Ω							
Inter-Port Isolation (typ.)	-20 dB		-25 dB	-30 dB	-20 dB		-25 dB	-30 dB
VSWR	<1.7:1	<1.8:1	<1.7:1	<1.5:1	<1.7:1	<1.8:1	<1.7:1	<1.5:1
Gain (typical)	1.5-3.5 dBi	2.0-3.5 dBi	3.5-6.0 dBi	5.0-6.0 dBi	2.0-3.0 dBi	2.5-3.5 dBi	3.5-5.0 dBi	4.0-5.5 dBi
PIM @ 2 x 43 dBm*	< -150 dBc*							
Input Power	25 W at ambient temperature of 77° F (25° C)							

2. SISO antennas shall have specifications that meet or exceed below:

Electrical Specifications					
Frequency Band	698-790 MHz	790-960 MHz	1710-2200 MHz	2300-4200 MHz	4300-6000 MHz
Polarization	vertical				
Antenna Structure	1 Port				
Impedance	50 Ω				
VSWR	<1.5:1	<1.5:1	<1.5:1	<1.7:1	<1.5:1
Input Connector Type	N-Type Connector (Female)				
Gain	1.5-2.5 dBi	2.0-3.0 dBi	4.5-6.5 dBi	4.0-7.0 dBi	5.0-7.5 dBi
Horizontal Beamwidth	Omni (360°)				
PIM @ 2x 43dBm	< -150 dBc				
Input Power	50 W at ambient temperature of 77° F (25° C)				

G. Directional Coverage: Directional coverage antennas shall feature a multiband design, accommodating multiple frequency bands in a single small antenna.

1. MIMO antennas shall have specifications that meet or exceed below:

Electrical Specifications		
Frequency Band	698-960 MHz	1710-2700 MHz
Polarization	Vertical/Horizontal	Dual slant 45° (±45°)
Input Connector Type	2x N-Type or 4.1/9.5 MiniDIN Connector (Female) with cable (12"/30cm length)	
Impedance	50 Ω	
VSWR	< 2.0:1	<1.8:1
Isolation between ports (typ.)	-25 dB	
Gain	5 dBi	8 dBi
PIM @ 2x 43 dBm	< -150 dBc	
Horizontal Beamwidth	~90°	~65°
Vertical Beamwidth	~110°	~65°
Input Power	50 W at ambient temperature of 122° F (50° C)	

H. All-Dielectric, Plenum-Rated Cable:

1. Material Characteristics:

a) Jacket: Halogenated, fire-retardant

b) Outer Conductor Material: Corrugated aluminum or corrugated copper
c) Inner Conductor Material: Copper-clad aluminum wire

2. Electrical Characteristics:

a) Impedance: 50 ± 2.0 Ohm
b) Frequency Band: 1-8800 MHz
c) Peak Power Rating: ≥ 40.0 kW

3. Mechanical Characteristics:

a) Diameter Over Jacket: ≤ .627 in
b) Minimum Bending Radius: ≤ 5 in
c) One-Time Minimum Bend Radius: ≤ 3 in

4. Attenuation Characteristics:

Frequency (MHz)	Attenuation (dB/100 ft)
150	≤ 0.848
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564

5. Standard Conditions: voltage standing wave ratio (VSWR) 1.0, ambient temperature 20°C (68°F)
6. Approved Manufacturer: Trilogy AP012J50 or equivalent.
7. Splitters, Combiners, Couplers, and Coax Jumpers: Approved Manufacturer: Microlab or equivalent.

I. Services: Upon commissioning, the DAS shall provide coverage for the WSPs and PSNs listed below on all frequencies currently being used by the designated WSPs and PSN in the given market.

1. AT&T
2. Verizon Wireless
3. Sprint
4. T-Mobile
5. 700/800 MHz PSN coverage, meet requirements of Oklahoma City, OK

J. WSP Approval: The Contractor shall propose and deploy a DAS system capable of receiving WSP Approval for interconnection to the WSPs' macro networks.

