

NORTH ORANGE COUNTY COMMUNITY COLLEGE DISTRICT  
SECTION 27 13 23 – ABF FIBER OPTIC CABLING SYSTEM  
***SAMPLE SPECIFICATION***

**RELATED SECTIONS:**

Section 27 00 00 General Requirements  
Section 27 02 00 General Communication Requirements  
Section 27 05 26 Grounding and Bonding for Communications  
Section 27 05 28 Pathways for Communication Systems  
Section 27 05 37 Fire-stopping For Communication Systems  
Section 27 10 00 Structure Cabling Testing  
Section 27 11 00 Communication Equipment Room Fittings  
Section 27 12 00 Communication Requirements for (RF) CATV System  
Section 27 13 00 Communication Copper Cable Backbone  
Section 27 15 00 Communications Horizontal Cabling  
Section 27 16 00 Communication Connecting Cords, Devices and Adapters

**PART 1 – GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections and Other related documents, apply to this section.

**1.2 SUMMARY**

- A. The authorized/licensed Sumitomo FutureFlex contractor (hereafter referred to as the Contractor) shall supply equipment, materials, labor, and services to provide the air blown fiber telecommunications distribution system including, but not limited to:
1. Optical fiber backbone and optical fiber riser backbone cable and terminations.
  2. Cross-connect and patch panel systems.
  3. Equipment racks and accessories installation.
  4. Grounding of communications systems components.
  5. Indoor Tube Cables and Tube Distribution Units
  6. Outdoor Tube Cables, splice Cases, and Outdoor Tube Distribution Units/Enclosures (TDUs)
  7. Labeling of all tube cabling, and optical fiber bundles, terminations, splices, patch panels, racks, and outlets.
  8. Testing and test documentation of all tube cable, and optical fiber bundles and connections.
  9. Fire stopping.
  10. Documentation preparation including but not limited to submittals, as-built drawings, product documentation and Extended warranty and manufacturer's certification of systems, products, and labor.
- B. Provide all equipment, materials, labor, whether specifically mentioned or not, which be necessary to complete or perfect all parts of the installation. Ensure that they are in compliance with requirements stated or reasonably inferred by the contract documents.

**1.3 REFERENCES**

1. ANSI/TIA/EIA 568-C.1 - Commercial Building Telecommunications Wiring Standards, General requirements.

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2. ANSI/TIA/EIA 568-C.3 - Commercial Building Telecommunications Wiring Standards, Optical Fiber Cabling Components standards.
3. ANSI/TIA/EIA 568-C.3 .1 – Additional Transmission Performance Specifications for 50/125µm Optical fiber Cables.
4. ANSI/TIA/EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
5. ANSI/TIA/EIA 606-B – Administration Standards for Telecommunications Infrastructures.
6. ANSI/TIA/EIA Joint Standard – 607-B – Commercial Building Grounding and Bonding requirements for Telecommunications.
7. ANSI/TIA/EIA 455-78B – Measurement methods for attenuation
8. ANSI/TIA/EIA 758-B – Customer Owned Outside Plant Telecommunications Cabling Standard.
9. ANSI/IEEE C2 – (NECS) Safety Compliance
10. Building Industry Consulting Services International (BICSI) Distribution Methods Manual (TDMM).
11. Building Industry Consulting Services International (BICSI) Customer Owned Outside Plant Design Manual.
12. National Electrical Manufacturers Association (NEMA).
13. National Fire Protection Association (NFPA 30-2003, NFPA 72, NFPA 497-2004, API RP 500-1997)

**1.4 DEFINITIONS**

- A. Acronyms (Refer to **Section 27 02 00** Communication General Requirements)

**1.5 SYSTEM DESCRIPTION**

- A. Provide, test, and install an ANSI/TIA compliant enterprise network/LAN/SAN/Data Center/Campus system comprised of interconnecting tube cables and tube distribution hardware, as the basic infrastructure to provide reusable pathways for reusable PEF jacketed (Polyethylene Extruded Foam), bundled fiber optic cabling containing from 2 to 24 fibers, installed per manufacturer’s requirements.
- B. One Fiber Span consists of a pre-installed, properly rated fiber optic distribution tube cable with a reusable PEF jacketed, bundled, (**Provide Total strand fiber optical fiber cable and type multimode, 50/125 µm multimode, or single-mode**) here. Terminate PEF jacketed, bundled, optical fiber cables in the appropriate optical fiber termination units.
- C. Vertical/horizontal backbone cabling consists of an interconnecting tube cable infrastructure of appropriately rated tube cables (Riser, Plenum, General Purpose, OSP) connected at strategic points implementing the appropriately rated tube distribution hardware (NEMA rated) populated with reusable PEF jacketed, air-blown fiber bundles of 50/125 µm multimode, or single-mode) (**Provide total strand fiber optical cable here**) optical fiber cable installed from the main cross-connect (MC) or Campus Distributor (CD) to the intermediate cross-connect (IC) or Building Distributor (BD).

