

SECTION 270100 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 27.
- B. This section is a Division 27 COMMUNICATIONS section, and is a part of each Division 27 Section.
- C. Requirements of the following Division 27 Sections apply to this section:
 - 1. Division 26 Section 260500 "Common Work Results for Electrical".

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01 - reference individual sections for further expansion of these requirements:
 - 1. Abbreviations and Definitions
 - 2. Permits, Codes, and Inspections
 - 3. Visiting Premises
 - 4. Submittals
 - 5. Project Drawings and Specifications
 - 6. Cooperation and Coordination with Other Trades
 - 7. Product Listing
 - 8. Nameplate Data
 - 9. Record Documents
 - 10. Maintenance Manuals
 - 11. Warranty
 - 12. Delivery, Storage, and Handling
 - 13. Sequence of Work
 - 14. Electrical Installations
 - 15. Cleaning
 - 16. Testing
 - 17. Instructions to the Owner

1.3 CONTRACTOR QUALIFICATIONS

- A. The apparent low bidder shall demonstrate their qualifications by providing the following documents for the local area network cabling:
 - 1. A listing of the LAST five (5) Local Area Network (LAN) systems that were installed by the bidder:
 - a. The listing shall include only LANs that included the installation of fiber optic cable, unshielded twisted pair (UTP) cable, and Gigabit Ethernet equipment.

- b. The listing shall be for the last five projects, regardless of size or location, which are operational and have been turned over to the Owner.
 - c. The listing shall include a brief description of the project, type of LAN, size of the system, Owner's name and address and representative, date started, and date of completion.
 - d. The listing shall include a letter from the Owner of each of the 5 projects. The letter shall be on the Owner's letterhead and shall be signed by an officer or authorized agent of the Owner. The letter shall state the overall satisfaction or dissatisfaction with the performance of the Contractor, and the quality of workmanship in regards to installation of the cabling, hardware, and software.
2. The bidder shall furnish a list of the names of all full-time employees that the Contractor plans to use on the project.
- a. The listing shall include each person's title, length of current employment with the company, training, and certification.
 - b. The listing shall also include a resume for the Project Manager.
 - c. The listing shall also include registration number and a copy of the current BICSI certificate for each RCDD.
- B. All bidders shall be certified and registered by the applicable cable/connector manufacturer and submit certifications of training in the installation and maintenance of the specified systems.
- C. The bidder shall furnish a list of all test equipment that will be used in the installation and testing of the fiber optics cable and the twisted pair cable.
- D. All of the above documents shall be submitted within 48 hours (excluding weekends and holidays) following the Bid due date/time.

1.4 ABBREVIATIONS

- A. General: Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.

1. Abbreviations:

a.	ANSI	American National Standards Institute
b.	ASA	American Standards Association
c.	ASTM	American Society of Testing Materials
d.	BICSI	Building Industry Consulting Services International
e.	CBM	Certified Ballast Manufacturers
f.	EC	Electrical Contractor
g.	EIA	Electronic Industries Association
h.	ETL	Electrical Testing Laboratories, Inc.
i.	GC	General Contractor
j.	HVAC	Heating, Ventilating, Air Conditioning Contractor
k.	ICEA	International Cable Engineers Association
l.	IEEE	Institute of Electrical and Electronics Engineers
m.	MC	Mechanical Contractor
n.	NEC	National Electrical Code
o.	NEMA	National Electrical Manufacturers Association
p.	NFPA	National Fire Protection Association
q.	OEM	Original Equipment Manufacturer
r.	OSHA	Occupational Safety and Health Act

- s. PC Plumbing Contractor
- t. TIA/EIA Telecommunications Industry Association/Electronic Industries Association
- u. UL Underwriters' Laboratories, Inc.

1.5 DEFINITIONS

- A. PROVIDE means to furnish, place, erect, connect, test, and turn over to Owner, complete and ready for the regular operation, the particular work referred to.
- B. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.
- C. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular work referred to.
- D. WIRING means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such work.
- E. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.
- F. AS DIRECTED means as directed by the Architect or their representative.
- G. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.
- H. ACCEPTED means as accepted by the Architect or their representative.
- I. APPROVED means as approved by the Architect or their representative.
- J. EQUAL means equivalent as approved by the Architect or their representative.
- K. CONTRACTOR as stated herein shall mean Communication Contractor.

1.6 PERMITS, CODES, AND INSPECTIONS

- A. General: Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules, and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Architect.
- B. Codes: The installation shall comply fully with all local, county, and state laws, ordinances and regulations applicable to local area network and related communication installations.
- C. The installation shall be in compliance with the requirements of the latest revisions of:
 - 1. Building Communication International (BISCI)
 - 2. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA)
 - 3. Occupational Safety and Health Act (OSHA)
 - 4. Institution of Electrical and Electronic Engineers (IEEE)

5. National Electric Code (NEC)
6. Underwriter's Laboratories, Inc. (UL)
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor's Association (NECA)
9. National Safety Code
10. Legislative Act 235 (1965) - Handicapped
11. Legislative Act 287 (1974) - Excavation
12. International Building Code (IBC) 2003
13. Americans with Disabilities Act (ADA)
14. All approved published instructions set forth by equipment manufacturers.

D. The installation shall be in compliance with the requirements of:

1. Middle Department Inspection Agency (MDIA)
 - a. Exception: Where the regulations of the local municipality require inspection services by an agency other than MDIA.
2. All local codes and ordinances in effect and having jurisdiction.
3. All requirements of electrical power utility companies.
4. All requirements of telephone utility companies.
5. All requirements of cable television utility companies.

E. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

F. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instructions of the Architect and at no additional cost to the Owner.

G. Certificate of Inspection: The Contractor shall procure and pay for the Certificate of Inspection from MIDA, or other required inspection agency, and deliver it to the Architect before final payment is made.

1.7 VISITING PREMISES

A. General: The Bidder shall visit the project site before submitting his/her bid, in order to familiarize him/herself with existing conditions that may affect the work. It is the Contractor's responsibility to analyze existing conditions. Sufficient allowances shall be provided in the Contractor's bid to cover work, due to existing conditions, that will be required to complete this contract work.

B. By submission of a bid the Contractor is attesting that responsible personnel did, in fact, visit the site during the bidding period and verified all existing pertinent conditions.

C. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid.

1.8 SUBMITTALS

A. General: Follow the procedures specified in Division 1 and as stated below.

- B. The Contractor shall submit a complete set of Project Documents and complete product data for the proposed system to the system vender for review prior to submission to the Architect/Engineer. The System Vender shall review the complete system package and provide documentation attesting to the system compliance with the extended system product and performance warranty. This documentation must accompany all submittals to the Architect/Engineer. Submittals will not be reviewed by the Architect/Engineer without the System Vender approval documentation.
- C. Submit for approval a complete Material Source of Supply and Subcontractor list for all work required under this project. Shop drawing submittals will not be reviewed until a complete Material Source of Supply and Subcontractor list is received.
- D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect, will not be processed.
- E. Prepare and submit detailed shop drawings for materials, systems, and equipment as listed herein, including locations and sizes of all required openings in floor decks, walls and floors.
- F. The work described in any shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted shop drawing shall include a certification that all related job conditions have been checked and that no conflict exists.
- G. All shop drawings shall be stamped by the Contractor, indicating approval, and space shall be provided for the Engineer's stamp and the Architect's stamp.
- H. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and re-submittal as may be required. All submittals shall be complete and contain all required and detailed information.
- I. Acceptance of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve the Contractor from responsibility of furnishing all items of proper dimensions, weight, capacities, sizes, quantity and quality as intended by the Contract. Such acceptance shall not relieve the Contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or shop drawings.
- J. Each shop drawing shall contain job title and reference to the applicable drawing and specification article, including the Contractor's drawings, specifications, and verification of compatibility with the systems involved.
- K. Individual shop drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided in other than this manner will be return without review.
- L. All nameplate data shall be complete at time of equipment submittals - refer to other sections for identification requirements.
- M. For each room or area of the building containing sound system cabinets, telephone backboards, consoles, etc., coordination drawings are required to be submitted for review and acceptance at the time of the equipment submittal.
- N. Equipment shall not be purchased until the shop drawing approval is received.

- O. Shop Drawings shall show conformance with specified equipment characteristics, or Contractor shall assume responsibility for all deviations including all additional costs involved for the deviations.
- P. The following is a list of some important material, equipment and systems that require shop drawing approval, refer to each section of this specification for additional submittal requirements:
- | | |
|-------------------------|------------------------|
| Sound System | Intercom/Paging System |
| Data Networking Systems | TV Distribution System |
| Wiring/Cables | Audio Visual Equipment |
- Q. Submittals shall include plan, riser and wiring diagrams complete with all wiring and required equipment.
- R. Product Options:
1. The product manufacturers listed in each section are either the product the design is based on or a product that the Engineer feels would be an acceptable substitution if that product can meet the intent of the written specifications and the scheduled capacities. The Communication Contractor is responsible for ensuring that the substituted product complies with the intent of the specifications, the scheduled capacities and the drawings. Substitutions of manufacturers not listed are not permitted unless prior approval is obtained from the Engineer as required by Part 2.2, SUBSTITUTIONS, of this specification section.
 2. It will be the responsibility of the Communication Contractor to pay any and all costs associated with any approved substitutions that impact the architectural layout, structure, electrical system(s), mechanical systems, and/or the plumbing systems, due to an increase in physical dimensions, weight, electrical requirements, connection sizes, etc., between the approved substitution item and the equipment item scheduled and/or indicated as the basis of design.
- S. In order for the manufacturer to certify this local area network cabling system, the system components must meet the requirements of the manufacturer. Review the system with the manufacturer in accordance with their system certification program and provide a letter from the manufacturer documenting the following;
1. That the Contractor is a manufacturer certified installer.
 2. That all the materials in the submittal are in accordance with the manufacturer's certification program.
 3. That the manufacturer has reviewed the entire system in accordance with their certification program and the system is in compliance.
- T. A system that does not have a manufacturer's certification will not be accepted.

1.9 PROJECT DRAWINGS AND SPECIFICATIONS

- A. Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Architect in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Architect.
- B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Architect. The Architect's interpretation is final and binding.

- C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction that may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.
- D. Drawings are diagrammatic only and do not show exact routes of cabling and locations of equipment. The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Architect.
- E. All work shall be considered new, unless noted otherwise.

1.10 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. This Contractor shall cooperate completely and coordinate work with the contractors of other trades. Due to the Project Schedule this Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.
- B. Prepare floor plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Specific equipment installations, including, but not limited to racks for LAN equipment, racks for sound system equipment, cable television equipment, etc.
 - 2. Where additional conduit sleeves are required in order to limit UTP cable length to 90 meters.
 - 3. Wiring diagrams: Indicating field installed communication wiring and cabling layouts, equipment, and equipment connections.

1.11 PRODUCT LISTING

- A. Prepare a listing of equipment and materials for the project.
- B. Submit this listing as a part of the submittal requirement specified in Division 1.
- C. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, fasteners, and similar items used in work, except as otherwise indicated.
- D. Provide products that are compatible within systems and other connected items.

1.12 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplate in an accessible location.

1.13 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1.
- B. When all work has been completed and before final acceptance, the Contractor shall furnish to the Architect a complete set of reproducible contract drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy of the as-built drawing.
- C. In addition to the above referenced reproducible contract drawings, the Communication Contractor shall furnish to the Architect a CD-Rom containing all of the floor plans. The floor plans shall be in AutoCAD 2000 format, and shall indicate the "as-built" conditions. A CD-Rom shall be provided to the Communication Contractor prior the completion of the project, with the drawing files from the bid set of documents. The Communication Contractor shall make changes to these files, indicating all changes made during construction, including tagging and room names. The Communication Contractor shall make these changes or retain the services of a third party to make the changes.
- D. Mark up a clean set of Specifications to indicate approved substitutions, change orders and actual equipment and materials used.

1.14 OPERATION MANUALS

- A. Prepare operation manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's data of each piece of equipment including:
 - a. Installation instructions.
 - b. Drawings and Specifications.
 - c. Parts list, including recommended items to be stocked.
 - d. Complete wiring diagrams.
 - e. Marked or changed prints locating all concealed parts and all variations from the original system design.
 - f. Test and inspection certificates.
- B. Format:
 - 1. Provide five (5) copies of each manual.
 - 2. Manuals to be 8-1/2 inches x 11 inches size in hard back 3-ring loose-leaf binders. Use more than one volume if required. Do not overfill binders.
 - 3. Submit one (1) copy to Architect. After review and acceptance, assemble other copies.
 - 4. Manuals to be completed and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.

1.15 WARRANTIES

- A. Refer to the Division 1 for procedures and submittal requirements for warranties and to individual equipment specifications for additional warranty requirements. If a contradiction exists, the most demanding requirements shall prevail.

