

## **SECTION 27 10 10 OUTSIDE PLANT CABLING**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Provide all materials and labor for the installation of a customer-owned outside plant telecommunication system. This section includes Customer-Owned Outside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Outside Plant Structured Cabling System (OSP-SCS - See Definition Below).
- B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the drawings but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant OSP-SCS.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 27 1005 - Telecommunications Cabling.

#### **1.03 DEFINITIONS**

- A. Contractor/Owner Scope Definitions
  - 1. Furnish
    - a. Supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations”.
  - 2. Install
    - a. Operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.
  - 3. Provide
    - a. To furnish and install, complete and ready for the intended operation.
- B. IDF: Intermediate Distribution Facility
  - 1. The IDF(s) is/are the consolidation and termination point(s) for the room cabling.
- C. MDF: Main Distribution Facility
  - 1. Centrally located support structure for terminating the point of entry backbone conduit and cable from the campus network and contains the backbone cables that extend to intermediate distribution frames (IDFs).
- D. MH: Manhole
  - 1. Utility/maintenance hole with an opening to a confined space often used as an access point for an underground public utility, allowing inspection, maintenance, and system upgrades.
- E. NDUS: North Dakota University System
  - 1. The North Dakota University System is a unified system of higher education governed by the State Board of Higher Education.
- F. OSP-SCS
  - 1. Outside Plant - Structured Cabling System. The OSP-SCS is defined as all required equipment and materials including, but not limited to, ANSI/TIA/EIA and ISO/IEC compliant fiber optic cable (singlemode), connectors, splices, splice closures and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.
- G. SM: Single Mode Fiber
  - 1. SM fiber is a cable designed to carry only a single mode of light that is the transverse mode. These are used for the long-distance transmission of signals.
- H. UIT: University Information Technology — division of UND
  - 1. UND's technology support unit serving students, faculty, and staff.

- I. UND: University of North Dakota, the state's oldest and largest university. UND offers 225+ highly accredited on-campus and online degrees.
- J. TMGB
  - 1. Telecommunications Main Grounding Busbar. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

#### 1.04 REFERENCE STANDARDS

- A. National Electrical Safety Code (NESC), latest edition.
- B. Occupational Safety and Health Act (OSHA), latest edition.
- C. ANSI/TIA/EIA - 455: Fiber Optic Test Standards
- D. ANSI/TIA/EIA - 526: Optical Fiber Systems Test Procedures
- E. ANSI/TIA/EIA - 568-B: Commercial Building Telecommunications Cabling Standard
- F. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
- G. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- H. ANSI/TIA/EIA - 758: Customer-Owned Outside Plant Telecommunications Cabling Standard
- I. ISO/IEC IS 11801: Generic Cabling for Customer Premises
- J. BICSI: BICSI Telecommunications Cabling Installation Manual
- K. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)
- L. BICSI: BICSI Customer-Owned Outside Plant Design Manual
- M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- O. TIA-492CAAB - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak; 2000 (Reaffirmed 2005).
- P. TIA-492CAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (Reaffirmed 2002).
- Q. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
- R. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- S. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Alliance/Electrical Components Association.
- T. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
- U. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Telecommunications Industry Association; 2002.
- V. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Telecommunications Industry Association; 2008 (with Addenda; 2011).
- W. TIA-598-C - Optical Fiber Cable Color Coding; Telecommunications Industry Association; Rev C.
- X. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Telecommunications Industry Association; Rev B, 2012 (with Addenda; 2013).
- Y. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.

Z. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.

AA. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

### **1.05 ADMINSTRATIVE REQUIREMENTS**

A. Coordination:

1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
2. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Notify Engineer/Owner of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section to review requirements and details with Owner.

### **1.06 SUBMITTALS**

A. Any deviations from the Contract Documents or specified product data shall be clearly noted and must be approved by the Engineer through an addendum prior to the bid date.

B. If the deviation is not approved by the Engineer/Designer, it remains the Contractor's responsibility to provide what is required in the Contract Documents”.

C. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

D. Quality Assurance/Control Submittals: Provide submittal information for review as follows:

1. Submit a cable routing and grouping plan as follows:
  - a. Where the cable routing and grouping is to be provided as shown on the Contract Documents, do not provide a cable routing and grouping plan. Submit written documentation stating that the cable routing and grouping will be provided as shown on the Contract Documents, that the Contractor has reviewed the routing and grouping on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts between trades, and that the routing and grouping meets applicable codes, regulations and standards.
  - b. Where changes in cable routing and grouping are proposed, submit complete floor plan(s) and/or detail drawing(s) showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Contract Documents. Ensure that any cabling changes are coordinated with comparable accommodating changes to the raceway routing and grouping. Specifically note each location where the proposed routing and grouping is different from the Contract Documents. Submit written documentation detailing the reason for each change request. Each change request must be approved in writing by the Engineer/Owner prior to proceeding with the change.
2. Submit a list of proposed test equipment for use in verifying the installation of the SCS. Proposed test equipment shall meet the criteria as stated in PART 3 - TESTING.

- a. Submit for each testing device:
    - 1) Manufacturer and product number.
    - 2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer's recommended calibration period, encompassing the period of time when the testing device will be used on this project.
    - 3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.
  - b. Submit proposed fiber cable test forms (see PART 3 - TESTING for more detail).
  - 3. Submit a list of the personnel who will be assigned to the project, the type of work they will be performing per QUALITY ASSURANCE below, and copies of the manufacturer's training certification for each. If personnel changes are made during the project, submit the above information for any new personnel prior to them beginning work on the project.
- E. Closeout Submittals:
- 1. A telecommunications-specific Operations and Maintenance (O&M) Manual for Communications shall be required for each project. O&M information submitted under other related communications sections (e.g. Raceway and Boxes for Communications Circuits, Bonding and Grounding for Communications, etc.) shall be included in the O&M Manual and statements should be included in each section directing the Contractor to provide applicable information in the O&M Manual for Communications. The requirement that the Contractor provide an O&M Manual for Communications should be stated in this section or in Inside Plant Communications Circuits.
  - 2. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals, updated to reflect any changes during the course of construction, to the Engineer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
  - 3. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including handhole butterfly drawings.
    - a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
    - b. Keep Record Drawings at the job site and make available to the Owner and Engineer at any time.
    - c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
    - d. Show identifiers for major infrastructure components on Record Drawings.
    - e. Provide a table/schedule showing the following information for each cable link in the project on the Record Drawings. Include the following items in the table/schedule:
      - 1) End locations of cable (telecommunications room and/or manhole)
      - 2) Link Type (campus, riser, horizontal)
      - 3) Media type (fiber, Cat 5, Cat 3, etc.)
      - 4) Cable Identifier
      - 5) Actual measured link length (from test results)
      - 6) For fiber optic cabling, actual measured link attenuation as tested with test frequency (from test results)

**1.07 QUALITY ASSURANCE**

- A. Pre-Approved Contractors:
  - 1. ABT Data Technologies, Inc.
  - 2. Archkey Technologies, Inc.
  - 3. Ernst Trenching, Inc.
  - 4. Master Construction.

5. MVM Contracting, Inc.
  6. RBB Electric and Communications, Inc.
  7. Other contractors to provide information listed below for prior approval.
- B. Manufacturer Qualifications: At least 5 years experience manufacturing products of the type specified.
- C. Contractor Qualifications: A company having at least 5 years experience in the installation and testing of the type of system specified
- D. Contractors requesting approval to bid shall submit the following information of evaluation:
1. Documentation from the OSP-SCS manufacturer demonstrating that the Contractor is trained and certified by the Manufacturer to install, test, and maintain the SCS and is certified by the OSP-SCS Manufacturer to provide the OSP-SCS Manufacturer's Warranty (see PART 1 - WARRANTY).
  2. Documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
  3. List of references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor's current business name within the past three years. Detail the following for each project:
    - a. Project name and location
    - b. Construction cost
    - c. A brief description of the project, the components involved, and the OSP-SCS manufacturer used on the project.
    - d. Customer contact names, phone numbers, and addresses
- E. Warranty
1. Contractor Warranty:
    - a. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
      - 1) Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
        - (a) The Contractor Warranty period shall commence upon Owner acceptance of the work.
  2. OSP-SCS Manufacturer Warranty:
    - a. Provide an OSP-SCS Manufacturer extended product, performance, application, and labor warranty that shall warrant all passive components used in the OSP-SCS. Additionally, this warranty shall cover components not manufactured by the OSP-SCS Manufacturer, but approved by the OSP-SCS Manufacturer for use in the OSP-SCS (i.e. "Approved Alternative Products"). The OSP-SCS Manufacturer warranty shall warrant:
      - 1) That the products will be free from manufacturing defects in materials and workmanship.
      - 2) That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
      - 3) That the installation shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
      - 4) That the system shall be application independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-B and ISO/IEC 11801 component and link/channel specifications for cabling.
    - b. Provide materials and labor attributable to the fulfillment of this warranty at no cost to the Owner.
    - c. The OSP-SCS Manufacturer Warranty shall be provided by the selected OSP-SCS Manufacturer and shall be:
      - 1) Fiber Optic System - minimum 15 year System Warranty