**1.6 SUBMITTALS**

- A. General:
  1. Provide submittals in accordance project specifications.
  2. Submit additional copies to: (list here who/where to send additional copies)
  3. Copies of Licensed FututreFLEX Installer Certificate furnished by the manufacturer.
- B. Shop Drawings:
  1. Provide per Project specifications.

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2. Provide submittals per owner's requirements and specifications.
  3. Provide Tube Cable Routing Diagrams.
  4. Provide logical fiber optic diagrams.
  5. Show Patch Panel numbering for fiber patch panels.
  6. Show PEF jacketed, bundled optical fiber cable numbering and labeling.
  7. Provide a schedule of materials list with quantities and manufactures indicated for all materials installed in the project.
  8. Provide Tube Cable System block diagram including interconnection and numbering of all tube cabling.
  9. Provide fabrication drawings for any proposed custom-built equipment.
- C. Product Data:
1. Provide manufacturer's product data specifications sheets indicating products being submitted.
  2. Provide submittals for products with long lead times (4) weeks prior to ordering the materials.
  3. Provide submittals (3) weeks after receiving notice to proceed and prior to installation of any of the product.
- D. Schedule:
1. Submit a coordinated schedule (3) weeks after notice to proceed to include the following;
  2. Preconstruction meeting and walkthrough.
  3. Start and duration of communications rooms and closets construction.
  4. Start and duration of tube cable installation, connection, routing, and testing.
  5. Start and duration of air-blown fiber optics installation, termination, and testing.
  6. (List here - remainder of all scheduling requirements.)
  7. Punch List.
  8. Final Punch List.
  9. Provide close out documents per project requirements.
- E. Cable Test Results: (Mandatory for Sumitomo FutureFlex Extended Warranty)
1. Tube Cable Tests
    - a. Pressure Tests shall be submitted to the Owner's Representative on appropriate forms showing; (Refer to Sumitomo Recommended Procedure SP F-04-003 – Tube Pressure Testing Procedure) for all tubes and tube cables installed with this installation
      1. Test date
      2. Installer's name
      3. Tube Cable ID
      4. Tube # (in)
      5. Tube # (out)
      6. Test Pressure (P.S.I.)
      7. Time held
    - b. Obstruction Tests shall be submitted to the Owner's Representative on appropriate forms showing; (Refer to Sumitomo Recommended Procedure SP F-04-004 – Tube Obstruction testing Procedure) for all tubes and tube cables installed with this installation
      1. Test date
      2. Installer's name
      3. Tube Cable ID

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4. Tube # (in)
  5. Tube # (out)
  6. Span Length
  7. Travel time
  8. P.S.I. test rate
2. PEF jacketed, Bundled Fiber Optics Testing shall be submitted to the engineer and copies to the Owner's Representative for all fibers and fiber bundles installed with this installation
    - a. Submit manufacturer's test reports for each reel of fiber bundle provided prior to installation.
    - b. Submit Contractors on-reel test results at 850 and 1300 nm for multimode and 1310 and 1550nm for single-mode.
    - c. Submit Contractor's OTDR or Power Meter/Light Source test results after bundled fiber terminations are installed. (**Required for Sumitomo FutureFlex Extended Warranties**)
    - d. Submit soft copy PEF jacketed, bundled fiber optic cable OTDR test results on compact disc (CD). Format CD test results in comma separated variable (CSV) format wherever possible. Provide proprietary software on the CD to enable viewing of the soft-copy test results. (**Required for Sumitomo FutureFlex Extended Warranties**)
- F. Project Record Drawings
1. Submit project record documents at Contract Closeout.
    - a. (**List all required submittals here.**)
  2. The contractor shall deliver three (3) sets of as-built drawings to the owner within four (4) weeks of completion of the project. A set of as-built drawings shall be provided to the owner in digital form (floppy disk or CD-ROM) and utilizing software that is acceptable to the owner. The contractor shall deliver the digital media to the owner within six (6) weeks of completion of the project.
    - a. As-built Drawings must contain;
      1. Distances for segments (Tube Cables)
      2. Distances for all Fiber Bundle Spans
      3. Labeling of all TDUs, and FTUs
- G. Submit, within 3 weeks after notice to proceed, the names and qualifications of those persons who will have management and supervisory positions over the employees on the job site. Submit the name of the supervisory person who will be on the job site daily and have responsibility for day-to-day decisions. Submit the name of the person who will attend meetings and have authority to make decisions for issues and requirements that arise from such meetings.
- H. Project Management and Coordination.
1. Installation crew must have a valid, current license by Sumitomo Electric Lightwave.
- J. Upon request by the engineer/designer, the Owner, and/or the Owner's representative will furnish a list of references with specific information regarding the type of project and involvement in providing other products and/or support equipment used on this project.
- K. Where equipment and materials have industry certification, labels, or standards (i.e. NEMA-National Electrical Manufacturer's Assn.), this equipment shall be labeled as certified or complying with the standards.
  - a. Indicate ABF equipment/materials locations and requirements on as-built drawings.
- L. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.