- B. Compile and assemble the warranties specified in Division 27 into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include date of beginning of warranty or bond; duration of warranty or bond; and names, address, and telephone numbers and procedures for filing a claim and obtaining warranty services.
- D. Warranty and Certification of the Data Network Wiring and connectors:
 - 1. The Contractor shall provide a minimum 20-year performance and product warranty that all cable, connectors, and connecting hardware shall be free from defects in material, workmanship, and fabrication.
 - 2. The system shall be certified by the cable/connector manufacturer and warranted for the specified performance for a minimum of 20 years. The Contractor shall conform to the manufacturer's certification program including testing and the submittal of all required documentation to the manufacturer.
 - 3. The Contractor shall obtain from the manufacturer, a "systems application assurance" warranty for a minimum of 20 years.
 - 4. The Contractor shall obtain, from the manufacturer, a Registration Document and Certificate for the specific installation. Upon receipt of the Registration Document and Certificate the Contractor shall forward a copy to the Engineer and deliver the original to the Owner.
 - 5. The certification shall be equivalent to the Hubbell Premise Wiring "Clear Bit Mission Critical" 25-year warranty Program.
- E. Submit a single warranty stating that all portions of the work are in accordance with Contract requirements. Warrant all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies that occur during the warranty period at no additional cost to Owner, all to the satisfaction of the Owner. Obtain similar warranties from subcontractors, manufacturers, suppliers, and sub-trade specialists.
- F. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

PART 2 - PRODUCTS

- A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached in a convenient place. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.
- B. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.
- C. In all cases where a device, function or item of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.
- D. All listed materials and equipment shown on drawings and/or specified herein, are indicative of complete and whole units and shall be furnished as such.

- E. In certain instances specific manufacturer/model/type and catalog numbers are set out herein or on the drawings for the purpose of indicating required criteria for quality, function, and acceptable physical size. Specifications, performance data, and descriptive data published by the designated manufacturer shall be taken as minimum requirements for the item to be provided.
- F. Comply with manufacturer's printed instructions and recommendations as minimum criteria for the installation of equipment.
- G. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Architect.
- H. Where the contractor proposes substitute equipment he shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material, or work shall be the responsibility of this Contractor, regardless of the trade involved.
- I. All materials and equipment provided under this Contract shall be completely satisfactory and acceptable in operation, performance and capacity. No approval, either verbal or written, of any drawing, descriptive data, or samples of such materials, equipment, and/or appurtenances, shall relieve this Contractor of his responsibility to turn over all items in perfect working order at completion of the work.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.2 SEQUENCE OF WORK

- A. Construct work in a sequence in accordance with Division 01.
- B. Due to current Project Schedule the Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.

3.3 INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for installations of cabling. Arrange such chases, slots and openings such that UTP cable does not exceed 90 meters.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
9. Coordinate the cutting and patching of building components to accommodate installation of equipment and materials.
10. Coordinate the installation of materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
11. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

3.4 CLEANING

- A. Refer to the Division 1 Section for general requirements for final cleaning.

3.5 TESTING

- A. Contractor, at his own expense, shall make any and all tests directed by an inspection authority, or connector manufacturer, or the Architect, and shall provide all equipment, instruments and materials to make such tests.
- B. Unless otherwise approved, all terminations shall be made and all components shall be in place, complete and operational, at time of final inspection and tests.
- C. Time of such tests, the manner in which they are made and the results of the tests, shall be subject to approval.
- D. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted, and left in satisfactory operating condition to suit load conditions, by means of instruments furnished by the Contractor.
- E. Complete testing of equipment and systems shall be provided throughout this project.
- F. Industry standards shall apply except as otherwise specified.

- G. Provide all labor, premium labor, and materials required by field-testing as specified in the Contract Documents and as required.
- H. Notify the Architect seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to the Architect for his approval.
- I. Conduct tests at a time agreeable to the Architect. Provide premium labor as necessary.
- J. Products that are found defective or do not pass such tests shall be removed and replaced at the Contractor's expense. Tests shall be repeated.

3.6 INSTRUCTIONS TO THE OWNER

- A. After the tests and adjustments have been made, approved factory-authorized system representatives and the Contractor shall fully instruct Owner in all details of operation and maintenance of equipment installed under this Contract. Dates and times of such instructions shall be as directed by Owner, including any necessary weekend or after-hours instruction.
- B. Additional instruction requirements are included in each section of the Specifications.
- C. The Contractor shall video tape all instruction sessions. Prepare a separate video tape for each system as shown on the schedule below. Clearly label the tape with the title "INSTRUCTIONS FOR THE USE OF ...", on both the face and the spine, in typewritten letters. Two (2) copies of each video tape shall be given to the Owner at the completion of the Contract; one (1) set for the maintenance staff and one (1) set for the administrative staff.
- D. Prepare an instructional training form indicating the topic of instruction, the date, the time, the purpose of instruction and lines for signatures of attendees. Each person attending the instruction shall print their name and sign the form. Provide a copy of the completed form to the Owner in the O&M manual as proof of instructional training. The Contractor shall keep the original in the Contractor's project file.
- E. The attached schedule indicates the extent of training.

Minimum Instructions to Owner Requirements										
Topic	Spec. Sec. ⁽⁴⁾	Session 1			Session 2			Session 3		
		F ⁽¹⁾	L ⁽²⁾	A ⁽³⁾	F ⁽¹⁾	L ⁽²⁾	A ⁽³⁾	F ⁽¹⁾	L ⁽²⁾	A ⁽³⁾
Cabling/Rack/Cabinets	27 1100	I	A/R	M	1F	A/R	M	-	-	-
Other Systems not listed above: Refer to individual Specification Section										

Notes:

Format: Provide training in the following format:

- I = Initial meeting to discuss system operation, safety issues, maintenance issues.
- 1 F = Follow-up session, 1 month from initial session.
- 2 F = Follow-up session, 2 months from initial session.

Length: Provide the length of instruction as follows:

1, 2, 3, etc. indicates the number of hours of training; does not include travel time, setup time,

question/answer time.

A/R = as required by Owner or the number of attendees.

Attendees:

A = Administrative Staff, as determined by Owner's representative.

M = Maintenance Staff, as determined by Owner's representative.

T = Teaching Staff, schedule multiple sessions to limit instructional session size to 15 people.

Specification Section:

Refer to the individual specification sections for additional training requirements.

END OF SECTION 270100

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SECTION 270800 - COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Section Includes: Testing of Telecommunications Backbone and Horizontal Cabling subsystems.
- B. Related Sections
 - 1. Consult all other Sections and Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to completely test a complete and operable system.
 - 2. Section 270100: Basic Telecommunications Requirements
 - 3. Section 271300: Communications Backbone Cabling
 - 4. Section 271500: Copper Cabling Systems
- C. Products Furnished and Installed Under Other Sections:
 - 1. Telecommunications Cabling

1.2 REFERENCES

- A. Comply with Section 270100 References requirements.
- B. Additional references to those listed in Section 27 01 00.
 - 1. TIA/EIA-526-14 ("OFSTP-14") Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - 2. TIA/EIA-526-7 ("OFSTP-7") Measurement of Optical Power Loss of Installed Single mode Fiber Cable Plant
 - 3. TIA/EIA-455-171 Attenuation By Substitution Measurement – For Short-Length Multimode Graded-Index And Single-Mode Optical Fiber Cable Assemblies (a.k.a., FOTP-171)

1.3 DEFINITIONS

- A. Refer to Definitions of Sections 270100, 271300 and 271500.
- B. In addition, the following list of terms as used in this specification shall be defined as follows:
 - 1. "Adapter" (associated with fiber connectivity): Shall mean a connecting device joining 2 fiber connectors, either like or unlike.
 - 2. "Channel": Shall mean a testing configuration which includes the Permanent Link and the line cord (at the workstation), the equipment cord, and, if a full cross connection is implemented, a patch cord and the cross connect termination/connecting apparatus.
 - 3. "Connect": Shall mean install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.

4. "Cord": Shall mean a length of cordage having connectors at each end. The term "Cord" shall be synonymous with the term "Jumper". The cord may be:
 - a. Unshielded twisted pair
 - b. Fiber (multimode or single mode), jacketed & buffered
5. "Launch Cord": Shall mean the cord certified for use in fiber optic characterization testing, as described in this section.
6. "OTDR": Shall mean Optical Time Domain Reflectometer.
7. "Passive Link Segment": Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.
8. "Permanent Link": Shall mean the 'permanent' portion of the Horizontal cabling to each outlet with the test cords de-embedded from the measurements; this includes cable, consolidation point (if used), termination/connecting apparatus in the IDF and the connector at the outlet.
9. "System Cord": Shall mean the cord used in the operating electrical or optical circuit.
10. "Test Cord": Shall mean the cord certified for use in testing, as described in this section.

1.4 SYSTEM DESCRIPTION

A. Work Provided Under Other Sections

1. Refer to Section 27 13 00 for a more complete System Description.
2. Backbone Cabling
 - a. The Backbone Cabling includes twisted pair and fiber cabling.
3. Horizontal Cabling
 - a. The Horizontal Cabling, in general, consists of multiple 4-pair Category 6 UTP cables to each outlet. Refer to the Drawings for specific requirements.

B. Base Bid Work

1. Testing of a completed Telecommunications Cabling System, including:
 - a. Procedures Submittals.
 - b. Equipment Submittals.
2. Testing Requirements:
 - a. Fiber optic passive link segment(s):

Table 270800-1.1: Tests For Fiber Optic Passive Link Segments

Subsystem	Type	Test	Direction	Wavelength
Backbone	Multimode	Characterization	Both	850nm and 1300nm
Backbone	Single mode	Characterization	Both	1310nm and 1550nm
Backbone	Multimode	Passive Link Ins. Loss	One	850nm and 1300nm

Backbone	Single mode	Passive Link Ins. Loss	One	1310nm and 1550nm
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- b. Multi-pair/UTP cabling:

Table 270800-1.2: Tests For Multi-pair/UTP Cabling

Subsystem	Type	Test	Configuration	Notes
Backbone	Riser	Wire map & length	-	-
Horizontal	CAT6	Category 6	Permanent Link	Per TIA/EIA-568-B.2-1

- c. Record Documents, including test reports.

1.5 SUBMITTALS

- A. Refer to Submittals of to Section 27 01 00 for procedural, quantity, and format requirements.
- B. Preconstruction Submittal Requirements:
 - 1. Testing Procedures Submittal, describing step-by-step procedures used by the field technicians.
 - 2. Product Submittal, including cut sheets of testing equipment to be used (note all software/firmware versions as applicable) and certificate of last calibration.
 - 3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for 27 XX XX series Sections.
- C. Submittal Requirements at Closeout:
 - 1. Record Documents.
- D. Submittal Description: Record Documents
 - 1. Test Reports: Record documents submittal shall include test reports showing the following information:
 - a. A title page which includes:
 - 1) Client Name
 - 2) Project Name
 - 3) Project Address
 - 4) General Contractor name / Telecommunications Installer name
 - 5) Date of Submittal
 - b. Individual tabs which break down the test results by building, and then by telecommunications room.
 - c. All Backbone Fiber Optic "Post Installation" Passive Link Attenuation test results (utilize the forms provided in Part 4 of this specification for documentation of test results if the tester used does not have data storage capabilities) and Fiber Optic OTDR test results.
 - d. All Backbone UTP test results.
 - e. All Horizontal cable test results, per cable

2. Furnish all test results on CD-ROM in their native data format and an exported Microsoft Excel compatible format.
 - a. Include all necessary software to allow viewing and printing of individual test results.
 - b. CD shall be labeled with the project name, contractor name, and date of submission.

1.6 QUALITY ASSURANCE

- A. Comply with the Quality Assurance requirements of Section 27 01 00.

1.7 WARRANTY

- A. Warrant the validity of the test results. Under no circumstances shall any cable's test results be substituted for another's. If a single instance of falsification is confirmed, the Contractor shall be liable for a complete retest of the cabling system at no additional cost to the Owner. This includes the retaining the services of a neutral party to observe all retesting.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The manufacturer may change the product numbers listed in this Section at any time, as well as software and firmware versions. In the event this Section contains an invalid product number or conflicts with the written description, or specifies an out-of-date software and/or firmware version, notify the Engineer in writing prior to issuing submittals or field testing.