- (a) Provide a copy of the warranty registration document to the Owner at the time of submittal to Corning.
- d. The OSP-SCS Manufacturer Warranty period shall commence upon a Warranty Certificate being issued by the manufacturer. The Warranty Certificate shall be issued no later than three months after Owner acceptance of the work.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Unless otherwise noted, provide items as specified. "Or equal" or equivalent items are only acceptable when given prior approval within an addendum during the bidding process.
- B. Physically verify existing site conditions prior to purchase and delivery of the materials, including but not limited to lengths and condition of conduit and/or pathway (including maintenance holes and handholes) to be used for routing backbone cabling. Pre-cut materials of insufficient length are the sole responsibility of the Contractor.
- C. OSP-SCS components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers unless the manufacturer of the OSP-SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the OSP-SCS Manufacturer Warranty (see PART 1 - WARRANTY).
- D. Bid only one OSP-SCS Manufacturer and only bid a manufacturer for which the Contractor is certified.
- E. For a given manufacturer, all components shall be part of a single OSP-SCS product line - components shall not be intermixed between a manufacturer's OSP-SCS product lines. The OSP-SCS product line shall be engineered "end-to-end" - the system and all of its components shall be engineered to function together as a single, continuous transmission path.
- F. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational, tested, certified and warranted system.

### **2.02 COPPER CABLE**

- A. Copper Backbone Cable: TIA/EIA-568 Category 3 solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm; 100 pairs formed into 25-pair binder groups; and complying with all relevant parts of and addenda to latest editions of TIA/EIA-568 and ICEA S-90-661, and UL 444.
- B. Manufacturer: Superior Essex Group SEALPIC-F (RUS PE39) water resistant with aluminum shield.
  - 1. 24 AWG, non-shielded, copper conductors.
  - 2. ETPR compound filling with polyethylene jacket.
  - 3. 100 pairs or as indicated on the drawings.
  - 4. Color Code: Standard telephone industry specifications.

### **2.03 FIBER OPTIC CABLE**

- A. Description:
  - 1. Rated for outdoor use, duct installation.
  - 2. All dielectric, single jacket, arid core construction, stranded loose tube construction, water swellable tape, black UV moisture resistant PE jacket with sequential meter marking.
  - 3. Installation Temperature: -22 F to 158 F.
  - 4. Operating Temperature: -40 F to 158 F.
  - 5. Single Mode Glass: 125 um cladding, 8.3 um core, dual window, zero water peak fiber with a maximum attenuation of 0.36 dB/km at 1310 nm and 0.22 dB/km at 1550 nm.
- B. Manufacturer:
  - 1. Commscope OSP LightScope ZWP Series.
  - 2. Corning Altos Series.

3. Approved Equal.

## 2.04 TERMINATION EQUIPMENT

- A. Exterior Fiber Splice Closures: Shall be outdoor rated and re-enterable without the destruction of the housing. Closures shall not require special tooling for entry and sealing of the closure. Closures shall be complete with all incidental and/or required hardware including, but not limited to end caps, grommet kits, splice trays, and grounding/bonding hardware. Closures shall be either butt or in-line depending upon the application.
  1. TYCO Raychem FOSC Series.
  2. Or Approved Equal.
- B. Copper Building Entrance Protector
  1. Manufacturer: Commscope 489ACC1 Series indoor entrance protector.
  2. Wall mounted enclosure, swivel hub input, 110 style termination block output, #6 ground strap.
  3. Provide with Commscope 4B1EW Series 5 pin gas tube protector modules.
- C. Fiber Patch Panels
  1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
    - a. Manufacturer: Panduit FRME2BL 24-port rack mount fiber panel with Panduit FAP Series LC adapter plates.
    - b. Panduit FWME2 wall mount fiber panel with Panduit FAP Series LC adapter plates.
    - c. Adaptors: maximum of 24 duplex adaptors per standard panel width.
    - d. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
    - e. Provide incoming cable strain relief and routing guides on back of panel.
    - f. Provide rear cable management tray at least 8 inches deep with removable cover.
    - g. Provide dust covers for unused adaptors.

