SECTION 16721
AIR BLOWN FIBER

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, apply to this section.

1.2 SUMMARY

A. The authorized/licensed 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) Telephone and data horizontal cable and terminations.

(2) Optical fiber riser backbone cable and terminations.

(3) Communications work area outlets.

(4) Cross-connect and patch panel systems.

(5) Equipment racks and accessories installation.

(6) Grounding of communications systems components.

(7) Indoor Tube Cables and Tube Distribution Units

(8) Outdoor Tube Cables and Outdoor Enclosures

(9) Labeling of all tube cabling, and optical fiber bundles, terminations, splices, patch panels, racks, and outlets.

(10) Testing and test documentation of all tube cable, and optical fiber bundles and connections.

(11) Fire stopping.

(12) Documentation preparation including but not limited to submittals, as-built drawings, system O&M documents, and product documentation.

(13) 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.

C. Work not included: (List here; all work not included)

SAMPLE

1.3 REFERENCES

A. (Refer to Master Format Divisions 01-40-00, 01-42-00)

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

C. ANSI/TIA/EIA 568-B.2 - Commercial Building Telecommunications Wiring Standards, Balanced Twisted Pair Cabling Components.

D. ANSI/TIA/EIA 568-B.3 - Commercial Building Telecommunications Wiring Standards, Optical Fiber Cabling Components standards.

E. ANSI/TIA/EIA 568-B.3 .1 – Additional Transmission Performance Specifications for 50/125µm Optical fiber Cables.

F. ANSI/TIA/EIA 569 - Commercial Building standard for Telecommunications Pathways and Spaces.

G. ANSI/TIA/EIA 606-A – Administration Standards for Telecommunications Infrastructures.

H. ANSI/TIA/EIA Joint Standard – 607-A – Commercial Building Grounding and Bonding requirements for Telecommunications.

I. ANSI/TIA/EIA 526-7 – Measurement of Optical power Loss of Installed Single-mode Fiber Cable Plant (Method A).

J. ANSI/TIA/EIA 526-14-A - Measurement of Optical power Loss of Installed Multi-mode Fiber Cable Plant.

K. ANSI/TIA/EIA 758 – Customer Owned Outside Plant Telecommunications Cabling Standard.

L. ANSI/TIA/EIA 758-1 - Customer Owned Outside Plant Telecommunications Cabling Standard.

M. Building Industry consulting services International (BICSI) Distribution Methods Manual (TDMM).

N. Building Industry consulting services International (BICSI) Customer Owned Outside Design Manual.

O. National Electrical Manufacturers Association (NEMA).

P. National Fire Protection association (NFPA) 72, National Electrical Code (NEC).

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SECTION 16721
AIR BLOWN FIBER

1.4 DEFINITIONS

A. Acronyms – (Refer to Master Format Division 01-42-16)

(1) List here all applicable acronyms.

1.5 PERMITS, FEES, AND CERTIFICATES OF APPROVAL

(Refer to Master Format Division 01-41)

A. The owner will make application and pay for all required permits.

B. As prerequisite to final acceptance, the Contractor shall supply to the owner certificates of inspection from an inspection agency acceptable to the owner and approved by local municipality and utility company serving the project.

1.6 SYSTEM DESCRIPTION

(Refer to Master Format Division 27-00-00)

A. Design, manufacture, 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), single bundled fiber optic cabling containing from 2 to 18 fibers, installed per manufacturer's requirements.

B. One work area outlet consists of a pre-installed, properly rated fiber optic distribution tube cable with a reusable PEF jacketed, bundled, two-fiber optical fiber cable (62.5/125 □m multimode, 50/125 □m multimode, or single mode). 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, outdoor) connected at strategic points implementing the appropriately rated tube distribution hardware (NEMA rated) populated with reusable PEF jacketed, air-blown fiber bundles of (62.5/125 □m multimode, 50/125 □m multimode, or single mode) optical fiber cable installed from the main cross-connect (MC) or Campus Distributor (CD) to the intermediate cross-connect (IC) or Building Distributor (BD), to the horizontal cross-connect (HC) or Floor Distributor (FD), and/or from the HC/FD to the IC/BD.