2.2 FIBER OPTIC LIGHT SOURCE

- A. All connection interfaces shall be factory installed. No field-configurable adapters will be allowed at the light source.
- B. Wavelengths output shall be continuous.
- C. LED-based light source for multimode fiber testing shall have a:
 1. Center wavelength of $850\text{nm} \pm 30\text{nm}$ and $1300\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) $30\text{nm} - 60\text{nm}$ at 850nm and $100\text{nm} - 140\text{nm}$ at 1300nm .
 3. Minimum output power level of $\geq 14\text{dBm}$.
- D. VCSEL-based light source for multimode fiber testing shall have a:
 1. Center wavelength of $850\text{nm} \pm 30\text{nm}$ and $1300\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) $30\text{nm} - 60\text{nm}$ at 850nm and $100\text{nm} - 140\text{nm}$ at 1300nm .
 3. Minimum output power level of $\geq 14\text{dBm}$.
- E. LASER-based light source for single mode fiber testing shall have a:

1. Center wavelength of $1310\text{nm} \pm 20\text{nm}$ and $1550\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) of $\leq 5\text{nm}$ at 1310nm and $\leq 5\text{nm}$ at 1550nm .
 3. Minimum output power level of $\geq 3\text{dBm}$.
- F. The light sources may contain internal lenses, pigtails, and modal conditioners, provided they meet the launch conditions as described in "Post-Installation" Passive Link Attenuation Testing Procedures (ref. PART 3 - EXECUTION).
- G. Equipment shall be factory-calibrated within 12 months of testing date.
- H. Equipment:
1. Agilent Technologies' WireScope 350 test set
 - a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
 - b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
 - c. #450-2020 Fiber SmartProbe testing adapter, single mode 1300nm.
 - d. ScopeData management software (version 5.20 or higher).
 2. Corning Cable Systems
 - a. #OS-301 light source
 - b. #OS-302 light source
 - c. #OS-100D light source
 3. Fluke Networks' DSP-4300 test set
 - a. #DSP-4300; "CableAnalyzer" test kit, loaded with firmware version 3.0.4.
 - b. #DSP-FTA420S; 'Multimode' fiber testing adapter, LED-based (850nm, 1300nm).
 - c. #DSP-FTA430S; 'Single mode' fiber testing adapter, LASER-based (1310nm, 1550nm).
 - d. #DSP-FTA440S; 'Gigabit' fiber testing adapter, VCSEL-based (multimode @ 850nm and single mode @ 1310nm).
 - e. LinkWare; "LinkWare" management software (latest version).
 4. Laser Precision #5150 test set

2.3 FIBER OPTIC POWER METER

- A. The power meter for both multimode and single mode testing must be capable of measuring relative or absolute power, and must be independent of modal distributions.
- B. All power meters used must be calibrated and traceable to the National Bureau of Standards.
- C. All power meters used shall have the following performance:
1. Dynamic range of 0dBm to -40dBm, minimum.
 2. Accuracy of $\pm 0.2\text{dB}$.
- D. Equipment shall be factory-calibrated within 12 months of testing date.
- E. Equipment:

1. Agilent Technologies' WireScope 350 test set
 - a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
 - b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
 - c. #450-2020 Fiber SmartProbe testing adapter, single mode 1310nm.
 - d. ScopeData management software (version 5.20).
2. Corning Cable Systems,
 - a. #OTS-210 power meter, with data storage capacity.
 - b. #OTS-310 power meter, with data storage capacity.
3. Laser Precision #5025 test set

2.4 FIBER OPTIC MANDREL

- A. For jacketed (3.0 mm) fiber, mandrel diameter shall be 22 mm for 50/125 um fiber. For unjacketed buffered (0.9 mm) fiber, mandrel diameter shall be 25 mm for 50/125 um fiber.
- B. Equipment: Fluke Networks
- C. #NF-MANDREL-50; red mandrel for jacketed 50/125 um fiber

2.5 FIBER OPTIC OTDR

- A. Multimode Source Module:

Wavelength	Dynamic Range	Attenuation Deadzone	Reflective Deadzone	Loss Resolution	Distance Accuracy
850nm	24dB	6.5mt	3.0mt	0.001dB	0.1mt
1300nm	27dB	7.0mt	3.0mt	0.001dB	0.1mt

- B. Single mode Source Module:

Wavelength	Dynamic Range	Attenuation Deadzone	Reflective Deadzone	Loss Resolution	Distance Accuracy
1310nm	40dB	6.0mt	3.5mt	0.001dB	0.1mt
1550nm	28dB	12.0mt	3.5mt	0.001dB	0.1mt

- C. Equipment, including main unit and source modules, shall be factory-calibrated within 12 months of testing date.
- D. Equipment:
 1. Agilent Technologies #8147, for multimode & single mode systems
 2. Corning Cable Systems
 - a. 2001HR, for multimode & single mode systems
 - b. 340 OTDR Plus Multitester II
 - c. MiniOTDR+, for multimode & single mode systems

3. Tektronix
 - a. TFP2A FiberMaster
 - b. TFS3031 TekRanger2

2.6 FIBER OPTIC TEST CORDS

A. Multimode Fiber Optic Test Cord:

1. The fiber of the multimode test cord(s) shall have the core diameter and numerical aperture nominally equal to that of the multimode fiber optic passive link.
2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
 - a. The connector of the test cords shall be that which the light source accepts.
4. The connectors shall exhibit $\leq 0.5\text{dB}$ loss per connection @ both 850nm and 1300nm, as measured per FOTP-171 D2.

B. Single mode Fiber Optic Test Cord:

1. The fiber of the single mode test cord(s) shall have the mode field diameter nominally equal to that of the single mode fiber optic passive link.
2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
 - a. The connector of the test cords shall be that which the light source accepts.
4. The connectors shall exhibit $\leq 0.5\text{dB}$ loss per connection @ both 1300nm and 1550nm, as measured per FOTP-171 D3.
5. All single mode connectors shall inhibit Fresnel reflections (i.e., have a "PC" finish).

2.7 CATEGORY 6 HORIZONTAL CABLE TESTER

- A. Equipment shall meet TIA/EIA-568B.2 Addendum 1 requirements for Level III accuracy.
- B. Test Standards (minimum): TIA Category 6 (per TIA/EIA-568B.2 Addendum 1); ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-T, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5
- C. Areas of Test Measurement (minimum): Wire Map; Length; Insertion Loss; Near End Crosstalk (NEXT) loss, at both master unit and remote unit; Power Sum NEXT (PSNEXT) loss, at both master unit and remote unit; Equal Level Far End Crosstalk (ELFEXT), at both master unit and remote unit; Power Sum ELFEXT, at both master unit and remote unit; Return Loss (RL), at both master unit and remote unit; Propagation Delay and Delay Skew; Attenuation-to-Crosstalk Ratio (ACR), at both master unit and remote unit; Power Sum ACR (PSACR), at both master unit and remote unit; Characteristic Impedance; DC Loop Resistance.
- D. Equipment: Agilent Technologies

1. #N2600A-100; "WireScope 350" test kit (main unit, remote unit, CAT6 permanent link probe, CAT6 channel probe, accessories), loaded with firmware version 3.1.1.
2. "ScopeData Pro" reporting and documentation software latest version.

E. Equipment: Fluke Networks

1. #DTX-1200 or #DTX-1800; "DTX CableAnalyzer" test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with latest version of firmware.
2. #DSP-4300; "CableAnalyzer" test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with firmware version 3.0.4.
3. "LinkWare" reporting and documentation software (version 1.1, or higher)

2.8 BACKBONE UTP CABLING TESTERS

A. Wire Map (continuity, opens, shorts, crossed pairs, split pairs) tester, or equal:

1. Siemon #MT-5000 test unit, with 25-pair adapter.

B. Length tester, or equal:

1. Harris #TS-90 test unit

PART 3 - EXECUTION

3.1 SCHEDULING

- A. Schedule both the Engineer of Record and a representative of the test equipment manufacturer for a demonstration of testing methods. Execute a demonstration of testing methods with aforementioned parties prior to 'production' testing activities. Test reports and acceptance testing will not be accepted without proof of methods demonstration.

3.2 FIELD QUALITY CONTROL

- A. Complete testing as delineated below prior to system acceptance.
- B. Permanently record all test results and presented in a format acceptable to the Owner or Engineer before system acceptance.
- C. Remove and replace with new, at no cost to the Owner, any cables or conductors (copper or glass) failing to meet the indicated standards. The Owner will not accept the installation until testing has indicated a 100% availability of all cables and conductors or the Owner has approved any deviation from this requirement.
- D. Calibrate test sets and associated equipment per the manufacturers printed instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.

3.3 "PRE-INSTALLATION" CONTINUITY TESTING PROCEDURES

- A. Ensure fiber continuity of all fiber strands of all cables prior to installation.
- B. Reports from "pre-installation" continuity testing are not required to be submitted at project close out.

3.4 BACKBONE FIBER OPTIC CHARACTERIZATION TESTING

- A. Test fiber optic passive links per "Base Bid Requirements" in Part 1 of this Section.
- B. Precautions:
 - 1. Adhere to the equipment manufacturer's instructions during testing activities.
 - 2. Prior to any testing activity or any measurements taken, complete the following activities:
 - a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for however long it takes to bring the test equipment to reach room temp).
 - b. Clean all launch cords and system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
 - 3. Do not power off OTDR's light source during testing activity.
 - 4. Do not remove launch cord from the OTDR's light source at any time (unless the testing is complete or the equipment is being put away for the evening, or during trouble shooting).
 - 5. Do not bend the launch cord smaller than 20 times the cord diameter during testing activities (this may induce loss into the cord reducing the accuracy of the measurement).
 - 6. Fully charge power source before each day's testing activity, if applicable.

C. "Post-Installation" Characterization Testing Procedures

- 1. Equipment settings / measurement parameters:
 - a. Index of Refraction: match cable-under-test fiber parameters; default settings as follows:

Multimode	Corning 50/125 Infinicor	1.483 @ 850nm	1.483 @ 1300nm
	SYSTIMAX 50/125	1.483 @ 850nm	1.478 @ 1300nm
Single mode	SYSTIMAX	1.466 @ 1310nm	1.467 @ 1550nm
	Corning SMF-28	1.4675 @ 1310nm	1.4681 @ 1550nm
 - b. Pulse Width: multimode: 20ns; single mode: 50 ns.

Multimode 50/125	4 ns for cable lengths up to 500 meters
	20 ns for cable lengths from 250 meters to 2,000 meters
Single mode	10 ns for cable lengths up to 2,000 meters
	50 ns for cable lengths from 2,000 meters to 20 kilometers
 - c. Backscatter:

- 1) Multimode: -67dB @ 850nm, -74dB @ 1300nm;
 - 2) Single mode: -74dB @ 1310nm and 1550nm
- d. Event Threshold: 0.05dB for both multimode and single mode
 - e. Reflection Threshold:
 - 1) Multimode: -45dB
 - 2) Single mode: -60dB
 - a) Fiber Break/End-Of-Fiber: 3dB for both multimode and single mode
2. Waveform: The waveform shall be real-time/normal density.
 3. Obtain measurements using a 'launch' cord connected to the test instrument and the cable-under-test.
 - a. The fiber of the launch cord shall match the fiber of the cable-under-test in physical and performance parameters (such as type, core/cladding size, index of refraction, refractive profile). The fiber of the launch cord should match the fiber of the cable-under-test in manufacturer and product.
 - b. The length of the launch cord shall be between 25 meters and 100 meters.
 4. Review the results of each test and bring to the attention of the Engineer all fibers that do not meet the manufacturer's allowed loss for splices and connectors, or fibers that do not meet the length of the overall cable length.
- D. Record Documents:
1. Test reports shall match the cable and fiber IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is associated with the electronic and printed test record.
 2. The units for distance measurements (i.e., the "X" axis of the graph) shown on the print of the test measurements shall be feet.
 3. For the traces, the x- and y-axis scales of a given cabling link shall be identical. Preferably, all reports shall be printed with identical scales on both x- and y-axis.
 4. The launch cord must be shown in the trace of the printed test report.
 5. Measurements shall carry a precision through one significant decimal place (minimum).
 6. Each test report shall contain the following information (not necessarily in this order):
 - a. Project name,
 - b. General Contractor name / Telecommunications Installer name
 - c. Cable identifier, fiber number, and fiber type (e.g., "multimode")
 - d. Measurement direction,
 - e. Date measurement was obtained,
 - f. Operator (name an company),
 - g. Test equipment model and serial number(s),
 - h. Set up parameters (minimum - pulse width, refractive index, event threshold.)
 - i. Wavelength,
 - j. OTDR trace,
 - k. Length of fiber,
 - l. Overall link loss.
 7. For each passive cabling link, include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show the launch cord with length, expected events with distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

3.5 Backbone fiber optic passive link Insertion Loss TESTING

- A. Test fiber optic passive links per “Base Bid Requirements” in Part 1 of this Section.
- B. Launch Conditions:
 - 1. For passive link insertion loss testing for multimode fibers, the modal launch condition from the light source shall be characterized as Category 1 per OFSTP-14.
 - 2. For passive link insertion loss testing of single mode fibers:
 - a. Use the launch conditions, as described in FOTP-78.
 - b. Employ a method to remove high-order propagating modes, as described in FOTP-77.
- C. Test Methods:
 - 1. The passive link insertion loss testing of multimode fibers shall be performed according to “Test Method B: One Jumper Reference”, per OFSTP-14, for ‘permanent’ links, and shall be performed according to “Test Method C: Three Jumper Reference”, per OFSTP-14, for ‘channel’ links.
 - 2. The passive link insertion loss testing of single mode fibers shall be performed according to “Test Method A.1: One Jumper Measurement”, per OFSTP-7.
- D. Precautions:
 - 1. Adhere to the equipment manufacturer’s instructions during testing activities.
 - 2. Prior to any testing activity or any measurements taken:
 - a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
 - b. Power on the light source and power meter for at least 5 minutes.
 - c. Clean all test cords & system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
 - 3. Do not power off light source or the power meter during testing activity.
 - 4. Do not remove Test Cord #1 from the light source at any time (unless the testing is complete or the equipment is being put away for the evening).
 - 5. Do not bend the test cords smaller than 20 times the cord diameter (this may induce loss into the cord reducing the accuracy of the measurement).
 - 6. Fully charge power sources before each day’s testing activity.
- E. Passive Link Insertion Loss Testing Procedures:
 - 1. Test Equipment Set Up
 - a. Follow the test equipment manufacturer’s initial adjustment and set up instructions.
 - b. If the power meter has a Relative Power Measurement Mode, select this mode.
 - c. If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
 - d. Set the light source and power meter to the same wavelength.
 - 2. Test Cord Performance Verification