## 2.05 IN-GROUND HAND HOLES

- A. Description: Polymer concrete, open bottom
- B. Manufacturer: Quazite PG Series or Equal.
  1. Provide in sizes indicated on the drawings
  2. Provide with open bottom and heavy duty cover rated for 15,000 lbs and two stainless bolts.
  3. Cover shall read "COMMUNICATIONS".
  4. Provide extension rings as necessary to ensure cover is at proper final grade elevation.

## 2.06 LABELING

- A. Review and edit the following products/part numbers as applicable to this project.
- B. Labels
  1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
    - a. Inside Telecommunication Rooms:
      - 1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
    - b. Outside Plant: Waterproof
      - 1) Panduit Marker Tie (or approved equal)
  2. Hand-carried label maker:
    - a. Brady: ID Pro Plus (or approved equal).

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

- B. All work shall comply with applicable safety rules and regulations including OSHA and WISHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- F. Store all materials to be protected from the elements. Pathway materials (conduit, fittings, maintenance holes, etc.) are permitted to be stored outdoors if stacked on boards to avoid direct contact with the ground. The Contractor shall be responsible for any deteriorating effects on the materials due to improper storage (or outdoor storage) prior to installation including damage caused by prevailing weather conditions.
- G. Remove surplus material and debris from the job site and dispose of legally.
- H. Service Loop: Provide a minimum of 50 feet in each manhole or handhole, and 10 feet at each termination point within the building.

### **3.02 RACEWAY**

- A. Handholes:
  - 1. Install handholes where shown on the contract documents.
  - 2. Provide adequate quantity of extension rings to set the handholes at final grade per the contract documents.
  - 3. Handholes shall be set level and be free of debris and dirt.
  - 4. Handholes shall be set parallel to the right-of-way or property line.
  - 5. Ducts shall be routed up into the bottom of the handholes and stubbed 6 inches above the bottom to keep dirt and moisture out of the duct.
- B. Outside Plant Ducts
  - 1. Provide in quantities, sizes and locations as shown on the Contract Documents.
  - 2. Cap duct immediately after placement to prevent debris from entering. Uncap only when cable is to be installed.
  - 3. Provide pull rope in all spare ducts.
  - 4. Encase ductbank conduits in at least 3 inches concrete, with minimum covered depth of 24 inches below finished grade.

### **3.03 SPLICE CLOSURES**

- A. Exterior Fiber Splice Closures: Provide fiber splice closures in sizes and quantities as shown on the Contract Documents. Do not install splice closures where not shown on the Contract Documents. Install closures per manufacturer's instructions. Closures shall be sized to accommodate the quantity of pairs to be spliced. Closures shall be outdoor or indoor rated (depending upon the use). Closures shall be either butt or in-line depending upon the application.
  - 1. Splice closures located in hand holes shall be supported on racks (at both ends) and shall be located to avoid blocking duct access.
  - 2. Connect each closure's ground lug to a 10'x3/4" ground rod with a #10 AWG copper grounding conductor.
  - 3. Fiber splices shall be fusion splices in exterior splice enclosures. Provide splice trays designed to mount within the closure to manage each splice. Protect each bare/stripped optical fiber strand with heat shrink or silicon adhesive to prevent exposure to moisture.



4. Closures shall be properly sealed and demonstrated watertight without encapsulant. Test seals after closure by pressurizing the closure and checking seals for leaks.
  5. Provide encapsulated closures in the locations shown on the Drawings, or if upon visual inspection during construction it appears that the location for closure installation is or is likely to be subject to prolonged immersion in water.
    - a. List additional splice closure product installation requirements above as applicable to this project.
- B. Interior Fiber Splice Enclosures: Install fiber patch panels on existing data racks within the building. Terminate fiber with type of connectors as indicated in product requirements. Install patch panels and terminate cables per the manufacturer's instructions.

### **3.04 GROUNDING AND BONDING**

- A. All grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 - REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Verify and edit referenced section titles.
- C. Bond non-current carrying metal telecommunications equipment and materials to the nearest TGB (if within a building or the nearest grounding conductor if in the outside plant).
  1. Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
    - a. List additional grounding/bonding product installation requirements above as applicable to this project.