D. Provide cable runway (as indicated by Owner).

E. Provide communications grounding system. (as indicated by Owner).

F. Provide bid alternate defined in (as indicated by Owner).

1.7 SUBMITTALS

A. General:

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(1) Provide submittals in accordance with Master Format Division 01 Submittal Procedures and Division 01- Closeout Procedures.

(2) Submit additional copies to (list here who/where to send additional copies)

B. Shop Drawings:

(1) (Refer to Master Format Division 01-33-23)

(2) (Provide submittals per owner's requirements and specifications.)

(3) Provide workstation outlet diagrams for all combinations of voice and data outlet jack configurations.

(4) Show Patch Panel numbering for voice and data patch panels.

(5) Show PEF jacketed, bundled optical fiber cable numbering and labeling.

(6) Provide a schedule of materials list with quantities and manufactures indicated for all materials installed in the project.

(7) Provide Tube cable system block diagram including interconnection and numbering of all tube cabling.

(8) Provide fabrication drawings for any proposed custom-built equipment.

(9) Submit for initial review 3 weeks after notice to proceed and for final review at substantial Completion. (Refer to Master Format Division 01-77 Closeout Procedures).

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;

a. Preconstruction meeting and walkthrough.

b. Start and duration of communications rooms and closets construction.

c. Start and duration of tube cable installation, connection, and routing.

SAMPLE

d. Start and duration of air-blown fiber optics installation and termination.

e. (List here - remainder of all scheduling requirements.)

f. Punch List.

g. Final Punch List.

h. (Refer to Master Format Div 0 and Div. 1 requirements)

E. Cable Test Results:

(1) Tube Cable Tests (Refer to Master Format Division 1-33-26)

a. Pressure Tests shall be submitted to the Owner's Representative on appropriate forms showing;

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;

1. Test date
2. Installer's name
3. Tube Cable ID
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.

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 multi-mode and 1310 and 1550nm for Single-mode.

c. Submit Contractor's test results after bundled fiber terminations are installed.

d. Submit soft copy PEF jacketed, bundled fiber optic cable OTDR test results on compact disc(CD). Format CDtest results in comma separated variable (CSV) format wherever possible. Provide proprietary software on the CD to enable viewing of the soft-copy test results.

F. Project Record Drawings

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(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.

G. Submit within 3 weeks after notice to proceed the names 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. Upon request by the engineer/designer, the Owner, and/or the Owner's representative 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.

I. 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.

J. 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.

1.8 QUALITY ASSURANCE

A. Submit documentation signed by the manufacturer of FutureFLEX® Air Blown Fiber® with the bid that states the Contractor is authorized and certified by FutureFLEX® to provide the 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 FutureFLEX® representatives. Bids from non-compliant firms will be rejected.

C. Complete Quality Assurance requirements.

1.9 WARRANTY

A. Submit at project closeout a signed and registered FutureFLEX® (15 or 25) Year Warranty consisting of extended product warranty and applications assurance in accordance with the FutureFLEX® Extended Warranty Program.

SAMPLE

B. Submit, at notice to proceed, the most current copy of the FutureFLEX® certificate of registration and the warranty terms and conditions that apply to the 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 in addition to manufacturer's stated and supplied warranties.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Comply with Master Format Division 1 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.

1.11 SEQUENCE AND SCHEDULING

A. Refer to Submittals Section 1.7.D.1 above.

B. (Complete this section per scheduling requirements.)

C. Refer also to Master Format Division 0 requirements.

1.12 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.

SAMPLE

F. Refer to Master Format Division 1 requirements.

1.13 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 manufacturers as named in individual articles.