- a. Connect Test Cord #1 between the light source and the power meter.
- b. The value displayed on the power meter is the reference power (P_{ref}) measurement. If the power meter has a relative power measurement mode, enter this reference power measurement (P_{ref}) value into the meter. If it does not, hand-write P_{ref} onto the record documents for future reference.
- c. Disconnect Test Cord #1 from the power meter. Do not disconnect Test Cord #1 from the light source.
- d. Connect the 'open' end of Test Cord #1 to an adapter (of matching connector type). Connect one end of Test Cord #2 to the adapter and the other end of Test Cord #2 to the power meter.
- e. The value displayed on the power meter is the power measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the test cord #2 connection attenuation. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the connection attenuation:
 - 1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc):
 Connection Attenuation (dB) = $|P_{sum} - P_{ref}|$
 - 2) If P_{sum} and P_{ref} are in watts: Connection Attenuation (dB) = $|10 \times \log_{10} [P_{sum}/P_{ref}]|$.
 - 3) The measured connection attenuation must be less than or equal to the value found in Table 3 (below).
- f. Flip the ends of Test Cord #2 so that the end connected to the power meter is now connected to the adapter, and the end connected to the adapter is now connected to the power meter.
- g. The meter reading is the reversed Power Measurement (P_{sum}). Perform the proper calculations if not using Relative Power Measurement Mode.
- h. Verify that both connection attenuation measurements are less than or equal to the value found in the following table:

	ST or SC Cord	Mini-Connector Cord
Multimode (50/125)	0.50 dB Max	0.20 dB Max
Single mode	0.55 dB Max	0.30 dB Max

- i. If both measurements are found to be less than or equal to the values found in Table 1, test cord #1 is acceptable for testing purposes. Unacceptable attenuation measurements may be attributable to test cord # or test cord #2. Examine each cord with a portable microscope and clean, polish, or replace if necessary.
 - j. Repeat this test procedure from the beginning reversing the test cords in order to verify the performance of test cord #2.
3. Determine the Launch Category of the Light Source
 - a. The launch category of a light source can be determined by measuring its Coupled Power Ratio (CPR). The CPR is a measurement of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower Category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.

- b. Provide two test cords, one multimode (Test Cord #1) and one single mode (Test Cord #2). Both cords shall be directly terminated on connectors that are compatible with the light source and power meter.
 - 1) The fiber of the multimode test cord shall have the core diameter and numerical aperture nominally equal to those of the permanent link.
 - 2) The fiber of the single mode test cord shall contain Class IVa single mode fiber, with a mode field diameter of $5.0\mu\text{m} \pm 0.5\mu\text{m}$ for 850nm tests and $9.0\mu\text{m} \pm 1.0\mu\text{m}$ for 1300nm tests.
- c. Connect test cord #1 between the light source and the power meter. Avoid placing bends in the cord that are less than 4 inches in diameter.
- d. The meter reading is the Reference Power Measurement (P_{ref}). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (P_{ref}) value into the meter. If it does not, hand-write P_{ref} for future reference.
- e. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
- f. Connect test cord #2 between the power meter and test cord #1, using an appropriate adapter between the test cords.
 - 1) Test cord #2, the single mode cord, shall include a high order mode filter. This can be accomplished by twice wrapping the cord around a 1.2" diameter (30-mm) mandrel.
- g. The meter reading is the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the CPR:
 - 1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc): $\text{CPR (dB)} = |P_{\text{sum}} - P_{\text{ref}}|$
 - 2) If P_{sum} and P_{ref} are in watts: $\text{CPR (dB)} = |10 \times \log_{10} [P_{\text{sum}}/P_{\text{ref}}]|$
Coupled Power Ratio (CPR) in dB, for 50/125 μm Fiber:

	Cat-1 Overfilled	Cat-2	Cat-3	Cat-4	Cat-5 Underfilled
850nm source	20 – 24	16 – 19.9	11 – 15.9	7 – 10.9	0 – 5.9
1300nm source	16 – 21	12 – 15.9	8 – 11.9	4 – 7.9	0 – 3.9

4. Multimode Insertion Loss Measurement

- a. After setting up the test equipment, verifying the performance of the test cords, and determining the light source's CPR, the insertion loss of the passive link segments can be measured.
- b. Connect test cord #1 between the light source and the power meter.
- c. The meter reading is the Reference Power Measurement (P_{ref}). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (P_{ref}) value into the meter. If it does not, hand-write P_{ref} for future reference and to be included in the Record Documents.
- d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
- e. Connect test cord #1 to the passive link segment 'input'.

- f. At the opposite end of the passive link segment, connect test cord #2 to the link segment 'input' and the power meter.
 - g. The meter reading is the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
 - 1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc): Link Segment Attenuation (dB) = $|P_{sum} - P_{ref}|$
 - 2) If P_{sum} and P_{ref} are in watts: Link Segment Attenuation (dB) = $|10 \times \log_{10} [P_{sum}/P_{ref}]|$
 - h. Record P_{sum} for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.
5. Single mode Insertion Loss Measurement
- a. After setting up the test equipment and verifying the performance of the test cords, the insertion loss of the passive link segments can be measured.
 - b. Connect test cord #1 between the light source and the power meter.
 - c. The meter reading is the Reference Power Measurement (P_{ref}). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (P_{ref}) value into the meter. If it does not, hand-write P_{ref} for future reference and to be included in the Record Documents.
 - d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
 - e. Connect test cord #1 to the passive link segment 'input'.
 - f. At the opposite end of the passive link segment, connect test cord #2 to the link segment 'input' and the power meter.
 - g. The meter reading is the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
 - 1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc): Link Segment Attenuation (dB) = $|P_{sum} - P_{ref}|$
 - 2) If P_{sum} and P_{ref} are in watts: Link Segment Attenuation (dB) = $|10 \times \log_{10} [P_{sum}/P_{ref}]|$
 - h. Record P_{sum} for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.
6. Acceptable Measurement Values
- a. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
 - b. The general insertion loss equation for any link segment is as follows:
 - 1) Insertion loss = <cable loss> + <connection loss> + <splice loss> + <CPR adjustment>.
 - 2) Note: A connection is defined as the joint made by two mating fibers terminated with remateable connectors (e.g., ST, SC, etc).
 - c. 50/125 μ m Multimode Insertion Loss Coefficients

- 1) Cable Loss = Cable Length (km) x (3.0 dB/km @ 850-nm or 1.0B/km @ 1300-nm).
- 2) Connection Loss (ST or SC Connectors) = (Connections x 0.4 dB) + 0.42 dB.
- 3) Connection Loss (Other mini-connectors) = (Connections x 0.2 dB) + 0.24 dB
- 4) Splice Loss = Splices x (0.05 dB for fusion or 0.10 dB for mechanical).
- 5) CPR Adjustment = See following table:

	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5
Links with ST or SC Connectors	+0.50	0.00	-0.25	-0.50	-0.75
Links with mini-connectors	+0.25	0.00	-0.10	-0.20	-0.30

d. Single mode Insertion Loss Coefficients

- 1) Cable Loss = Cable Length (km) x (0.50 dB/km @ 1310-nm or 0.50 dB/km @ 1550-nm)
- 2) Connection Loss (ST or SC Connectors) = (Connections x 0.44 dB) + 0.42 dB
- 3) Connection Loss (Other mini-connectors) = (Connections x 0.24 dB) + 0.24 dB
- 4) Splice Loss = Splices x (0.07 dB for fusion or 0.15 dB for mechanical)
- 5) CPR Adjustment = Not applicable for single mode.

F. Record Documents:

1. All cable and fiber IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is entered into the stored test result in the power meter.
2. Measurements shall carry a precision through one significant decimal place (minimum).
3. Each test report shall contain the following information (not necessarily in this order):
 - a. Project name and address,
 - b. General Contractor name / Telecommunications Installer name.
 - c. Operator's name(s),
 - d. Date of measurement,
 - e. Test equipment - manufacturer, model, and serial number,
 - f. Cable identifier, fiber and fiber type,
 - g. Measurement direction,
 - h. Wavelength, and
 - i. Measured loss values.

3.6 BACKBONE TWISTED PAIR CABLING TESTING REQUIREMENTS AND PROCEDURES

A. Testing Requirements:

1. Test backbone multi-pair cabling per "Base Bid Requirements" in Part 1 of this Section.
2. The installation will be accepted when testing has indicated a 100% availability of all terminated pairs or the Owner has approved any deviation from this requirement.

B. Testing Procedures

1. Test wire map and continuity for all pairs.

2. Test length for 2% of pairs of each cable. None of the pairs tested for length shall be of the same 25-pair binder group.

C. Record Documents:

1. All cable and pair IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/termination label shall be the same as what appears on the test reports.
2. Measurements shall carry a precision through no significant decimal place.
3. Each test report shall contain the following information (not necessarily in this order):
 - a. Project name and address,
 - b. General Contractor name / Telecommunications Installer name,
 - c. Operator's name(s),
 - d. Date of measurement,
 - e. Test equipment - manufacturer, model, and serial number,
 - f. Cable identifier and pair numbers,
 - g. Overall test result, and
 - h. Measured values of minimum requirements.

3.7 HORIZONTAL CATEGORY 6 TESTING PROCEDURES

A. Precautions:

1. Adhere to the equipment manufacturer's instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature - approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day's testing activity

B. Test Equipment Set Up:

1. Set up the tester to perform a full Category 6 test, as a Permanent Link configuration.
2. If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6.
3. Set the tester to save the full test results (all test points, graphs, etc.).
4. Save the test results with the associated cable link identifier to match that as specified in Section 27 15 00.
5. Calibrate the test set per the manufacturers instructions.

C. Acceptable Test Result Measurements:

1. Links which report a Fail, Fail* or Pass* for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
2. Any reconfiguration of link components required as a result of a test Fail, must be re-tested for conformance.
3. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
4. Minimum measurement requirements:

Wire Map	All pairs of the cabling link shall be continuous and terminated correctly at both ends. No exceptions shall be accepted.
Length	The maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration shall be 94 meters, including test cords.
Insertion Loss	The acceptable insertion loss measurements for any Category 6 cabling link shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Worst Pair-to-Pair Near End Cross-Talk (NEXT) Loss	The acceptable worst pair-to-pair NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Power Sum NEXT Loss	The acceptable power sum PS-NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Worst Pair-to-Pair ELFEXT and FEXT Loss	The acceptable worst pair-to-pair ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Power Sum ELFEXT and FEXT Loss	The acceptable PS-ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Return Loss	The acceptable return loss measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.
Propagation Delay and Delay Skew	The acceptable propagation delay and delay skew measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.

D. Record Documents

1. For each Horizontal Category 6 test measurement, record the following information:
 - a. Project name and address,
 - b. General Contractor name / Telecommunications Installer name,
 - c. Operator's name(s),
 - d. Date of measurement,
 - e. Ambient temperature,
 - f. Test equipment - manufacturer, model, and serial number,
 - g. Cable identifier,
 - h. Overall test result, and
 - i. Measured values of minimum requirements.

END OF SECTION 270800

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SECTION 271100 - COMMUNICATION EQUIPMENT ROOM FITTINGS AND GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.
- B. Requirements of the following Division 27 Sections apply to this section:
 - 1. Division 27 Section 270100 "Basic Communication System Requirements".
 - 2. Division 27 Section 270500 "Common Work Results for Communications".

1.2 SUMMARY

- A. This section includes the following:
 - 1. Racks
 - 2. Cabinets
- B. This Section includes solid grounding of communications systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
- C. The Contractor shall be responsible for proper grounding of all racks, cabinets, and active components as shown on the Drawings and as specified herein.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Product data for connectors and connection materials, and grounding fittings.
- C. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
- D. Report of field tests and observations certified by the testing organization.

1.4 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, whose products have been in satisfactory use in similar service for not less than 3 years.

- B. Installer: Qualified with at least 3 years of successful installation experience on projects with communications grounding work similar to that required for project.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
 - 1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).
- F. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to grounding and bonding.
- G. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to grounding.

1.5 DESCRIPTION OF WORK

- A. The Contractor shall furnish and supply all equipment, including but not limited to, equipment racks, cabinets, mounting hardware, and all associated equipment necessary to provide a complete and operating system.
- B. All bids shall be based on equipment as specified herein. All alternate equipment must be approved ten (10) days prior to bid date. Adequate information must be made available for a evaluation and approval of alternate equipment.
- C. Contractor shall furnish a manufacturer's manual of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding. All published specifications of the manufacturers of equipment specified shall be considered as being a part of this specification, even though they have not been included in detail.
- D. As-built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project.
- E. Wire management shall be in accordance with the recommended practices as established by BISCO.
- F. All equipment installation and wiring shall meet all requirements of manufacturer.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-Line Systems Inc.
2. Burndy Corporation
3. Crouse-Hinds Company
4. Electrical Components Division Gould Inc.
5. General Electric Supply Company
6. Ideal Industries, Inc.
7. Thomas and Betts Corporation

B. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Conductor Materials: Copper with 98% conductivity.

2.2 WIRE AND CABLE CONDUCTORS

A. General: Comply with Division 26 Section "Low Voltage Electrical Power Cables".

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B-3.
2. Assembly of Stranded Conductors: ASTM B-8.