### **3.05 FIBER OPTIC CABLE**

- A. For each conduit in which innerduct or cable is to be installed:
  1. Test Mandrels: Clean each conduit with a wire brush and swab with clean rags a minimum of two times in the same direction until the rag comes out of the conduit clean and dry. Swab away from buildings for duct sections connected to buildings. Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the duct.
- B. Test fiber optic cable on the reel upon delivery to the job site, and again prior to installation. Permanently affix the test results to the reel and submit a copy to the Owner prior to installation. Do not install cables that fail the on-reel test. Replace any cables that fail the on-reel test at no additional expense to the Owner.
- C. Test shall conform to the procedures as outlined in the paragraph entitled TESTING at the end of this specification section.
  1. Install cables in compliance with ANSI/TIA/EIA requirements, BICSI practices, and manufacturers recommendations. Adhere to the requirements detailed in the manufacturer's recommendations and ANSI/TIA/EIA Standards relating to bending radius, pulling tension, other mechanical stresses, and pulling speed.
    - a. Monitor pulling tension on runs of 300 feet or longer. Acceptable monitoring devices are:
      - 1) Winch with a calibrated maximum tension..
      - 2) Breakaway link (swivel).
      - 3) In-line tensiometer.
  2. Set up cable reels on the same sides of hand holes as the conduit sections in which cables are to be placed. Level and align reels with conduit sections to prevent twisting of cables during installation into conduits. Pull cables into conduits from tops of reels in long smooth bends. Do not pull cables into conduits from bottoms of reels. Use a cable feeder guide (shoe) of suitable dimensions between the cable reel and the face of the duct to protect the cable and to guide it into the duct. Carefully inspect the cables for sheath defects as the cables pay off the reel. If defects are found during the pulling operation or if

- the cable on the reel binds, twists, or does not pay off freely, stop the pulling operation immediately and notify the Owner's representative.
3. Cables of 1-¼ inch diameter or larger shall be equipped with factory installed pulling eyes, or install a core hitch on site. Use pulling grips for cables smaller than 1-¼ inches in diameter. Do not pound grips into the cable sheath to prevent the grips from slipping. Use a ball-bearing based swivel between the pulling-eyes or grips and the pulling strand.
  4. Once pulling begins, and tension is applied to the cable, continue the pull at a steady rate. If it is necessary to stop the pull at any point, the tension shall not be released unless it is necessary to do so.
  5. Do not splice cables unless specifically noted on the Contract Documents.
  6. Where cables are pulled through handholes, select the same duct at both sides of handholes unless specifically noted on the Contract Documents. Avoid changes in duct selections, especially in elevations, to ensure that no damage occurs to the cable sheaths and that pulling tensions are kept as low as possible.
  7. Maintain and provide a minimum of 50 lineal feet of cable in each handhole. Route cables in hand holes to avoid blocking duct access.
  8. When more than one cable is being installed in a conduit, pull all cables through the conduit simultaneously.
  9. Where practicable, feed cables into ducts from the end of the duct that creates the least sidewall pressure on a bend during installation (i.e. feed cable from the end closest to the bend).
  10. Use pulling compound or lubricant where necessary. Use lubricants that are compatible with the cable jacket material and in accordance with the manufacturer's recommendations. Do not use soap-based lubricants. Where cable is pulled through a maintenance hole or handhole, re-lubricate the cable prior to feeding into the next duct. Immediately after cables have been installed, clean lubricant from exposed cables in handholes and at termination points using dry rags.
  11. Seal cable ends with end caps immediately after installation and until terminated in a termination enclosure to prevent moisture entry into the core of filled cables and to prevent damage during installation.
  12. Provide a service loop in the ER/TR long enough to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 25 feet at each end.
  13. Comply with the NEC 50-ft rule when installing outdoor-rated cable (i.e. do not exceed 50 feet of exposed outdoor-rated cable length within a building).
  14. Cable at the backboards:
    - a. Lay and dress cables to allow future cabling to enter raceway (conduit or otherwise) without obstruction by maintaining a working distance from these openings.
    - b. Route cable as close as possible to the ceiling, floor or other corners to ensure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
    - c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap together similarly routed and similar cables and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.
  15. Cable in the Telecommunications Rooms:
    - a. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals.
  16. Building Entrances: Seal conduits (both in-use and spare) that enter the building from the outside plant to prevent intrusion of water, gases, and rodents.