B. Where no manufacturer is specified, provide products of manufacturers incompliance with requirements.

2.2 TUBE CABLES AND HARDWARE

The Contractor shall furnish and install all cables, connectors, and equipment as shown on drawings and as specified below.

A. Indoor Tube Cable

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

(2) All indoor tube cables shall be composed of dielectric materials and properly rated (i.e. – plenum/riser/general purpose) per application.

(3) During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants.

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

(5) Upon completion of tube cable installation, all tubes shall pass the standard 150 psi pressure test and 5 mm bead obstruction test per the cable manufacturer's recommended procedures.

(6) All unoccupied tubes shall be plugged on both ends per manufacturer's specifications.

SAMPLE

(7) All Tube Distribution Units (NEMA rated per application), tube-splice enclosures/Tube Splice Cases/cold-shrink closures per manufacturer's recommendations.

B. Outdoor Tube Cables

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

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

(3) Tube cables for direct buried applications shall be steel armored for rodent protection.

(4) Conductive material(s) shall be bonded and grounded per ANSI/TIA/EIA-J Std-607.

(5) During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants, including water.

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

(7) Upon completion of tube cable installation, all tubes shall pass the standard 150 psi pressure test and 5 mm bead obstruction test per the cable manufacturer's recommended procedures.

(8) All unoccupied tubes shall be plugged on both ends per manufacturer's specifications.

(9) All Tube Distribution Units (NEMA rated per application), Tube-splice enclosures/Tube Splice Cases/cold-shrink closures per manufacturer's recommendations.

C. TUBE DISTRIBUTION UNITS (TDUs)

(1) A NEMA-rated enclosure, suitable for the site environmental conditions (i.e. NEMA 1 for indoor use) shall be provided for tube distribution, routing, and termination.

(2) TDUs shall be installed as shown in the drawings, wherever several cables enter the same location or where tube cable type transitions take place.

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

(4) Choose TDU size based on the number of tubes to enter the unit.

SAMPLE

(5) TDUs shall be wall-, floor-, rack-, or ceiling-mounted to provide better protection and geometry for distribution.

D. Outdoor Enclosure/Splice Case

(1) 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, are water-tight, and air-tight are recommended as a cost effective alternative to NEMA 4, 4X, 6, & 6P enclosures.

b. Recommended Outdoor Closure: Preformed Line Products, Armadillo Series Splice Case – or equivalent.

(2) Outdoor enclosures/splice cases shall be installed as shown in the drawings wherever several cables enter the same location or cable type transitions take place.

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

(4) NEMA-4 and 4X enclosures or properly rated splice cases shall be used in areas where hosing and splashing environmental conditions exist.

(5) NEMA-6 and 6P enclosures or properly rated splice cases shall be used in areas where temporary or long term flooded environmental conditions exist.

(6) Kellems Grips shall be used to secure tube cables to outdoor enclosures. Choose outdoor enclosure size based on the number of tubes to enter the enclosure.

2.3 REUSABLE, PEF JACKETED FIBER OPTIC BUNDLES

A. Part Numbers (see Appendix 1)

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, and 18-fiber bundles.

C. Fiber bundles shall be provided based on immediate needs only.

D. All fiber bundles shall be installed within the properly rated tube cable infrastructure.

E. The contractor shall furnish and install optical fiber bundles as identified on the drawings.

F. Fiber bundles shall not be spliced or patched at transition points from indoor to outdoor environments.

G. 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.

SAMPLE

H. Zero tensile stress shall be placed upon the fiber bundles during installation to eliminate micro-fractures within the glass.

2.4 MULTIMODE 62.5/125µM

Reusable, PEF jacketed Fiber Optic Bundles - 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

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

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

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

E. Gigabit Ethernet Distances – 550m at 850 nm, 550m at 1300 nm

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

G. 10-Gigabit Ethernet Distances - 300m at 850 nm, 300m at 1300 nm

2.6 SINGLE-MODE

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.