E. Tinned Conductors: ASTM B-33.

2.3 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

D. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cm. Protect braid with copper bolt hole ends with holes sized for 3/8" diameter bolts.

2.4 CONNECTOR PRODUCTS

A. General: Listed and labeled as grounding connectors for the materials used.

- B. Pressure Connectors: High-conductivity-plated units.
- C. Bolted Clamps: Heavy-duty units listed for the application.

2.5 GROUNDING ELECTRODES

- A. Signal and Communications: For communication systems, provide a #6 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each rack, cabinet or central equipment location.
- B. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
- C. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

2.6 COMMUNICATION ROOM EQUIPMENT

- A. Provide the following equipment, including but not limited to, the purchase, delivery, unpacking, installation, connection, testing, and operation of the same.
- B. The quantities of items required shall be as shown on the drawings, or as stated below. Where a conflict exists between the quantities shown on the drawings, and the quantities stated hereinafter, the greater of the two quantities shall be used. All Item Tags listed below are referenced to the Item Tags shown and listed on Drawing T-503.
- C. 19" Floor Rack - Item Tag A01:
 - 1. Description: 19" distribution rack
 - 2. Manufacturer/Model No.: Cooper B-Line SB7703084UFB or approved equal.
 - 3. Requirements:
 - a. Unit shall be standard 19" width by 84" high
 - b. Unit shall be painted black
 - 4. Accessories:
 - a. Hardware
 - 1) Provide vertical cable management racks on both side of rack, full height.
 - 2) Provide one horizontal cable management for each 24-port patch panel and two horizontal cable management for each 48-port patch panel installed on the rack, Cooper B-Line SB8701952FB or approved equivalent.
 - 3) Provide one stationary shelf per MDF and IDF Closet, SB745V1919AFB or approved equivalent.
 - 4) Provide one rack mounted, 6 position power strip per rack, Cooper B-line No. SB300051020LFB or approved equivalent.

- b. Software
 - 1) None required
 - 5. Quantity: as shown on the Drawings.
 - 6. Remarks: provide engraved label at top center of rack indicating rack number.
- D. 19" Wall Rack - Item Tag A02:
- 1. Description: 19" distribution rack
 - 2. Manufacturer/Model No.: Cooper B-Line SB708195418FB or approved equal.
 - 3. Requirements:
 - a. Unit shall be standard 19" width by 54" high
 - b. Unit shall be painted black
 - 4. Accessories:
 - a. Hardware
 - 1) Provide vertical cable management racks on both side of rack, full height.
 - 2) Provide one horizontal cable management for each 24-port patch panel and two horizontal cable management for each 48-port patch panel installed on the rack, Cooper B-Line SB8701952FB or approved equivalent.
 - 3) Provide one rack mounted, 6 position power strips per wall rack, Cooper B-line No. SB3005615FB or approved equivalent.
 - b. Software
 - 1) None required
 - 5. Quantity: as shown on the Drawings.
 - 6. Remarks: provide engraved label at top center of rack indicating rack number.
- E. Electrostatic Discharge Kit:
- 1. Description: One-hole barrel lug, angled at 45-degrees, permanently marked with protective earth (ground) symbol, designated to accommodate a 4mm ESD wrist strap plug. Kit shall include an antioxidant compound, and one #12-24x 1/2" threaded-forming screw.
 - 2. Manufacturer/Model No.: Panduit Corporation, part no. RGEDS-1 approved equal.
 - 3. Requirements:
 - a. Provide one kit for each floor rack or wall cabinet.
 - 4. Accessories:
 - a. Hardware
 - 1) Accessories for a complete and neat installation.
 - b. Software
 - 1) None required.

5. Quantity: one (1) per rack and/or freestanding cabinet.
6. Remarks: none

F. Ladder Rack:

1. Description: 12" wide ladder rack.
2. Manufacturer/Model No.: B-Line, SB17T12B or approved equal.
3. Requirements:
 - a. Provide ladder rack extending from cable tray to each equipment rack or wall cabinet.
 - b. Provide ladder rack extending from cable tray to each free standing rack.
 - c. Ladder Rack shall have 9" rung spacing. Secure ladder rack to rack and cable tray.
 - d. Ladder rack shall be painted black.
4. Accessories:
 - a. Hardware
 - 1) Provide mounting and wire management accessories for a complete and neat installation.
 - b. Software
 - 1) None required.
5. Quantity: one (1) per rack and freestanding cabinet.
6. Remarks: none

PART 3 - EXECUTION

3.1 GENERAL

- A. Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

3.2 INSPECTION

- A. Installer must examine areas and conditions under which grounding connections are to be made and notify the Architect in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 APPLICATION

- A. Provide grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

3.4 INSTALLATION

- A. General: Ground communications systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
- B. Coordinate with other electrical work as necessary to interface installation of communication system grounding system with other work.
- C. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

3.5 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 - 2. Make connections with clean bare metal at points of contact.
 - 3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
- B. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

- A. Upon Completion of installation of communications grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms, or less, by driving additional ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance.
- B. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.
- C. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal.
- D. Ground/resistance maximum values shall be as follows:
 - 1. Equipment rated 500 kVA and less: 10 Ohms

- E. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.
- F. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.7 COMMUNICATION ROOM EQUIPMENT TESTING

- A. Before final acceptance of the installation, the contractor shall test in the presence of the Architect/Engineer/Owner or their representative's the complete installation and show that the system is completely operational and free from unwanted grounds, shorts, breaks, etc. The Contractor shall obtain all equipment required to test the final installation. The testing of the system shall be made under the direct supervision of the equipment manufacturer's or their designated representative.
- B. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Architect/Engineer/Owner.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SCOPE

- A. This section includes the copper and fiber backbone cable and the termination requirements from a Switch Room/MDF to a BDF or ER or TR and from a BDF to a ER or TR and from a ER to TR and from a TR to another TR.
- B. This section includes minimum requirements for the following:
 - 1. Outside Plant (OSP)
 - 2. Outdoor Rated Optical Fiber Cables
 - 3. Heavy Wall Innerducts
 - 4. Optical Fiber Connectors - ST
 - 5. Optical Fiber Splicing Trays for Exterior Enclosures
 - 6. Optical Fiber Splice Enclosures
 - 7. 24 AWG Underground Rated Copper Cables
 - 8. (PE89)
 - 9. Vault Closures
 - 10. End Caps
 - 11. Plugs
 - 12. Bushings
 - 13. Lubricants
 - 14. Sealing Kits
 - 15. Clamps
 - 16. Bonding Harnesses
 - 17. Dome Enclosures
 - 18. Encapsulated Enclosures
 - 19. Encapsulants
 - 20. Splicing Tapes
 - 21. Splicing Modules - Filled
 - 22. De-Gel Stripper
 - 23. Installation, Termination, and Splicing Methods
 - 24. Inside Plant (ISP)
 - 25. Plenum and Riser Rated Optical Fiber Cables
 - 26. Riser and Plenum Rated Innerducts
 - 27. Optical Fiber Connectors - ST
 - 28. ARMM/CMR Copper Cables
 - 29. Splicing Modules
 - 30. Splicing Tapes
 - 31. Clamps
 - 32. Split Riser Splice Cases
 - 33. Bonding Connectors
 - 34. Grounding Braid

1.2 QUALITY ASSURANCE AND REFERENCES

- A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Network & Telecommunication Department. Equipment and

materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA/EIA - 568-B Commercial Building Telecommunications Cabling Standard
2. ANSI/TIA/EIA - 569-A Commercial Building Standard for Telecommunications Pathway and Spaces
3. EIA/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. EIA/TIA-607 Commercial Building Grounding and Bonding requirements for Telecommunications
5. NFPA 70 - 2002, including:
 - a. NEC - Article 770
 - b. NEC - Article 800
6. Underwriters Laboratory
7. NEMA - 250
8. Federal Communications Commission 47 CFR 68.
9. BICSI Telecommunications Distribution Design Manual (10th edition)
10. BICSI Customer Owned Outside Plant Design Manual (2nd edition)
11. BICSI Telecommunications Cabling Installation Manual (2nd edition)
12. ANSI/NECA/BICSI 568-2001 Standard for Installing Commercial Building Telecommunications Cabling
13. ISO/IEC 11801
14. Bellcore GR-20

C. The fiber optic cable specified in this project may be used to support an ATM or Gigabit Ethernet network. At the time of installation all fiber optic products shall support the latest draft or formal specification released by the IEEE 802.Z (for Gigabit Ethernet).

1.3 SUBMITTALS

- A. Manufacturers catalog sheets, specifications, and installation instructions for all products to be installed within the scope of work included under this contract.
- B. Test Results and Documentation as per Section 270800.

1.4 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. Requirements of the following Division 27 Sections apply to this section:
 1. Division 27 Section 270100 "Basic Communication Systems Requirements".
 2. Division 27 Section 270500 "Common Work Results for Communications".

PART 2 - PRODUCTS

2.1 PLENUM AND RISER RATED OPTICAL FIBER CABLES

A. Multimode Fiber:

1. Shall be graded-index optical fiber waveguide with nominal 50µm Multi-mode-core/cladding diameter. The primary coating diameter of 900µm UV cured acrylate buffer material.
2. The fiber shall comply with ANSI/EIA/TIA-492AAAA
3. Transmission Characteristics for Multimode Fiber Optic Cable:
 - a. Each cabled fiber shall meet the graded performance specifications below. Attenuation shall be measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61. Information transmission capacity shall be measured in accordance with ANSI/EIA/TIA-455-51 or 30. The measurements shall be performed at 23 degrees C +/- 5 degrees.
 - 1) Maximum attenuation dB/Km @ 850/1300 nm: 3.25/1.0
 - 2) Bandwidth 200 Mhz-km @ 850nm
 - 3) Bandwidth 500 Mhz-km @ 1300nm
 - 4) Distance vs. bandwidth using a LED transmitter operating at a 1300nm Wave length
 - 5) 10Gig 50/125µm (OM3) multimode plenum rated.

B. Single Mode:

1. Class IVa dispersion - unshifted single mode optical fibers complying with ANSI/EIA/TIA-492BAAA. Primary coating diameter of 250µm UV cured acrylate buffer material.
2. The zero dispersion wavelength shall be between 1300 nm and 1324 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.093 ps/km-nm². Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175.
3. The nominal mode field diameter shall be 8.7 µm to 10.0 µm with a tolerance of +/- 0.5 µm at 1300 nm when measured in accordance with ANSI/EIA/TIA-455-164 or ANSI/EIA/TIA-455-167.
4. Transmission Characteristics:
 - a. Maximum attenuation dB/Km @ 1310/1550 nm: 1.0/1.0
 - b. The cutoff wavelength shall <1279 nm when measured in accordance with ANSI/EIA/TIA-455-170
 - c. Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength:

C. Physical Characteristics:

1. 900 µm tight buffer.
2. 2.0 mm sub-unit diameter.
3. OFNR/OFN Flame Rated meeting U.L. 1666.
4. Suitable for indoor installations.
5. Strength members shall be FGE/Aramid yarn with extruded PVC sub-cable jacket.
6. Secondary thermoplastic type buffer over each fiber.
7. Suitable for underground or aboveground conduits.
8. Shall have individual fiber tube colors per TIA/EIA-598 and overall orange jacket.
9. Provide stiff central member with cables stranded around center.
10. Provide ripcord for overall jacket.
11. Suitable for -40o to 80o C.

12. Suitable for lashing.
13. Must be UV rated for exterior installation. [100 % Corning fiber]

2.2 OPTICAL FIBER CONNECTORS - ST

A. Physical Characteristics:

1. All fiber connectors shall meet ANSI/EIA/TIA-604-2 standards.
2. Multimode connectors shall be orange colored, Single Mode connectors shall be yellow colored.
3. The connector shall have an optical axial pull strength of 33 N at 0 degree angle and an optical off axial pull strength of 2.2 N at a 90 degree angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
4. Connectors must be fusion-spliced, factory polished pigtails (see Network & Telecommunications management for part numbers).

B. Transmission Characteristics:

1. The maximum optical attenuation per each mated field installed fiber connector pair shall not exceed 0.5 dB.
2. The total optical attenuation through the cross-connect from any terminated optical fiber to any other terminated fiber shall not exceed 1.0 dB.
3. Shall have a return loss greater than or equal to 20 dB for multimode fiber and greater than or equal to 26 dB for single mode fiber.
4. The connectors shall sustain a minimum of 500 mating cycles without degrading this performance.

2.3 CMP COPPER CABLES

A. Backbone UTP cables shall consist of 24 AWG, groups of 50/100 pair thermoplastic insulated copper conductors following the ANSI/ICEA S-80- 576 color code. The 50/100 pair groups shall be bound together and covered by a protective sheath consisting of an overall thermoplastic jacket an underlying metallic shield and one layer of dielectric material applied over the core.