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**1.7 QUALITY ASSURANCE**

- A. Submit documentation signed by the manufacturer of Sumitomo FutureFlex® Air Blown Fiber® with the bid that states the Contractor is authorized and certified by Sumitomo Electric Lightwave to provide the Sumitomo FutureFlex® Air Blown Fiber® cable products installation and warranty certification. Bids from non-compliant firms will be rejected.
- B. Submit documentation with the bid listing the names of employees that will be used on this project indicating their experience, level of expertise, and certificates of training signed by Sumitomo Electric Lightwave representatives. Bids from non-compliant firms will be rejected.
- C. Complete Quality Assurance requirements.
- D. Submit documentation from the manufacturer of the optical fiber cable, bundles, tube cables and components that they are either ISO 9000 or TL9000 Certified.
- E. All tube cables, fiber bundles and blowing equipment must be manufactured and supplied by one manufacturer. Combining tube cables/micro-ducts, fiber bundles or fiber cables and blowing equipment from different manufacturers is not permitted.

**1.8 WARRANTY**

- A. Submit at project closeout, a signed and registered Sumitomo FutureFlex® Warranty consisting of extended product warranty and applications assurance in accordance with the Sumitomo FutureFlex® Extended Warranty Program. There are three options for warranty;
  - 1. Standard 2-year warranty (SEL warrants the Sumitomo FutureFlex products to be free of defects in material and workmanship for a period of two (2) years from the date of shipment.)
  - 2. 15 Year Extended Warranty (SEL warrants the Sumitomo FutureFlex products to be free of defects in material and workmanship for a period of fifteen (15) years from the date of shipment.)

The following is a list of required items that must be submitted for application for this warranty:

Complete the Warranty registration Form on the Sumitomo FutureFlex website and submit to SEL.

Testing data for the Obstruction and Pressure Test for each tube and tube cable in the system.

Sample Test Data Sheets are available on the website.

Original handwritten test results from the field are required; typed results are not acceptable.

Electronic copies of OTDR or Power Meter Readings with viewing software and fiber spans identified per As-Built Drawing.

Bi-Directional measurements are required for OTDR results at the highest wavelength.

All software required to run or view the test data must accompany the application.

Copies of as built drawings must be submitted to SEL via electronic or hard copy to SEL. (Drawings must be in AutoCAD or Visio) Drawings must correlate with the tube cable and fiber testing documents for verification and validation of testing.

Submit copies of purchase invoices for the Sumitomo FutureFlex products used in the installation. (Hard copies only)

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3. 25-Year Extended Warranty (SEL warrants the Sumitomo FutureFlex products to be free of defects in material and workmanship for a period of twenty five (25) years from the date of shipment.)

The following is a list of required items that must be submitted for application for this warranty:

Complete the Warranty registration Form on the Sumitomo FutureFlex website and submit to SEL.

Testing data for the Obstruction and Pressure Test for each tube and tube cable in the system.

Sample Test Data Sheets are available on the website.

Original handwritten test results from the field are required; typed results are not acceptable.

Electronic copies of OTDR or Power Meter readings with viewing software and fiber spans identified per As-Built Drawing.

Bi-Directional measurements are required for OTDR results at the highest wavelength

All software required to run or view the test data must accompany the application.

Copies of as built drawings must be submitted to SEL via electronic or hard copy to SEL. (Drawings must be in AutoCAD or Visio) Drawings must correlate with the tube cable and fiber testing documents for verification and validation of testing.

Submit copies of purchase invoices for the Sumitomo FutureFlex products used in the installation. ( Hard copies only )

- B. At notice to proceed, submit the most current copy of the Sumitomo FutureFlex® certificate of registration and the warranty terms and conditions that apply to the Sumitomo FutureFlex® solution.
- C. Submit a statement, at notice to proceed, of any Contractor warranties in addition to the manufacturer's stated and supplied warranties. Submit at closeout signed copies of the Contractor provided warranties that are in addition to manufacturer's stated and supplied warranties.