K. PSN Approval: The Contractor shall propose and deploy a DAS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).

L. Broadband Active Distribution: Single-mode fiber-optic cable will be used for Active distribution. In-line amplifiers are not allowed.

M. Network Management:

1. NMS: The DAS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all Active Components.
2. SNMP Integration: The DAS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

1.012 ALTERNATIVES

A. No alternative component(s) shall be accepted as equal to the components and manufacturers specified in this document unless the Contractor proves that the alternative component(s) are of equal or superior specifications and quality, and that they have been used in similar projects of size and complexity for no less than 3-years. The following information shall be required for each alternative component with submittal of the bid response:

1. Passive Components:

   a) Product samples
   b) Detailed product specifications
   c) Independent test results verifying the product specifications
   d) Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 7-years from the date of system acceptance.

2. Active Components:

   a) Hardware and software manuals
   b) Detailed product specifications
   c) Mean Time Between Failure (MTBF) data for each Active Component
   d) Independent test results verifying the product specifications
   e) Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 7-years from the date of system acceptance.
   f) For Active Components serving the WSPs, written documentation from the WSPs that the alternative component(s) are approved for use within the WSP's network and that interconnection of the DAS to the WSP's network will not be withheld due to the alternative component being used in the DAS.
   g) For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the DAS to the PSN will not be withheld due to the alternative component being used in the DAS.

1.013 PERFORMANCE REQUIREMENTS

A. WSP DAS:

1. On a per channel basis, the downlink RSL for each frequency band shall meet or exceed the criteria:

    a) Minimum downlink receive signal level (RSL) Lower 700 MHz, BRS/EBS -75 dBm; Cellular, PCS, AWS, Commercial 800/900 MHz -85 dBm; Public Safety 380 - 512, 700, 800 MHz -95 dBm

2. Contractor shall state the assumed channel loading and frequency bands for the proposed WSP in-building coverage. Prior to installation, contractors shall confirm the channel loading and frequency use in the serving area, and shall guarantee coverage for these channels per the above criteria.
3. The DAS shall deliver coverage per the criteria in 1.9.A.1.a throughout 95% of all occupied spaces in the facility. The coverage areas shall include the stairwells, elevators, exhibit halls, and immediate outside areas.
4. The contractor shall explain the method used to avoid downlink and uplink interference.

B. PSN DAS:

1. The PSN DAS shall comply with IFC 510 2012 and NFPA-72 2013 Edition.
2. Where the in-building coverage requirements include 700 - 800 MHz public safety system and commercial wireless in-building coverage, the two systems shall operate over a unified Passive Cable and Coverage Antenna Infrastructure.
3. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.9.A.1.a with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.
4. The DAS shall deliver coverage per the criteria in 1.9.A.1.a throughout 95% of all occupied spaces in the facility and 99% in critical areas as defined in NFPA 72.
5. The DAS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.
6. The contractor shall explain the method used to avoid downlink and uplink interference.

1.014 ADDITIONAL REQUIREMENTS

A. Use RadioReference.org to determine frequencies used by emergency services. Confirm with AHJ as the Arkansas Wireless Information Network is undergoing upgrades.

B. WSP Approval: The Contractor shall be responsible for providing the WSP with information each WSP requires to approve interconnection of the DAS to the WSP's macro network.

C. PSN Approval: When approval of the DAS deployment is required by code or ordinance, the Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

D. Setup, configuration, testing, labeling and documentation of all equipment installed under this contract.

E. Preparation and submission of shop drawings, testing reports, as-built drawings, and documentation as described later in this section and in Section 27 21 00.

1.015 COORDINATION

A. The drawings generally do not indicate the number of each type of Data Communications Network Equipment. Provide the correct types and quantity as required by the design intent of any example drawings or schedules, and the applicable requirements of the section.