B. Provide plenum rated cable.

C. Transmission Characteristics:

1. The resistance of any conductor, measured in accordance with ASTM D 4566 shall not exceed 9.38 ohms per 100m at 20 degrees C.
2. The resistance unbalance between the two conductors of any pair shall not exceed 5%.
3. The mutual capacitance of any pair shall not exceed 6.6 nF per 100m.
4. The capacitance unbalance to ground at 1 kHz of any pair shall not exceed 330 pF per 100m.
5. The characteristic impedance shall be 100 ohm +/- 15% from 1 kHz to 16 MHz.
6. The attenuation shall meet the requirements of the horizontal cable specified in section 271500.
7. The insulation between each conductor and the core shield shall be capable of withstanding a minimum dc potential of 5 kV for 3 seconds.
8. The propagation delay of any pair at 10 MHz should not exceed 5.7 ns/m.
9. The Power Sum NEXT loss shall meet the following:

10. Frequency (MHz) NEXT loss (dB)

- a. 0.150 53
- b. 0.772 43
- c. 1.0 41
- d. 4.0 32
- e. 8.0 27
- f. 10.0 26
- g. 16.0 23

2.4 ARMM COPPER CABLES

- A. Shall be of size indicated on the drawings.
- B. Shall consist of a core of 24 AWG solid annealed copper conductors, color-coded in accordance with telephone industry standards.
- C. Transmission Characteristics:
 - 1. The nominal resistance of any conductor shall not exceed 27.3 ohms per 1000 feet at 20 degrees C.
 - 2. The mutual capacitance of any pair shall not exceed 15.7 nF per 1000 feet at 1 kHz.
 - 3. The maximum attenuation at 1.0 MHz shall not exceed 6.8 dB per 1000 feet.
- D. Conductors shall be twisted to form pairs. Cable having more that 25 pairs shall be assembled in units, each individually identified by color-coded unit binders.
- E. The core shall be covered with a plastic tape.
- F. The core and tape shall be overlaid with a corrugated shield applied longitudinally with overlap using the following materials:
 - 1. .008 inch coated aluminum
 - 2. .005 inch copper
 - 3. Shall be bonded to outer jacket to form an ALVYN sheath.
- G. The outer jacket shall consist of a fire retardant sheath that meets NEC low flame requirements.
- H. Cable shall be suitable, listed and marked for use in a riser application. (CMR)
- I. Manufacturer's cable code, pair size, manufacturing plant location, month and year or manufacture shall be marked on cable every two feet.

2.5 VAULT AND RISER CLOSURES

- A. Closure shall consist of a black solid or split PVC sleeve as indicated on the drawings.
- B. Minimum inside diameter shall be 5" (127mm).
- C. Minimum inside length shall be 26" (660mm).

- D. Actual sizes shall be indicated on the drawings. Otherwise, closure to be sized to accommodate the maximum number of cable pairs to be spliced and the type of connector to be used for splicing.
- E. Closure shall be flame retardant.
- F. Closure shall be re-enterable.
- G. When assembled with properly sized end caps, bushing, plugs and clamps, the closure shall be air and watertight.

2.6 VAULT CLOSURE END CAPS

- A. At MDF and BDF locations, multiple End caps shall be sized precisely to fit the diameter of the tip cables entering the closure.
- B. Number of openings in the multiple end caps shall be determined by dividing the number pairs in the feed cable by 100 and doubling that number. (i.e. 1200 pair cable would have 24 openings for tip cables.
- C. Collared Cap opening can be up to 6.35mm (1/4") larger than the feed cable diameter.
- D. Actual end cap to be provided shall be based on the diameter of the feed cable to be spliced.

2.7 PLUGS

- A. Use tapered or collared plugs as required to fill extra opening in end caps.
- B. Use sealant to seal if inside diameter of hole is less than 6.35mm (.25").

2.8 BUSHINGS

- A. Use rubber or variable bushing as required to reduce standard opening in end caps to accommodate custom diameters.
- B. Use KBS-1 to seal if inside diameter of hole is less than 6.35mm (.25").

2.9 LUBRICANTS

- A. Lubricant shall evaporate are use and shall not damage closure elements in any way.

2.10 SEALING KITS

- A. Shall consist of a urethane adhesive designed for sealing split vault sleeves and split end caps.

2.11 CLAMPS

- A. Provide Sleeve and Collared clamps as required to complete work.

- B. Adhere to all manufacturer installation guidelines.

2.12 BONDING HARNESSSES

- A. Shall be used to ground the shields of the spliced cables.
- B. Bonding harness shall be 14 AWG and sized according to closure.
- C. Adhere to all manufacturer installation guidelines.

2.13 SPLICING MODULES

- A. All splicing modules shall have an integrated encapsulate in all environments. (ISP and OSP).
- B. Crimping process shall strip the installation from the wire and trim the excess wire.
- C. The module shall create a gas tight connection.
- D. All modules shall have test entry ports on the front side of the module.
- E. Straight splicing modules shall have a yellow cover and body top and the base and body bottom shall be dark gold.
- F. Pluggable/Bridge splicing modules shall have a transparent cover, the body top and bottom shall be blue and the insulator shall be red.
- G. Design Make:
 - 1. Straight Splicing Modules
 - a. Pluggable/Bridge Splicing Modules
 - b. Wire connectors may be used for small pair count splices, pending Network Telecommunication Department approval.

2.14 SPLICING TAPES

- A. Shall be an all-weather, Vinyl Plastic material.
- B. Shall resist:
 - 1. Water
 - 2. Acids
 - 3. Alkalies
- C. Shall be flame retardant
- D. Shall not be affected by sunlight.
- E. Shall release smoothly in zero weather and will not ooze adhesive in hot climates.

2.15 BONDING CONNECTORS

- A. Shall consist of a base and upper member, two securing nuts and a plastic shoe to aid connector installation and protect the conductors.
- B. Base and upper members shall be made of tin plated tempered brass, slightly curved so as to exert a continuous spring form on sheath and shield after clamping.

2.16 GROUNDING BRAID

- A. Shall be a flat tin plated copper braid conductor.
- B. Shall have eyelets at regular intervals.
- C. Eyelets shall fit shield connector studs up to 6 mm (1/4") in diameter.

2.17 HEAVY WALL INNERDUCT

- A. Shall be 1" heavy wall construction.

2.18 OPTICAL FIBER CONNECTORS

- A. See inside plant category for same, this section.

2.19 UNDERGROUND RATED BACKBONE COPPER CABLES

- A. Shall be of size indicated on the drawings.
- B. Shall consist of a core of 24 AWG solid annealed copper conductors, color coded in accordance with telephone industry standards.
- C. Transmission Characteristics:
 - 1. The nominal resistance of any conductor shall not exceed 135.5 ohms per mile at 20 degrees C.
 - 2. The resistance unbalance between the two conductors of any pair shall not exceed 4%.
 - 3. The mutual capacitance of any pair shall not exceed 83 +/- 4 nF per mile at 1000 Hz.
 - 4. The capacitance unbalance pair to ground at 1000 Hz of any pair shall not exceed 800 pF per 1000 feet.
 - 5. The capacitance unbalance pair to pair at 1000 Hz of any pair shall not exceed 80 pF per 1000 feet.
 - 6. The dielectric strength of the insulation shall be capable of withstanding a conductor to conductor minimum dc potential of:
 - a. 3 kV for 3 seconds for PE-89.
 - b. 4 kV for 3 seconds for PE-39.
 - 7. The dielectric strength of the insulation shall be capable of withstanding a conductor to shield, minimum dc potential of: 15 kV for 3 seconds (single jacket) and 20 kV for 3 seconds (double jacket).

8. The maximum attenuation at 772 kHz at 20 degrees C shall not exceed:
 - a. 5.6 dB per 1000 feet for PE-89
 - b. 4.9 dB per 1000 feet for PE-39
 - D. Conductors shall be twisted to form pairs. Cable having more than 25 pairs shall be assembled in units, each individually identified by color-coded unit binders.
 - E. The core shall be covered with a non-hygroscopic tape.
 - F. The cable shall be filled with a filling material that seals air spaces in the cable core, meeting or exceeding REA compound flow tests.
 - G. The core and tape shall be overlaid with a corrugated shield applied longitudinally with overlap using the following materials:
 1. .008 inch coated aluminum
 2. .005 inch copper
 3. Gopher resistant types shall use 0.10 inch copper, .006 inch bimetallic alloy 194 (copper/stainless or steel/copper) or .008 inch coated aluminum/.006 inch coated steel (CACSP).
 4. Shall be bonded to outer jacket to form an ALVYN sheath.
 - H. The outer jacket shall consist of a high molecular weight polyethylene.
 - I. Cable shall be suitable, listed, and marked for use in a duct application.
 - J. Manufacturer's cable code, pair size, manufacturing plant location, month and year of manufacture shall be marked on cable every two feet.
- 2.20 ENCAPSULATED CLOSURE.
- A. Minimum inside diameter shall be 5" (127mm).
 - B. Minimum inside length shall be 26" (660mm).
 - C. Actual sizes shall be indicated on the drawings. Otherwise, closure to be sized to accommodate the maximum number of cable pairs to be spliced and the type of connector to be used for splicing.
 - D. Closure shall be re-enterable.
 - E. When assembled the closure shall be air and watertight.
- 2.21 END CAPS AND CLOSURE EXTENSION SLEEVES FOR ENCAPSULATED CLOSURE
- A. Actual end caps and closure extension sleeves to be provided shall be based on the quantity and diameter of the feed cables to be spliced.

2.22 SPLICING TAPES

- A. See inside plant category for same, this section.

2.23 BONDING HARNESSSES

- A. See inside plant category for same, this section.

2.24 ENCAPSULANTS

- A. Encapsulant shall be transparent.
- B. Encapsulant shall be on low viscosity to allow it to penetrate around connectors and wires.
- C. When splice is re-entered, the encapsulant must easily come off hands.
- D. Must possess sufficient tack to adhere well to the splice components during expansion and contraction caused by temperature changes.
- E. When new gel is poured, it must bond thoroughly to existing gel in the closure.
- F. Shall be compatible with the cable insulation.
- G. Shall not be corrosive to copper and must not support fungi or mold growth.
- H. Shall cure quickly. (20- 30 minutes)

2.25 SPLICING MODULES - FILLED

- A. See inside plant category for same, this section.

2.26 DE-GEL STRIPPER

- A. Shall be non-toxic.
- B. Shall be compatible with the cable insulation.
- C. Shall not be corrosive to copper.

2.27 OUTDOOR RATED OPTICAL FIBER CABLES

- A. Shall be composite fiber optic cable for all ER to TR connections.
- B. Install cable inside of an inner duct.
- C. Adhere to all manufacturer installation guidelines.

- D. A service loop of 15 feet shall be maintained at all points of termination. Service loops shall not exceed manufacturer's recommended bend radius and shall be neatly dressed and shall not interfere with other cables and termination equipment.
- E. Pulling tensions shall not exceed those recommended by the fiber optic cable manufacturer.
- F. Manufacturer's minimum specified bend radius shall not be exceeded.
- G. In the event that cabling is totally dielectric (nonmetallic) and installed in a nonmetallic duct, a #6 copper wire shall be placed in the conduit with the cable to be used as tracer for cable locating purposes.

2.28 HEAVY WALL INNERDUCT

- A. Install 1/8" polypropylene monofilament utility rope with a minimum pull tensile strength of 200 pounds. This rope shall have footage marked printed on it.

2.29 OPTICAL FIBER CONNECTORS

- A. See inside plant category for same, this section.

2.30 UNDERGROUND RATED COPPER CABLES

- A. All underground cable shall have been manufactured within 6 months of purchase date.
- B. All open ends of the cable shall have sealing caps installed at the factory prior to shipping so that infiltration of moisture between shipment and installation is prevented.
- C. Contractor shall provide notice 2 days advance notice prior to pulling any cable greater than 400 pairs in size or when a winch is planned for use.
 - 1. Network and Telecommunications Engineer shall be present to observe all pulling activities of cable greater than 400 pair or when a winch is planned for use.
- D. Cable bend radius shall be at least 10 times the diameter of the cable.
- E. Contractor shall be responsible for verifying that ducts are ready for occupancy prior to cable placement.
- F. Contractor shall assume responsibility for any difficulties or damage to the cable during placement.
- G. Cable feeder guides shall be used between the cable reel and the face of the duct.
- H. Cable shall be watched and inspected for sheath defects, as it is played off the reel. Pulling operation shall be stopped and Network & Telecommunication Engineer shall be notified if a defect or any other irregularity is found.
- I. Cable shall be paid off from the top of the reel.

- J. Adhere to all manufacturers requirements regarding pulling tension allowable lubricants and bending radius.
- K. Use Line Tension meter during cable pull to provide accurate measurement of the force exerted on a cable as it is installed. The meter shall have a programmable overload set point with an audible and visual indication of an overload condition. The meter shall have controls to disengage the cable puller if an overload condition occurs.
- L. Secure all cables and splice cases as required with heavy duty tie-wraps to T-slot cable racking and steps. See section for 270543 for additional exterior pathway requirements.
- M. Cable shield shall be continuous from end to end.
- N. Ground and bond all cable at the lightning protection. Also, see section 271100.
 - 1. All cables to be grounded at the MDF end with a minimum #6 solid soft copper ground wire as required by code.
- O. All cable pairs shall be terminated.
- P. Cables shall be tested and the results documented on Network and Telecommunication Department provided or approved test sheets as specified in section 270800.
- Q. Cables shall be labeled as specified in section 270800.