**1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with Division 01 requirements.
- B. Protect equipment during transit, storage, and handling to prevent damage, theft, soiling, and misalignment. Coordinate with the owner for secure storage of equipment and materials.
- C. Do not store equipment where conditions fall outside manufacturer's recommendations for environmental conditions.
- D. Follow manufacturer's recommended procedures for storage of materials & equipment.
- E. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

**1.10 SEQUENCE AND SCHEDULING**

- A. Refer to Submittals Section 1.7 above
- B. **(Complete this section per scheduling requirements.)**

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**1.11 USE OF THE SITE**

- A. Use of the site shall be at the owner’s direction in matters in which the owner deems it necessary to place restriction.
- B. Access to building wherein the work is performed shall be as directed by the owner.
- C. The owner will occupy the premises during the entire period of construction for conducting his or her normal business operations. Cooperate with the owner to minimize conflict and to facilitate the owner’s operations.
- D. Schedule necessary shutdowns of plant services with the owner, and obtain written permission from the owner.
- E. Proceed with the work without interfering with ordinary use of streets, aisles, passages, exits, and operations of the owner.
- F. Refer to Master Format Division 01 General Requirements.

**1.12 CONTINUITY OF SERVICES**

- A. Take no action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the owner’s representative. Arrange the work to minimize shutdown time.
- B. Owner’s personnel will perform shutdown of operating systems. The contractor shall give three (3) days’ advance notice for systems shutdown.
- C. Should services be inadvertently interrupted, immediately furnish labor, including overtime, material, and equipment necessary for prompt restoration of interrupted service.

**PART 2 – PRODUCTS**

**2.1 MANUFACTURERS**

- A. Provide products of Sumitomo Electric Lightwave Corp. as named in individual articles.
- B. Where no manufacturer is specified, provide products of manufacturers in compliance with requirements.
- C. Provide proof the manufacturer selected has successfully had these same products installed at other facilities and provide references with name, title, address, phone number & e-mail address of each point of contact within each referenced account.
- D. Provide proof the manufacturer has 20 years or more of designing, manufacturing and providing an air-blown fiber system within the continental United States.
- E. Provide proof the manufacturer is located within the U.S., is incorporated within the U.S. and that the major products (tube cables, fiber bundles, blowing equipment and termination hardware) are manufactured within the U.S.

**2.2 TUBE CABLES AND HARDWARE**

The Contractor shall furnish and install all Tube Cables, Tube Couplings, Tube Distribution Units (TDUs), Fiber Bundles, Fiber Termination Units (FTUs), connectors, and equipment as shown on drawings and as specified below. (**Provide FutrueFLEX Materials and Parts List**)

**A. INDOOR TUBE CABLE**

(**Architect shall specify tube cables and the number of tubes required. NOCCCD Design Standards to complete the initial fiber bundle installation requirements**).

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All indoor tube cables shall be composed of dielectric materials and properly rated (i.e. – plenum/riser/general purpose) per application. (TCxxTGX or TCxxMTX - OFN, TCxxTRC or TCxxTRX or TCxxTRC-OFN, and/or TCxxTPX or TCxxTP2 –NFPA 262) To be installed per Sumitomo Recommended Procedure SP F-04-008 Tube Cable Installation Procedures.

All tubes contained within the tube cables must be 6mm ID x 8mm OD except for TCxxTP2 which are to be no less than 5.5mm ID x 8mm OD and no greater than 8mm OD.

During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants. SP F-04-019 – Tube & Tube Cable Sealing Procedures.

The minimum bend radius shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation.

Upon completion of tube cable installation, all tubes shall pass the Standard Pressure and Obstruction Tests per the Sumitomo Electric's Recommended Procedures. (SP F-04-003 – Tube Pressure Testing Procedure and SP F-04-004 – Tube Obstruction Testing Procedure)

All unoccupied tubes shall be plugged on both ends per manufacturer's specifications. (SP F-04-019 – Tube & Tube Cable Sealing Procedures)

All Tube Distribution Units (NEMA rated per application); Tube-Splice Enclosures, Splice Cases, and Cold-Shrink Enclosures shall be installed per applicable manufacturer's recommendations. (SP F-04-008 – Tube Cable Installation Procedures, SP F-04-011 – Restoration Procedures – Dielectric Tube Cables & Tube Cable Splice Kits, SP F-04-012 – Restoration Procedures – Metallic Tube Cables & Splice Case Kits, SP F-04-015 – Splice Case Kit Installation Procedures, SP F-04-016 – Tube Cable Splice Kit Installation Procedure, SP F-04-019 – Tube & Tube Cable Sealing Procedures (for applications outside of classified areas), SP F-04-029 – Plenum Rated Jacketed Tube Cable TCxxTP2 Installation Procedure, SP F-04-030 – Grounding & Bonding Metallic Tube Cable Procedure, SP F-04-031 – Tube Cable Splicing Procedure.)