- D. Provide fiber optic cable in quantities, strand counts, and types (singlemode, multimode, or composite multimode/singlemode (hybrid)), as shown on the Contract Documents. Provide cable with fan-out kits for both ends.
- E. Test fiber optic cable on the reel upon delivery to the job site, prior to installation. Permanently affix test results to the reel and provide a copy to the Owner prior to installation. Do not install cables that fail. Replace failing cables at no additional expense to the Owner.
  - 1. Conform to the test procedures as outlined in the paragraph entitled TESTING at the end of this specification.
  - 2. Demonstrate that the test results are similar to the factory test results as shipped with the reel.
  - 3. Terminate all fiber strands within a fiber cable. The installation of "dark fiber" is not acceptable.
  - 4. For shielded cable, bond the shield at both ends to the TGB.
  - 5. Fiber splices are not acceptable.
    - a. List additional cable product installation requirements above as applicable to this project.

### 3.06 LABELING

- A. General: Labeling and administration shall comply with TIA/EIA 606 and standard industry practices. Coordinate with Owner for exact numbering requirements of new fiber optic cables to correlate with campus numbering standards.
- B. Provide labels at each end of each cable within 24" of building entrance and again within 24" of termination point. Provide labels in each handhole through which a cable passes. Label each cable immediately as it enters a maintenance hole or handhole and again just prior to exiting the maintenance hole or handhole. Where cabling is routed unexposed via innerduct through maintenance holes or handholes, provide labels on exterior of innerduct indicating contents of innerduct. List additional label product installation requirements above as applicable to this project. List additional patch cable product installation requirements above as applicable to this project.
- C. Termination Equipment:
  - 1. Fiber Patch Panels (Verify Exact Labeling with the Owner):
    - a. Outside the panel: Label fiber patch panels on the outside with a minimum of ½ inch high lettering that clearly indicates the building at the opposite end of each cable. In addition, label patch panels with a patch panel designation label as directed by the Owner.
    - b. Inside the Panel:
      - 1) General: Label patch panels with a single label which details the following information for cables terminating in the panel per the Owner's direction.
- D. Grounding/Bonding Conductors: Label bonding conductors "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

### 3.07 TESTING

- A. Provide test records on a form approved by the Owner and Engineer. Include the test results for each cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Engineer/Designer for review and acceptance within two weeks of Substantial Completion.
- B. Print test records for each cable within the system directly from the tester and submit in paper form (in a binder) and in electronic form on disc or flash drive to the Owner and Engineer/Designer for review. Handwritten test results will not be accepted.
- C. Test the SCS after installation for compliance to all applicable standards as follows:

1. Fiber: Test fiber cable on the reel upon delivery to the job site, again prior to installation, and again after installation.
  - a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
    - 1) For Backbone Distribution:
      - (a)  $\text{Max Loss} = [(\text{allowable loss/km}) * (\text{km of fiber})] + [(.3\text{db}) * (\# \text{ of connectors})]$
      - (b) A mated connector to connector interface is defined as a single connector for the purposes of the above formula.
      - (c) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
    - b. Test all strands using a bi-directional end-to-end Optical Transmission Loss Test Instrument (OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B, and the Optical Cable Corporation field testing guidelines (latest edition).
      - 1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
      - 2) Provide test measurements as follows:
        - (a) For singlemode cable: Test at both 1310 and 1550nm.
    - c. Test results shall conform to:
      - 1) The criteria specified in ANSI/TIA/EIA-568-B
      - 2) The Contractor's calculated loss budget above
      - 3) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)
- D. Identify cables and equipment that do not pass to the Owner and Engineer. Determine the source of the non-compliance and replace or correct the cable or the connection materials and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Engineer in the same manner as above.
  1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
    - a. Prior to removal of damaged cable and installation of new cable:
      - 1) Inform the Owner and Engineer of the schedule for the removal and installation.
      - 2) Test the new cable on the reel per paragraph B, above.
      - 3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      - 4) Provide test results to the Owner and Engineer for approval by the Owner and Engineer/Designer.
    - b. Remove the damaged cable and provide new cable.
    - c. After the removal of the damaged cable and installation of the new cable:
      - 1) Test the new cable per the paragraph titled TESTING.
      - 2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
        - (a) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
      - 3) Provide test results to the Owner and Engineer for approval by the Owner and Engineer.
    - d. If a cable which occupies the same innerduct or conduit (if not in innerduct) as a damaged cable is damaged by the extraction and installation process, replace the cable at no additional expense to the Owner.

- 1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.
- 2) List additional testing requirements above as applicable to this project.

**END OF SECTION**