2.31 ENCAPSULATED CLOSURES

- A. Adhere to all manufacturer installation guidelines.
- B. Support closure at both end via racks and steps.

2.32 END CAPS AND CLOSURE EXTENSION SLEEVES

- A. Adhere to all manufacturer installation guidelines.

2.33 ENCAPSULANTS

- A. Adhere to all manufacturer installation guidelines.

2.34 SPLICING TAPES

- A. Adhere to all manufacturer usage guidelines.

2.35 DE-GEL STRIPPER

- A. Adhere to all manufacturer usage guidelines.

2.36 PLENUM AND RISER RATED OPTICAL FIBER CABLES

- A. Shall be MM/SM composite fiber optic cable for all ER to TR connections. (See riser diagram)
- B. All fiber optic cable shall be installed in conduit, cable tray or supported from building structure at 3-foot centers.
- C. Maintain polarization for entire system as described in ANSI/EIA/TIA-568- B.1
- D. Cable shall be continuous from the ER to the ER's and TR's.
- E. For ER to TR fiber runs, leave a 15' service loop at the ER end and at the TR end leave a 15' service loop.
- F. For ER to ER fiber runs leave a 25' service loop at each end.
- G. Adhere to all manufacturers' requirements regarding pulling tension and allowable lubricants.
- H. The contractor shall be responsible for verifying the actual footage's and distances identified on the attached prints (i.e. wall-to-wall, pullbox-to pullbox and ER to TR).
- I. The contractor shall be responsible for verifying that conduits and raceways are "ready for occupancy" before cable placement.
- J. The contractor shall assume the responsibility for any difficulties or damage to the cable during placement.
- K. Where fiber optic cable passes through a vertical riser closet or TR secure fiber to wall vertically every 48". Review fasteners, strain relief, and routing with customer.
- L. Test, label, and document as per Section 270800.

2.37 RISER AND PLENUM RATED INNERDUCT

- A. Adhere to all manufacturer installation guidelines.
- B. Support inner duct every 36" on center.

2.38 OPTICAL FIBER CONNECTORS - ST

- A. Adhere to all manufacturer installation guidelines.
- B. Connector shall be installed with less than .50 dB of attenuation.
- C. Connectors must be fusion-spliced, factory polished pigtails

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All placements shall conform to industry standards with regard to anchoring, cable support and separation from other facilities.
- B. All placements shall conform to industry standards with regard to anchoring, support, etc.
- C. Cables and Inner duct shall not sag or droop but should be installed to maintain a flat plane with smooth transitions from one level or direction to another.
- D. All cables entering and leaving a splice as well as the splice itself shall be appropriately racked to eliminate stress on the cables and/or connections.
- E. All cables shall be sufficiently racked and supported in order to eliminate stress on the cable or splice.

3.2 CMR/CMP COPPER CABLES

- A. UTP backbone cables may be installed in conduit, cable tray, or in cat 6 cable hangers 4' on center.
- B. Cables above drywall ceilings shall be installed in conduit. Cables in exposed areas other than communications equipment rooms shall be installed in conduit or surface raceway.
- C. Cables shall not be allowed to lay on ceiling or ceiling support structure. They must be anchored in such a way as to not interfere with other services or space access.
- D. Unless otherwise specified, noted UTP backbone cables shall be sized based on two-pairs/connected voice jack. Round up to the next audible pair sizing when doing calculations.
- E. Where UTP backbone cable incorporates a campus system (i.e., multiple buildings connected to the backbone), all cable shall be installed with gas tube or solid-state protection devices at both ends.
- F. Test, label, and document as per Section 270800.

3.3 ARMM COPPER CABLES

- A. Secure all ARMM cables to wall within 12" of all splice enclosures
- B. UTP backbone cables may be installed in conduit, cable tray, or in cat 6 cable hangers 4' on center.
- C. Cables above drywall ceilings shall be installed in conduit. Cables in exposed areas other than communications equipment rooms shall be installed in conduit or surface raceway.
- D. Cables shall not be allowed to lay on ceiling or ceiling support structure. They must be anchored in such a way as to not interfere with other services or space access.
- E. Unless otherwise specified, noted UTP backbone cables shall be sized based on two-pairs/connected voice jack. Round up to the next audible pair sizing when doing calculations.

- F. Where UTP backbone cable incorporates a campus system (i.e., multiple buildings connected to the backbone), all cable shall be installed with gas tube or solid state protection devices at both ends.
- G. Test, label, and document as per section 270800.

3.4 VAULT AND RISER CLOSURES

- A. In vault environment or other horizontally installations support splice closure at both end via racks and steps.
- B. Secure Riser closures to wall with heavy-duty Panduit tie-wraps.

3.5 SPLICING

- A. Fold back method of splicing is required for all new splices.
- B. Ends of unused binder groups shall be staggered, cleared, and encapsulated with capping kits.
- C. Terminal counts shall be installed as per the drawings and may not be split or multiplied.
- D. Binder group and color code integrity shall be maintained.
- E. Striped nylon cable ties shall be used to identify binder groups on both sides of the splices and at all other sheath openings.
- F. The quantity of bad pairs per sheath of 100 pairs or more shall not exceed 1% of the total pair count.
- G. Use Cover Removal Tool to remove bases and covers.
- H. Use Separation Tool to separate modules from any other module.
- I. All cable pairs shall be free of electrical opens, shorts (within and between pairs), polarity reversals, transpositions, and the presence of AC voltage, from the Communication Equipment Room to the termination hardware at the main cross connect frame. All defects must be corrected.

3.6 SPLICING TAPES

- A. Tape all entries to vault and riser closures to prevent water, insects, or rodents from entering enclosure.

3.7 BONDING CONNECTORS

- A. Install Bonding Connectors so as not to damage the conductors in the cable.

3.8 GROUNDING BRAID

- A. Adhere to all manufacturer installation guidelines.

END OF SECTION 271300

SECTION 271500 - COPPER CABLING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.
- B. Requirements of the following Division 27 Sections apply to this section:
 - 1. Division 27 Section 270100 "Basic Communication System Requirements".
 - 2. Division 27 Section 270500 "Common Work Results for Communications".

1.2 SUMMARY

- A. This Section includes copper cables and jacks designed and used for voice/data networks.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Submittals shall be made as complete systems including all required accessories and special installation tools (i.e. termination hardware).
- C. Product information including the following cable transmission characteristics:
 - 1. Insertion Loss
 - 2. Near-end Crosstalk (NEXT)
 - 3. Power Sum Near-end Crosstalk (PS NEXT)
 - 4. Attention-to-Cross Talk Ratio (ACR)
 - 5. Power Sum Attention-to-Cross Talk Ratio (PS ACR)
 - 6. ELFEXT
 - 7. Power Sum ELFEXT (PS ELFEXT)
 - 8. Return Loss
 - 9. Skew
 - 10. LCL
- D. Manufacturers complete installation instructions including, but not limited to, the following information:
 - 1. Minimum bend radius
 - 2. Maximum pulling tension
 - 3. Recommended installation of pulling points (i.e. every 270 degrees of bends in the conduit, or every 150 feet of raceway)

- E. Provide information regarding all terminations that will be required to complete this installation. This information shall include complete specifications and installation instructions.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."
- B. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in voice/data cables.
- C. UL Compliance: Comply with applicable requirements of UL Standard 910 "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces." Provide products that are UL-listed and labeled for such use.
- D. Comply with the following Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA) Standards:
 - 1. TIA/EIA-568-B, "Commercial Building Telecommunications Wiring Standard"
 - 2. TIA/EIA-569-A, "Commercial Building Standard for Telecommunications: Pathways and Spaces"
 - 3. TIA/EIA-570, "Residential and Light Commercial Telecommunications Wiring Standard"
 - 4. TIA/EIA-606-A, "The Administration Standard of the Telecommunications Infrastructure of Commercial Building"
 - 5. EIA Standards EIA-230, "Color Marking of Thermoplastic Wire" and
 - 6. EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms."
- E. MIL-SPEC Compliance: Comply with " MIL-C-55021, "Twisted-Pair and Triplet Cables;

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cable factory-packaged in containers or reels. Store in clean dry space and protect products from damaging fumes and traffic. Handle wire and cable carefully to avoid damage.

PART 2 - PRODUCTS

2.1 UNSHIELDED TWISTED PAIR (UTP) VOICE/DATA CABLE AND JACKS

- A. General: Provide unshielded twisted pair cable of manufacturer's standard materials as indicated on the drawings. All cables shall be designed and constructed as recommended by the system/equipment manufacturer, for a complete installation and for applications indicated.
- B. Manufacturers: All cable and connectors for the voice/data system shall be provided in compliance with the warranty requirements of section 27 01 00.

C. Manufacturers: Subject to compliance with requirements, provide unshielded twisted-pair cabling products and connectivity products of one of the following:

1. Connectivity/Cable:

- a. ADC/Krone.
- b. Hubbell Premise Wiring, Hubbell Incorporated connectivity with General Cable Corporation cable, or cable as warranted by Hubbell Premise Wiring.
- c. Ortronics with Berk-Tek cable.
- d. Siemons connectivity with Belden Cable, General Cable, Berk-Tek Cable, or Mohawk Cable.
- e. SYSTIMAX SCS connectivity with SYSTIMAX SCS cable.
- f. Tyco Electronics, AMP Netconnect connectivity with Tyco Electronics, AMP Netconnect cabling.
- g. Leviton connectivity with Belden Cable, General Cable, Berk-Tek Cable, or Mohawk Cable.
- h. Panduit connectivity with General Cable.

D. Category 3 Voice UTP Cable and Jacks

- 1. Provide where indicated on the Drawings or where required by the Specifications, standard TIA/EIA Category 3 unshielded twisted pair cable complete with jacks.
- 2. Provide plenum rated cable in all areas having plenum rated ceiling. All areas of the building shall be considered as having plenum rated ceiling unless noted otherwise on the Drawings.
- 3. Category 3 UTP cable shall meet the following requirements:
 - a. Provide the 50 pair cables as indicated on the drawings.
 - b. Manufacturer/Model Number: Provide cable manufactured by one of the following companies:

Manufacturer	Plenum (CMP)	Riser (CMR)
ADC/Krone	YXV0024-19xx	D024D0-GYxx
Belden	12xxA2 series	12xxA1 series
Berk-Tek		
General Cable Corporation	2131 series	2133 series
SYSTIMAX SCS	2010 series	1010 series
Tyco Electronics/AMP NetConnect	219560-X	219567-X

- 4. Provide 110 connector blocks to accommodate 50 pair cabling at the IDF closets and the MDF closet. Provide Field Termination Kit for 50 pair with 5 pair per block, Hubbell Model No. 110BLK50FTK5 and Wiring Blocks with Stand-Off Legs, Hubbell Model No. 110BLK50BWL. Equivalent manufacturers shall be ADC/Krone, Ortronics, Siemons, Tyco Electronics. Provide all accessories for a complete system of terminations for 50 pair, Cat. 3 telephone cabling.
- 5. Jacks and Patch Panels:
 - a. All jacks shall be RJ-45, 568B configuration.
 - b. Patch Panel shall be in 24 or 48-port configuration as required by the number of workstation cables (plus 10%).
 - c. Manufacturer/Model Number: Provide jacks manufactured by one of the following companies:

Manufacturer	Jacks
ADC/Krone	6467-1-095-xx
Hubbell	HXJ3 series
Ortronics	
Siemons	MX3 series
SYSTIMAX SCS	M1 series
Tyco Electronics/AMP NetConnect	406373-X
Panduit	NetKey
Leviton	eXtreme 6 +

E. Category 6e Voice/Data UTP Cable:

1. Provide where indicated on the Drawings or where required by the Specifications, enhanced TIA/EIA Category 6e unshielded twisted pair cable.
2. Provide plenum rated cable in all areas having plenum rated ceiling. All areas of the building shall be considered as having plenum rated ceiling unless noted otherwise on the Drawings.
3. Cable/connectivity system shall be certified by Graybar Electric Company, Inc., as compliant the VIP 2000 program and/or Anixter Inc., as compliant with the Levels XP7 program.
4. Category 6e UTP cable shall meet the following requirements:
 - a. Structured cabling system shall support 1GB Ethernet.
 - b. All cables shall have 4-pairs with a pair separator built into the cable.
 - c. All Category 6e cables shall meet the minimum requirements of the TIA/EIA-568B as adopted in June 2002 and all addenda ratified thereafter.
 - d. All cables shall be tested by ETL, UL, or an equal third-party testing organization as approved by the Engineer. All cables shall be third-party tested using a standard TIA/EIA 4-connector channel test. Provide printed test reports from the third-party testing organization with the Submittals indicating the following minimum performance requirements:

Test ⁽¹⁾	Statistics ⁽²⁾	Frequency ⁽³⁾	Channel ⁽⁴⁾	Link ⁽⁵⁾
ACR	Minimum	250 MHz	20.2db	⁽⁶⁾
ACR	Typical	250 MHz	24.7db	⁽⁶⁾
PS ACR	Minimum	100 MHz	30.9db	⁽⁶⁾
PS ACR	Typical	100 MHz	33.0db	⁽⁶⁾
PS ACR	Minimum	250 MHz	17.7db	⁽⁶⁾
PS ACR	Typical	250 MHz	19.4db	⁽⁶⁾

- 1) TIA/EIA standard test
- 2) minimum means worst-case value, typical means average value
- 3) test frequency
- 4) 100 meter channel test results, plenum (CMP) cable
- 5) 90 meter link test results
- 6) submit values for Link test

5. Manufacturer/Model Number: Provide cable manufactured by one of the following companies:

Manufacturer	Series	Plenum (CMP)	Riser (CMR)
ADC/Krone	TrueNet 6	6TP-xyyy	6TRT-xyyy

Belden	Media Twist	1874A series	1872A series
Berk-Tek			
General Cable Corporation	GenSpeed 6500	7131431 (*)	7133374 (*)
SYSTIMAX SCS	GigaSPEED XL	2071 series	1071 series
Tyco Electronics/AMP NetConnect		1499033-X	1499038-X

(*) MODEL NUMBER IF FOR BLUE CABLE, USE MODEL NUMBER FOR REQUIRED COLOR CABLE.