B. OUTDOOR TUBE CABLES (**Provide Sumitomo FutureFlex Material and Products List**)

Unless otherwise specified, tube cables shall provide at least two times the number of tubes needed to complete the initial fiber bundle installation requirements.

All tubes contained within the tube cables must be 6mm ID x 8mm OD and no greater than 8mm OD.

Tube cables may be composed of dielectric and metallic materials and shall be suitable for underground, buried, and/or aerial applications.

- a. TCxxTOX- UV resistant, dielectric, underground applications.
- b. TCxxTOX-2 -jacketed, galvanized steel armored – Underground, or outdoor tray or rack applications.
- c. TCxxMSOS – UV resistant – Aerial, outdoor rack or tray applications
- d. TCxxMSOS-2 -jacketed, galvanized steel armored - aerial, outdoor rack or tray applications.
- e. TCxxMTX – UV resistant, dielectric, underground, aerial, outdoor cable tray, or indoor OFN-LS/NFPA 130 for mass transit/ IEEE 383 applications

Tube cables for direct buried applications shall be armored for rodent protection where required.

Conductive material(s) shall be bonded and grounded per ANSI/TIA/EIA-J Std-607 and manufacturer's recommended procedures. (SP F-04-030 – Grounding & Bonding Metallic Tube Cable Procedure)

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During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants, including water. (SP F-04-019 – Tube & Tube Cable Sealing Procedures)

The minimum bend radius of tube cable shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation.

Upon completion of tube cable installation, all tubes shall pass the Standard Pressure and Obstruction Tests per the Sumitomo Electric's Recommended Procedures. (SP F-04-003 – Tube Pressure Testing Procedure and SP F-04-004 – Tube Obstruction Testing Procedure).

All unoccupied tubes shall be plugged or capped on both ends per applicable manufacturer's specifications. (SP F-04-019 – Tube & Tube Cable Sealing Procedures (for applications outside of classified areas), SP F-04-030 – Grounding & Bonding Metallic Tube Cable Procedure, SPF-04-031 – Tube Cable Splicin Procedure.

Install all Tube Distribution Units (NEMA rated per application), TDUs, Stainless Steel Splice Cases, and/or Cold-Shrink Closures per Sumitomo Electric's Recommended Procedures. (SP F-04-005 – Indoor, Wall Mount TDU Installation Procedure, SP F-04-015 Splice Case Kit Installation Procedure, and SP F-04-016 – Tube Cable Splice Kit)

C. TUBE DISTRIBUTION UNITS (TDUs) (**Provide Sumitomo FutureFlex Material and Products List**)

A NEMA-rated enclosure, suitable for the site environmental conditions (i.e. a generic NEMA rated box for indoor use) shall be provided for tube distribution, routing, and termination. TDUs shall be installed as shown in the drawings, wherever several Tube Cables enter the same location or where Tube Cable type transitions take place.

The contractor is responsible for selecting the TDU hardware to meet site conditions.

Choose TDU size based on the number of tubes to enter the unit and Sumitomo recommended Procedure SPF-04-005 – Indoor, Wall Mount TDU Installation Procedure.

TDUs shall be mounted to provide proper geometry for distribution.

D. OUTDOOR ENCLOSURE/SPLICE CASE (**Provide Sumitomo FutureFlex Products List-Appendix**)

Outdoor NEMA-rated enclosure, or splice case suitable for the site environmental conditions shall be provided for outside plant tube distribution and routing.

- a. Splice Cases – Re-enterable splice cases that do not require re-entry kits, shall be water-tight, and air-tight. Recommended Outdoor Closure: Sumitomo FutureFlex DE09SPC or DE12SPC Stainless Steel Splice Case or equivalent.

Outdoor enclosures/splice cases shall be installed as shown in the drawings wherever several cables enter the same location or Tube Cable style transitions take place.

The contractor is responsible for selecting the enclosure/splice case hardware to meet site conditions.

NEMA-4 and 4X enclosures or DE09SPC/DE12SPC splice cases shall be used in areas where hosing and splashing environmental conditions exist.

NEMA-6 and 6P enclosures or DE09SPC/DE12SPC splice cases shall be used in areas where temporary or long term flooded environmental conditions exist.