B. Refer to Division 27 Section "Communications Network Requirements" for additional coordination requirements.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Basis-of-Design

1. Specified manufacturers for passive optical network (PON) Hardware: Tellabs, Zhone, Corning, or Approved Equal
2. Specified manufacturers for Switch Hardware: Brocade, Corning, or Approved Equal
3. Specified manufacturers for 50 Ohm passive DAS components: RFS, MARS, CSS, CSI, Trilogy, Galtronics, Huber-Suhner, Microlab, or Approved Equal
4. Specified manufacturer for DAS active components: Corning or Approved Equal
5. Specified manufacturer for optical fiber components: Corning or Approved Equal

2.02 FIBER AND COMPOSITE CABLE AND COMPONENTS

1. General

a) The cable must meet the requirements of the National Electrical Code® (NEC®) Section 725 and Article 770.

b) Plenum Applications – Applicable Flame Test: NFPA 262. Cables shall be listed CL2P.

c) Finished cables shall conform to the applicable performance of the Insulated Cable Engineers Association, Inc. (ICEA) *Standard for Fiber Optic Premises Distribution Cable* (ICEA S-83-596).
d) The cable must be RoHS compliant.
e) The cable manufacturer shall be ISO 9001 registered.

2. Fiber Specification

a) Must be compliant with ITU-T G.657.B3, ITU-T G.657.A1, and ITU-T G.652.D as applicable
b) Maximum attenuation: 1310nm/ 1383 nm, 1550 nm by construction:

1) Loose tube, ribbon: 0.4 db/km, 0.4 db/km, 0.3 dB/km
2) Tight Buffer: 0.65 db/km, 0.65 db/km, 0.5 dB/km

3. Temperature Range

a) Storage -40 °C to 70 °C (-40 °F to 158 °F)
b) Installation 0 °C to 60 °C (32 °F to 140 °F)
c) Operation

1) Indoor Cables: 0 °C to 70 °C (-4 °F to 158 °F)
2) Indoor/Outdoor Cables: -20 °C to 70 °C (-4 °F to 158 °F)

4. Cable Construction

a) Optical fibers shall be placed inside a loose polyvinyl chloride (PVC) subunit or be tight-buffered. The subunit may contain strength yarns depending on conductor gauge.
b) Loose Tube subunits shall contain up to 12 fibers.

1) Ribbon cables may have more than 12 fiber in one buffer tube.

5. Subunits or tight-buffered fiber may be stranded along with 12-24 AWG insulated copper conductors.
6. Outer Cable Jacket

a) The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
b) The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.
c) The standard cable jacket color shall be yellow for cables containing single-mode fiber.

1) Indoor/Outdoor cables shall be black for UV resistance.
2) Cable jackets shall be capable of being colored any of the 12 colors identified in EIA/TIA-598, “Optical Fiber Cable Color Coding,” if requested to enhance cable identification.

7. The cable specified herein shall be available with an optional interlocking armor made of aluminum. The interlocking armor for riser cables may be left uncoated or may have a jacket. The interlocking armor for plenum cables shall have a PVC jacket. The color of the armor jacket shall match the jacket color of the optical fiber cable located inside of the armor. The armor for these cables shall be comparable to liquid-tight flexible metal conduit if jacketed, or flexible metal conduit if not.

8. Identification

a) The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Optical Fiber Cable Color Coding." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers.
b) When multiple fiber subunits exist, each fiber subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The number shall be repeated at regular intervals.
c) The outer jacket for all dielectric cable shall be marked with the manufacturer's name or Electrical Testing Labs (ETL) file number, date of manufacture, shop order number, fiber count, fiber type, conductor count, flame rating, listing symbol, and sequential length markings every 2 ft (e.g., “CORNING OPTICAL COMMUNIICATIONS OPTICAL CABLE - MM/YY - SO### - 12 SME – 6x14 AWG CL2P OF c(ETL)us XXXXX FEET”). The marking shall be in contrasting color to the cable jacket.
d) Cables with a jacket over interlocking armor shall be marked with the manufacturer's name or ETL file number, date of manufacture, shop order number, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every 2 ft (e.g., “CORNING OPTICAL COMMUNICATIONS OPTICAL CABLE - MM/YY - SO### - 12 SME – 6x14 AWG CL2P OF c(ETL)us XXXXX FEET”). The cable jacket color shall match the color of the core optical fiber cable.
e) Individual copper conductors shall be insulated with PVC and colored per Belden Code-1 for electronic instrumentation cable.