6. Jacks and Patch Panels:

- a. All jacks shall be RJ-45, 568B configuration.
- b. Patch Panel shall be in 24 or 48-port configuration as required by the number of workstation cables.
- c. Manufacturer/Model Number: Provide jacks and patch panels manufactured by one of the following companies:

Manufacturer	Series	Jacks	Patch Panels
ADC/Krone	TrueNet 6	EC06-xx	EC06-PANELxx
Hubbell		HXJ6 series	P6xxUE series
Ortronics			
Siemons	System 6	MX6 series	HD6 series
SYSTIMAX SCS		MGS-400 series	1100GS3 series
Tyco Electronics/AMP NetConnect		1375055-X	137501X-1
Pandiut	NetKey		
Leviton	eXtreme +		

PART 3 - EXECUTION

3.1 INSTALLATION OF VOICE/DATA CABLES

- A. Voice/data cables shall be installed with a minimum 18" clearance from light fixtures, electrically operated equipment and all wiring operating at 120 or more volts.
- B. Voice/data cables shall be installed in accordance with manufacturer's written instructions and in compliance with NEC.
- C. Coordinate installation with other Work.
- D. Install without damaging conductors or jacket.
- E. Do not, either in handling or installation, bend cable to smaller radii than minimum recommended by manufacturer.
- F. Ensure that minimum manufacturer's recommended pulling tensions are not exceeded.

- G. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.
- H. Install all cable parallel and/or perpendicular to building surfaces or exposed structural members, and follow surface contours where possible. In ceiling cavities, install cables at bottom of trusses.
- I. Provide "J" hooks for all cables not installed in raceways. "J" hooks shall be spaced no greater than five feet (60") on center, with a maximum spacing of four feet (48") for bundles of 20 or more cables. Do not exceed manufacturer's capacity for "J" hooks.
- J. No cable splices are allowed.

3.2 TERMINATIONS

- A. Terminations at the RJ-45 voice/data jacks shall be made in accordance with TIA/EIA Standard T568B.

3.3 COLOR CODING

- A. The color of the outer jacket of all cables shall be the same, and shall as follows:

	<u>Plenum</u>	<u>Non-Plenum</u>
Fiber Optic	orange	orange
Category 6e	as indicated on drawings	
CATV	black	black
Fire alarm	red	red
Intercom/clock	brown	brown

- B. All voice/data wiring strands shall be color coded as follows:

	<u>Tip</u>	<u>Ring</u>
Pair #1	White/Blue	Blue
Pair #2	White/Orange	Orange
Pair #3	White/Green	Green
Pair #4	White/Brown	Brown

- C. This color-coding shall be consistent and continuous throughout the system.

3.4 TRAINING

- A. Provide adequate length of conductors within boxes at workstation end. Leave sufficient cable length within box to allow for easy removal of faceplate and devices. At the workstation end, leave 24" of excess cable above finished ceiling, directly above voice/data outlet, coil excess cable in a 10" loop with four tie wraps.
- B. Provide adequate length of conductors at patch panels and at punch down blocks. Leave sufficient cable length so that cables can be trained vertically down ladder rack and vertical wire management accessories without cables being tight. All cables shall be secured with Velcro

straps every 12" on center on the rack/cabinet and the ladder racks. Tie wraps shall not be acceptable.

3.5 FIELD QUALITY CONTROL

- A. Prior to usage, test each cable for electrical continuity, short circuits, length, mapping and pairing, attenuation, return loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, and PSELFEXT.
- B. Test all cable segments for faulty connectors, terminations, and the integrity of the cable and its component parts.
- C. System Certification Testing
 - 1. Test the entire cabling system in accordance with the termination manufacturer's warranty program. Warranty programs are specified in section 27 01 00.
 - 2. Coordinate this testing with the Architect and Engineer. Notify both the Architect and Engineer at least seven days in advance of testing in order for the Architect and Engineer to make plans to witness this testing.
 - 3. After all punchdowns and cable terminations are complete test each cable from the workstation outlet to the patch panel. Perform both channel and link tests.
 - 4. This testing shall be conducted with a LAN Tester, as manufactured by Microtest, Wavetek, or as approved by the cable/termination manufacturer.
 - 5. Measure and record the following data: mapping and pairing, attenuation, return loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, and PSELFEXT.
 - 6. Document the test results in graphic plot/text format immediately following the testing. Documentation shall be in printed form, 8½" x 11" paper printed via a laser printer. Provide two copies of the recordings bound in two separate cable record books, indexed for easy reference and transmit these books to the Architect for review by the Engineer. Bind the original recordings in a cable record book indexed for easy reference during future maintenance operations and turn book over to the Owner's authorized representative.

3.6 COMMISSIONING

- A. Subsequent to installation of voice/data cable and equipment demonstrate proper functioning. Replace malfunctioning components with new materials, and then retest until satisfactory performance is achieved.

END OF SECTION 271500

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SECTION 271510 - STRUCTURED CABLING SYSTEM COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
- B. Related Sections include the following:
 - 1. Division 26 Section 260500 "Common Work Results for Electrical".
 - 2. Division 27 Section 270100 "Basic Communication System Requirements".
 - 3. Division 27 Section 271300 "Communications Backbone Cabling".
 - 4. Division 27 Section 271500 "Copper Cabling Systems".

1.2 GENERAL

- A. This Section includes the following:
 - 1. Individual structured cabling system components.

1.3 DESCRIPTION OF WORK

- A. The Contractor shall furnish and supply all equipment, including but not limited to, UTP cabling, fiber optics cable, patch panels, and other equipment necessary to provide a complete and interconnected structured cabling system.
- B. Contractor shall furnish a manufacturer's manual of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included. All published specifications of the manufacturers of equipment specified shall be considered as being a part of this specification, even though they have not been included in detail. Any bidder using other than the specified equipment must provide this information prior to bidding.
- C. As-built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project. Refer to Section 27 01 00 for additional requirements.
- D. Cabling system shall be in accordance with good engineering practices as established by the BISCI, TIA/EIA, and NEC, and any other applicable codes or regulations.
- E. All equipment installation and cabling shall meet all requirements of manufacturer.

PART 2 - PRODUCTS

2.1 REQUIRED EQUIPMENT

- A. Provide the following items, including but not limited to, the purchase, delivery, unpacking, installation, connection, testing, and operation of the same.
- B. The quantities of items required shall be as shown on the drawings, or as stated below. Where a conflict exists between the quantities shown on the drawings, and the quantities stated hereinafter, the greater of the two quantities shall be used. All Item Tags listed below are referenced to the Item Tags shown and listed on the Riser Diagram on the Drawings.
- C. Category 6e Workstation Cable - Item Tag C01:
 - 1. Description: TIA/EIA standard Category 6e horizontal distribution cable.
 - 2. Requirements:
 - a. Cable shall meet performance characteristics specified in Section 27 15 00 of the Specifications.
 - b. Cable shall be plenum rated for all cable routed through the ceiling.
 - 3. Accessories:
 - a. None
 - 4. Remarks: None
- D. Category 6e Patch Panel - Item Tags C02, C17, C18, C19:
 - 1. Description: TIA/EIA standard Category 6e RJ-45 patch panel.
 - 2. Requirements:
 - a. Patch panel shall meet performance characteristics specified in Section 27 15 00 of the Specifications.
 - b. Patch panel shall be rack mounted.
 - 3. Accessories:
 - a. Rack mount hardware.
 - b. Labeling hardware.
 - 4. Remarks: None
- E. Category 6e Cross Connect Cable - Item Tag C03:
 - 1. Description: factory fabricated TIA/EIA standard Category 6e cross connect cable.
 - 2. Requirements:
 - a. Cable shall be used to cross connect patch panel to network switch.
 - b. Cable shall meet performance characteristics specified in Section 27 15 00 of the Specifications.

- c. Cables shall average 7' in length. Quantities of different lengths will be required for this project. Coordinate actual lengths with Owner prior to ordering.
 - d. Cables shall be colored. Coordinate color with Owner prior to ordering.
 3. Accessories:
 - a. None
 4. Remarks: None
- F. Category 3 Telephone Cable - Item Tags C04, C05, C06:
 1. Description: 25-pair (C04), 50-pair (C05), 100-pair (C06) TIA/EIA standard Category 3 telephone cable
 2. Requirements:
 - a. Cable shall meet performance characteristics specified in Section 27 15 00 of the Specifications.
 - b. Cable shall be plenum rated.
 - c. Cables shall extend from wall mounted 110 cross connect blocks in each IDF to the wall-mounted 110 connector blocks in MDF.
 - d. Terminate all cables on 110 cross connect blocks.
 3. Accessories:
 - a. None
 4. Remarks: None
- G. Fiber Optic Distribution Cable - Item Tags C07, C08:
 1. Description: Multi-mode and single-mode fiber optic cable
 2. Manufacturer/Model No.: Refer to Section 27 13 00 of the Specifications.
 3. Requirements:
 - a. Cable shall extend from rack-mounted distribution shelf in IDF to rack mounted distribution shelf in MDF.
 - b. Cable shall meet performance characteristics specified in Section 27 13 00 of the Specifications.
 - c. Cable shall be plenum rated.
 - d. All strands of the cable shall be terminated at both ends.
 - e. Cable shall be suitable for 10 Gigabit Ethernet at 300 meters 50/125um (OM3) multimode plenum rated.
 4. Accessories:
 - a. None
 5. Remarks: None
- H. 12-Strand F.O. Distribution Shelf - Item Tags C09, C10:
 1. Description: 6-port (C09) and 72-port (C10) fiber optic rack mounted distribution shelf

2. Manufacturer/Model No.: Panduit Opticom QuickNet series.
 3. Requirements:
 - a. Cable shall meet performance characteristics specified in Section 27 13 00 of the Specifications.
 - b. Cable shall be plenum rated.
 4. Accessories:
 - a. None
 5. Remarks: none
- I. 2-Strand Fiber Optic Cross Connect Cable - Item Tag C11:
1. Description: 2-strand 50um multi-mode fiber optic cross connect cable
 2. Manufacturer/Model No.: Refer to Section 27 13 00 of the Specifications.
 3. Requirements:
 - a. Cable shall meet performance characteristics specified in Section 27 13 00 of the Specifications. Panduit Opti-core 10 Gig 50/125 um (OM3) fiber optic patch cords and pigtails. Part # FXE10-10M1Y.
 - b. Cables shall have LC (coordinate connector type with Owner prior to purchase) connectors at one end and connectors compatible with network switches at other end.
 - c. Cable shall be adequate length to cross connect distribution shelf to Gigabit modules and ports.
 4. Accessories:
 - a. None
 5. Remarks: None
- J. Wall-Mounted Category 6e Data Jack - Item Tag C12:
1. Description: wall mounted TIA/EIA standard Category 6e data jack(s)
 2. Requirements:
 - a. Number of jacks per outlet as shown on the drawings.
 3. Accessories:
 - a. None
 4. Remarks: Panduit Mini-Com Stainless Steel Faceplates with Labels.
- K. Floor Box Category 6e Data Jack - Item Tag C13
1. Description: TIA/EIA standard Category 6e data jack(s) mounted in floor box.
 2. Requirements:
 - a. Number of jacks per outlet as shown on the drawings.

- b. Install a maximum of 3 data jacks per insert plate.
 - 3. Accessories:
 - a. None
 - 4. Remarks: None
- L. Wall-Mounted Category 3 110 Cross Connect Block - Item Tag C15:
 - 1. Description: Wall mounted TIA/EIA Category 5 110 cross connect blocks
 - 2. Requirements:
 - a. 110 cross connect blocks shall meet performance characteristics specified in Section 271500 of the Specifications.
 - b. 110 cross connect blocks shall be wall mounted.
 - 3. Accessories:
 - a. Wall mount hardware.
 - b. Labeling hardware.
 - 4. Remarks: None

PART 3 - EXECUTION

- A. Before final acceptance of the installation, the contractor shall test in the presence of the Architect/Engineer/Owner or their representative's the complete installation and show that the system is completely operational and tests to the performance levels of the cable specified. The Contractor shall obtain all equipment required to test the final installation. The testing of the system shall be made under the direct supervision of the equipment manufacturer's or their designated representative.
- B. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. In addition, the structured cabling systems shall have a 25-year warranty. Guarantee period shall begin on the date of acceptance by the Architect/Engineer/Owner.

END OF SECTION 271510