Kellems Grips (Hubbell) shall be used to secure tube cables to outdoor enclosures. Choose outdoor enclosure size based on the number of tubes to enter the enclosure. (See SP F-04-024 – Kellems Grip Installation Procedure)

**2.3 REUSABLE, PEF JACKETED FIBER BUNDLES (PROVIDE SUMITOMO FUTUREFLEX MATERIAL AND PRODUCTS LIST)**

A. Part Numbers (**Provide Sumitomo FutureFlex Material and Products List**)

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- B. All single mode and multi-mode fiber optic cabling will be in PEF (polyethylene extruded foam) jacketed, bundled fibers available in 2, 4, 6, 12, 18, and 24-fiber bundles.
- C. All fiber bundles shall be installed within the properly rated tube cable infrastructure (OSP, OFN, OFNR, OFNP).
- D. The contractor shall furnish and install optical fiber bundles as identified on the drawings.
- E. Fiber bundles shall not be spliced or patched at transition points from indoor to outdoor environments.
- F. Fiber bundles shall be installed end to end or “home run” from CD to MC, BD, FD, TR, or work area outlet whenever possible to minimize splicing and patching.
- G. All 2, 4, & 6 fiber bundles will contain the fibers and ripcords within a 1mm OD nylon sub-unit and have a 2mm OD PEF jacket.
- H. All 12, 18 and 24 fiber bundles will have three or four 1mm sub-units with a 3mm OD PEF jacket.
- I. All fiber bundles must be designed and manufactured to facilitate the rapid installation of the fiber bundle, be able to be blown out without risk or damage to the fiber bundle and be able to be re-installed without degradation of the optical specifications and performance of the fiber and fiber bundles.
- J. All fiber bundles must be manufactured so that each and every fiber bundle can be installed in OSP, OFN, OFNR and UL262(Plenum OFNP) rated tube cables and applications without change to the fiber bundle type in any manner.

**2.4 MULTIMODE 62.5/125µm (Provide Sumitomo FutureFlex Material and Products List)**

The optical fiber, with fiber counts as indicated on drawings, shall have the following specifications:

- A. Dual window, 850 nm and 1300 nm.
- B. Minimum bandwidth – 220 MHz-km at 850 nm, 600 MHz-km at 1300 nm.
- C. Maximum attenuation – 3.5 dB/km at 850 nm, 1.5 dB/km at 1300 nm
- D. Standard Ethernet Distances – 300m at 850nm, 500m at 1300nm
- E. Extended Gigabit Ethernet Distances—500m at 850nm, 1000m at 1300nm

**2.5 MULTIMODE 50/125µm (Provide Sumitomo FutureFlex Material and Products List)**

The optical fiber, with fiber counts as indicated on drawings, shall have the following specifications:

Dual window, 850 nm and 1300 nm

Minimum Overfilled Launch Bandwidth – 500 MHz-km at 850 nm, 500 MHz-km at 1300 nm

Maximum attenuation – 3.5 dB/km at 850 nm, 1.5 dB/km at 1300 nm.

Gigabit bandwidth – 500 MHz-km at 850 nm, 500MHz km at 1300 nm

Gigabit Ethernet Standard Grade Distances – 550m at 850 nm, 550m at 1310 nm

Gigabit Ethernet Max. Grade Distances – 1km at 850nm, 600m at 1310nm

10-Gigabit Ethernet Bandwidth – 1500MHz at 850nm, 500 MHZ at 1300nm

10-Gigabit Ethernet Extended Grade Distances - 300m at 850 nm, 300m at 1300 nm

10-Gigabit Ethernet Max. Grade Distances – 550m at 850nm

**2.6 SINGLE-MODE (Provide Sumitomo FutureFlex Material and Products List)**

The optical fiber, with fiber counts as indicated on drawings, shall have the following specifications:

- A. Dual window, 1310 nm and 1550 nm.
- B. Maximum attenuation – 0.40 dB/km at 1310 nm, 0.30 dB/km at 1550 nm.
- C. Dispersion unshifted, matched-clad, zero water peak.

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**2.7 FIBER ACCESSORIES** (Provide CommScope Systimax Material and Products List

**A. FIBER TERMINATION UNITS (FTUs)** (See **Section 27 11 00**)

A suitable enclosure (FTU) shall be provided at all locations where fiber is to be terminated. FTUs shall provide for strain relief of incoming tube cables as well as providing connector panels and connector couplings adequate to accommodate the number of fibers to be terminated. All FTUs shall incorporate radius control mechanisms to limit bending of the fibers to the manufacturer's recommended minimums or 3", whichever is larger.

FTUs shall be wall or rack-mounted as specified in the drawings.

If rack-mount fiber termination hardware is required, wall-mount a TDU near the rack and use individual tube cabling (provided with the fiber termination unit) to route and connect fiber bundle passing through the TDU to the fiber termination hardware.

All terminated fibers shall be mated to (SC,) connectors mounted on patch panels.

Couplers shall be mounted on a panel that, in turn, snaps into the housing assembly.

Panels shall be available to accommodate a changing variety of connector types.

Size FTUs to accommodate the total fiber count to be installed at each location as defined in the drawings.