9. Cable Specifications

a) Bend Radius

1) The minimum bend radius shall be 15 times the cable outside diameter while under tension and 10 times the cable outside diameter installed.
2) For Interconnect cable where 250 um fibers are in direct contact with dielectric strength members the minimum bend radius shall be 2 in under tension and 0.7 in installed.

b) Tensile Strength

1) The cable shall be rated to the following tensile loads:

a) Tight Buffer with Copper

i) Maximum Tensile Strength, Short-Term: 93 N (21 lbf)
ii) Maximum Tensile Strength, Long-Term: 311 N (70 lbf)

b) Tight Buffer without Copper

i) Maximum Tensile Strength, Short-Term:

(1) ≤12 fibers: 440 N (100 lbf)
(2) >12 fibers: 660 N (150 lbf)

ii) Maximum Tensile Strength, Long-Term:

(1) ≤12 fibers: 132 N (30 lbf)
(2) >12 fibers: 200 N (45 lbf)

c) Loose Tube

i) Maximum Tensile Strength, Short-Term: 2700 N (600 lbf)
ii) Maximum Tensile Strength, Long-Term: 810 N (180 lbf)

d) Ribbon Cable

i) Maximum Tensile Strength, Short-Term: 1320N (300 lbf)
ii) Maximum Tensile Strength, Long-Term: 400 N (90 lbf)

c) Quality Assurance Provisions

1) All optical fibers in cable lengths of 300 m or greater shall be 100 percent attenuation tested by the manufacturer. The attenuation shall be measured at 850 and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of five years. These values shall be available upon request.

2.03 FIBER OPTIC APPARATUS

A. General Specifications- Panel shelves and wall-mount housing shall be used for combination of splicing pigtails, direct connectorization, or plug-and-play cabling. Shelf shall be designed for use as termination shelf only (direct connector termination) or as splice and termination shelf.

B. Building riser cabling shall not terminate directly to equipment, and patch panels shall be installed at both the headend and remote locations. Panels shall be sized to match fiber and/or copper termination count of cable being installed as well as allow for future expansion.

C. Optical splitter modules, if required, shall be utilized with integrated PON solutions.

1. Shall be able to mount in Panel Shelves or Panel Housings.
2. Shall utilize the OS2 single-mode (OS2) fiber category.
3. Shall support SC APC or LC APC fiber connectors.
4. Shall utilize connected pigtail jumpers or support ports for fiber jumpers.
5. May utilize different split ratios based on project requirements such as 1x2 – 1x32.
6. May utilize a dual input for redundancy options.
7. Shall support a wavelength range of 1260-1360 and 1480-1626 nm.

D. Fiber terminations for converged solutions at a zone or end locations shall be terminated into appropriately sized fiber panels or small wall terminals.

E. Fiber Termination Hardware:

1. Fiber Connector Housings:

   a) Shall fit in standard 19 in racks or wall mountable housings.
   b) Shall hold 1 to 12 panels/modules/splice cassettes/splitters per housing.

2. Fiber Patch Panels:

   a) Shall support single-mode LC APC or SC APC adapters.
   b) Shall support 12 or 24 counts

3. Fiber Splice Cassettes:

   a) Shall support single-mode LC APC or SC APC adapters.
   b) Shall support 12 or 24 counts
   c) Shall support fusion splicing for individual or ribbon fibers.