**B. Optical Fiber Patch Cables** – See **Section 27 16 00** for Patch Cables

Optical fiber jumpers shall incorporate SC connectors.

The connector body shall be of materials similar to that used in the proposed couplings.

Channels shall be of equal length.

The optical fiber patch cables shall be 50/125µm multimode, or single mode of tight buffer construction.

The optical fiber patch cables shall be a minimum of 3 meters long.

**C. Connectors - SM/MM**

The connector type(s) shall be (SC).

The attenuation per mated pair shall not exceed 0.75 dB (individual) and 0.5 dB (average).

Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.

Connectors shall meet the following performance criteria:

<u>Test</u>	<u>Procedure</u>	<u>Maximum Attenuation Change (dB)</u>
Cable Retention	FOTP-6	0.2 dB
Durability	FOTP-21	0.2 dB
Impact	FOTP-2	0.2 dB
Thermal Shock	FOTP-3	0.2 dB
Humidity	FOTP-5	0.2 dB

**D. Approved Pre-terminated shelves**

1. CommScope Systimax (Provide latest Product Number)

**E. Approved pigtailed with splices**

1. CommScope Systimax (Provide latest Product Number)

**F. Approved breakout kits (for direct, field termination of fibers)**

1. CommScope Systimax or Sumitomo FutureFlex, FTFLDxx – Breakout Kit

**PART 3 - EXECUTION**

**3.1 Pre-Installation Site Survey**

- A. Prior to the start of systems installation, The Contractor will meet at the project site with the owner's representative and representatives of trades performing related work to coordinate

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efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with the general contractor shall be necessary to plan the crucial scheduled completions of the equipment rooms and telecommunications rooms.

Exact locations TDUs, and Splice Cases shall be field verified with owner.

- B. Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.
- C. Exact location of tube cable terminations shall be field verified with owner.

**3.2 Handling and Protection of Equipment and Materials**

- A. The contractor shall be responsible for safekeeping own materials and subcontractor's property, such as equipment and materials, on the job site. The owner assumes no responsibility for protection of above-named property against fire, theft, and environmental conditions.

**3.3 Protection of Owner's Facilities**

- A. Effectively protect the owner's facilities, equipment, and materials from dust, dirt, and damage during construction.
- B. Remove protection at completion of work.
- C. Should it be found by the engineer that the materials, or any portion thereof, furnished and installed under this contract fail to comply with the specifications and drawings, with respect or regard to the quality, amount of value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the contractor, and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the contractor's expense.

**3.4 INSTALLATION**

**3.4.1 Tube Cable Installation**

- A. Prior to pulling tube cable, mandrel the conduits to remove foreign material before pulling cables.
- B. Beginning installation means contractor accepts existing conditions.
- C. Contractor shall furnish all required installation tools to facilitate Tube Cable installation without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, pulling tension gauges, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the cable or employees shall not be used.
- D. Tube Cable pulling shall be done in accordance with cable manufacturer's recommended procedures (SP F-04-008 – Tube Cable Installation Procedures, SP F-04-029 – Plenum Rated, Jacketed Tube Cable TCxxTP2 Installation Procedures) and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and minimum bending radii shall not be exceeded. Any tube cable bent or kinked to a radius less than recommended shall not be installed.
- E. During tube cable pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.
- F. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age. (i.e.- Polywater)

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- G. Avoid abrasion and other damage to cables during installation.
- H. Tube Cable slack is required for thermal expansion/contraction per manufacturer's recommendations. (See SP F-04-008 – Tube Cable Installation Procedures)
- I. All exposed tube cable shall be labeled at 35-foot (maximum) intervals with tags indicating ownership, cable type, and fiber type installed.
- J. Tube cable shall be riser or plenum-rated if required by the installation environment.
- K. Where not installed in a continuous length, tube cable segments shall be spliced using tube couplings designed for that purpose and housed within a properly rated TDU (tube distribution unit), splice case, or cold shrink boot per manufacturer's specifications and labeled appropriately.

3.4.2 Fiber Bundle Installation

- A. Reusable, PEF jacketed (Polyethylene Extruded Foam), fiber bundles shall be installed according to manufacturer's recommended procedures. (See SP F-04-002 – Fiber Bundle Installation Procedures)
- B. PEF jacketed optical fiber cable bundles shall be continuously inserted and propelled or blown into the individual tubes utilizing compressed nitrogen or dry compressed air as the propellant per the manufacturer's instructions. The blowing installation process and the fiber bundles must also be designed to allow removal, replacement, and reuse of the fiber bundles at any time in the future as deemed necessary by the owner.
- C. Slack in each PEF jacketed fiber bundle shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (39") of slack shall be retained at the work area, and a minimum of 3 meters (approximately 10') of slack shall be retained in equipment rooms and telecommunications closets.
- D. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all optical fiber terminations.

3.4.3 Labeling

- A. All labeling shall be in accordance with ANSI/TIA/EIA-606 unless otherwise noted by the owner.
- B. Mark up floor plans showing Tube Cable routes, segments, Tube Cable type, and marking of cables. Turn these drawings over to the owner two (2) weeks prior to move-in to allow the owner's personnel to connect and test owner-provided equipment in a timely fashion.
- C. The contractor shall deliver three (3) sets of as-built drawings to the Owner's Representative within four (4) weeks of completion of the project. A set of as-built drawings shall be provided to the owner in digital form (floppy disk or CD-ROM) and utilizing software that is acceptable to the owner. The contractor shall deliver the digital media to the owner within six (6) weeks of completion of the project.

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**3.5 COOPERATION**

- A. The contractor shall cooperate with other trades and owner's personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the owner, provided such decision is reached prior to actual installation. The contractor shall check location of electrical outlets with respect to other installation before installing.

**3.6 TESTING**

**3.6.1 Tube Cable Tests**

- A. The contractor shall provide to the Owner's Representative, obstruction and pressure test data for each tube installed. Both pressure and obstruction tests shall be completed per manufacturer's recommended procedures prior to installing fiber bundle(s). (See SP F-04-003 – Tube Pressure Testing Procedure and SP F-04-004 – Tube Obstruction Testing Procedure)
- B. Pressure testing is required for testing end-to-end tube spans after completion of tube cable installation and tube inter-connection. (See SP F-04-003 – Tube Pressure Testing Procedure)
- C. Tube pressure testing shall be completed before proceeding with end-to-end tube obstruction testing.
- D. Obstruction testing shall be performed on all tubes upon completion of tube cable installation and prior to fiber bundle installation. (See SP F-04-004 – Tube Obstruction Testing Procedure)
- E. The contractor shall notify the architect/engineer/owner at least one week in advance of the test date so that the architect/engineer/owner may be present to witness testing.

**3.6.2 Bundled Fiber Optic Testing**

- A. The contractor shall provide to engineer/Owner's representative, the cable manufacturer's test report for each reel of fiber bundle provided. These test reports shall include manufacturer's on-reel attenuation test results at both 850 nm and 1300 nm for multimode and 1310 nm and 1550 nm for single-mode for each optical fiber of each reel prior to shipment from the manufacturer.
- B. The contractor will perform an attenuation test with an OTDR or Power Meter of each optical fiber of each fiber bundle reel prior to installation. The contractor shall supply this test data to the engineer prior to installation.
- C. The fibers utilized in the installation shall be traceable to the manufacturer. On-the-reel bandwidth performance as tested at the factory shall be provided upon request.
- D. Optical fiber bundle shall be tested before utilization as follows:
1. Perform all tests and provide copies of all test results to the engineer/Owner's Representative.
  2. The contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. The bidder should detail the proposed test plan for each cable type including equipment to use, test frequencies, and wavelengths, etc.
  3. The contractor shall conduct acceptance testing according to a schedule coordinated with the owner. Representatives of the Owner may be in attendance to witness the test procedures.
  4. The contractor shall offer adequate advance notice (at least one week) to the Owner's Representative as to allow for such participation.

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5. The contractor is to describe how they will conduct the tests and provide copies of all test results to the architect/engineer Owner's Representative.
- E. All fibers shall be initially tested with a light source and OTDR utilizing procedures as stated in ANSI/TIA/EIA 455-78B Measurement Methods for Attenuation. Measured results shall be plus/minus 1 dB of the submitted loss budget calculations. If loss figures are outside this range, test cable with an optical time domain reflectometer to determine cause of variation. Correct improper splices and replace damaged fiber at no charge to the owner.
  1. Fibers shall be tested at 850 nm and 1300 nm for multimode optical fiber bundles.  
Fibers shall be tested at 1310 nm and 1550 nm for single-mode optical fiber bundles.
  2. Bi-directional testing of optical fibers is required.
- F. Test results shall include a record of wavelength, fiber type, fiber and bundle number, test equipment and model number, date reference setup, and operator (crew members).
- G. The contractor shall provide written reports of all test data in written form to the owner. At such time the contractor turns over test data to the engineer.
- H. In the event that test results are not satisfactory, the contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation method, and shall perform additional tests as the engineer deems necessary.

Tests related to connected equipment of others shall only be done with the permission and presence of the contractor involved. The contractor shall perform only that testing as required to prove the fiber connections are correct. Three (3) record copies of all test data shall be submitted to the architect/engineer for approval. The contractor shall notify the architect/engineer at least one week in advance of the test date so that the architect/engineer may be present.

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