F. Fiber Connectors: If pre-terminated fiber connectors are not used in cable assemblies and bulk ended fiber is utilized, specific field terminators should be utilized. Connectors must support single-mode OS2 fiber. Connector types shall be SC APC or LC APC for simplex or duplex connections as needed. If multifiber

cable is used, MTP® APC connectors may be spliced to ribbon fiber solutions. Additional considerations should be made for:

1. Mechanical Field Fiber Terminations:
    a) Shall have a typical factory-tested insertion loss of 0.3 dB for APC connectors (LC or SC).
    b) Shall be Fiber-Optic Cable Intermateability Standard (FOCIS)-compliant with TIA/EIA 604-3 (SC), FOCIS 10 (LC) intermateability.
    c) Shall pass EIA/TIA 568-B.3 approvals.
    d) Shall pass Telcordia GR-1209 and GR-1221 design and test criteria.
    e) Shall not require polishing of the end face in the field and shall have factory-polished fiber stub in the connector ferrule.
    f) Shall not require the use of epoxies.
2. Splice-on Field Fiber Terminations:
    a) Single-Fiber Splice-On Connectors:
        1) Shall be FOCIS compliant with TIA/EIA 604-3 (SC) and TIA/EIA 604-10A (LC) intermateability.
        2) Shall meet Telcordia GR-326-CORE and GR-1081-CORE qualifications..
        3) Shall meet a typical/maximum insertion loss of 0.15/0.30 dB.
        4) Shall not require polishing of the end face in the field and shall have factory-polished fiber stub in the connector ferrule.
        5) Shall not require the use of epoxies.
    b) MTP® (multifiber) Single-Mode Splice-On Connectors:
        1) Shall be designed to comply with the appropriate TIA/EIA FOCIS document.
        2) Shall have a ferrule constructed of polyphenylene sulfide (PPS) base.
        3) Shall not require polishing of the end face in the field and shall have factory-polished fiber stub in the connector ferrule.
        4) Shall not require the use of epoxies.
        5) Shall meet a typical/maximum insertion loss of 0.15/0.30 dB.

G. Solution shall be able to handle the internal termination of composite copper DC power and optical fiber cable without the use of third-party components. Headend components shall be capable of inclusion of power-limiting or conversion components that meet NEC Class 2 or 3 requirements.

2.04 FIBER OPTIC PATCH CORDS

A. General Specifications- To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots and shall have the same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords shall be available with the following options as specified or indicated:

1. Termination Types: SC APC, LC APC, MTP® connector
2. Connector/cable configuration: Simplex, duplex or multifiber
3. Flame Rating: Riser, plenum, and/or LSZH™
4. Outside Diameters: 2.0, 2.9, or 3.0 mm
5. Lengths: As specified or indicated

PART 3 - EXECUTION

3.01 GENERAL

A. The contractor and/or subcontractor shall design, install, commission, and test the Converged Optical Infrastructure in accordance with the manufacturer's instructions and recommendations.

B. The contractor and/or subcontractor shall install the Converged Optical Infrastructure in accordance with the accepted SOW.

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

D. The contractor and/or subcontractor shall have a project foreman on-site overseeing the installation.

E. The contractor and/or subcontractor shall have at a minimum one PMP-certified project manager on staff overseeing the project. The project manager will be responsible for the following:

1. Develop and maintain a project plan consistent with the overall milestones of the project.
2. Oversee and coordinate the activities of the DAS project including: initiating and holding weekly project conference calls, as well as maintaining and distributing meeting minutes.
3. Act as the point-of-contact interface for all DAS project activities.
4. Provide weekly status updates regarding work performed, work scheduled, open items, problems/issues, and resolutions.

F. The contractor and/or subcontractor shall be prepared to deploy the Converged Optical Infrastructure in a phased approach as dictated by the building construction and/or work of other trades.

G. The contractor and/or subcontractor shall facilitate WSP approval and connection to their respective macro-networks if DAS is included in the scope of the project.

H. The contractor and subcontractor shall be prepared to connect to the WSP's network(s) in a phased approach as dictated by the WSP's schedules if DAS is included in the scope of the project.

3.02 ACCEPTANCE TESTING

A. Acceptance testing will be performed confirming the requirements of Section 1.08 have been met.

B. The contractor shall complete the WSP acceptance testing per the WSP's requirements and as prescribed in the approved WSP (ATP) submittal.

C. All submittals shall be completed.

END OF SECTION