SAMPLE

2.7 BUNDLED FIBER ACCESSORIES

A. Fiber Termination Units (FTUs)

(1) A suitable enclosure (FTU) shall be provided at all locations where fiber is to be terminated.

(2) 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.

(3) All FTUs shall incorporate radius control mechanisms to limit bending of the fibers to the manufacturer's recommended minimums or 3", whichever is larger.

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

a. f 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.

(5) All terminated fibers shall be mated to (state preference) couplings mounted on patch panels.

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

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

(8) All FTUs shall have a common key lock that opens all FTUs installed for this project.

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

(10) The contractor is responsible for selecting the FTU hardware to meet site conditions

B. Optical Fiber Patch Cables

(1) Optical fiber jumpers shall incorporate (state preference) connectors.

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

(3) Channels shall be of equal length.

(4) The optical fiber patch cables shall be (62.5/125µm multimode, 50/125µm multimode, single mode) fiber utilizing tight buffer construction.

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

C. Connectors - SM/MM

(1) The connector type(s) shall be (appropriate FC, SC, ST, LC, etc.).

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

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

(4) Connectors shall meet the following performance criteria:

Test	**Procedure**	**Maximum Attenuation Change (dB)**
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) (List preferences here)

E. Approved pigtails with splices

(1) (List preferences here)

F. Approved breakout kits

(1) (List preferences here)

G. Equipment Racks

Nineteen-inch equipment racks shall have the following requirements:

(1) The rack shall be 72” high.

(2) The base footprint shall be no smaller than 15” x 20”.

(3) The rack shall be supplied with a 6 AWG ground lug.

(4) The rack shall be equipped with vertical and horizontal cable management hardware to allow an orderly routing of optical fiber from the patch panel to the customer provided network equipment.

(5) The contractor shall bolt the rack to the floor as recommended by the manufacturer.

SAMPLE

PART 3 - EXECUTION

3.1 PRE-INSTALLATION SITE SURVEY

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

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

A. Tube Cable Installation

(1) Prior to pulling tube cable, thoroughly swab conduits to remove foreign material before pulling cables.

(2) Beginning installation means contractor accepts existing conditions.

(3) 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

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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 shall not be used.

(4) Tube Cable pulling shall be done in accordance with cable manufacturer's recommended 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.

(5) 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.

(6) 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.

(7) Avoid abrasion and other damage to cables during installation.

(8) Tube Cable slack is required for thermal expansion/contraction per manufacturer's recommendations.

(9) All exposed tube cable shall be labeled at 35-foot (maximum) intervals with tags indicating ownership, cable type, and fiber type installed.

(10) Tube cable shall be riser or plenum-rated if required by the installation environment.

(11) Where not installed in a continuous length, tube cable segments shall be spliced using couplings designed for that purpose and housed within a properly rated TDU (tube distribution unit), splice case, or cold shrink wrap per manufacturer's specifications.

B. Fiber Bundle Installation

(1) Reusable, PEF jacketed (Polyethylene Extruded Foam), fiber bundles shall be installed according to manufacturer's recommended procedures.

(2) PEF jacketed optical fiber cable bundles shall be continuously inserted and propelled or blown into the individual tubes utilizing compressed nitrogen 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.

(3) 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

SAMPLE

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.

(4) Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all optical fiber terminations.

C. Labeling

(1) All labeling shall be in accordance with ANSI/TIA/EIA-606 unless otherwise noted by the owner.

(2) Mark up floor plans showing outlet locations, type, and cable 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.

(3) 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.

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

A. Tube Cable Tests

(1) 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 prior to installing fiber bundle(s)

(2) Pressure testing is required for testing end-to-end tube spans after completion of tube cable installation and tube inter-connection.

(3) Tube pressure testing shall be completed before proceeding with end-to-end tube obstruction testing.

(4) Obstruction testing shall be performed on all tubes upon completion of tube cable installation and prior to fiber bundle installation.

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B. Bundled Fiber Optic Testing

(Refer to Master Format Division 1-33-26)

(1) 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.

(2) The contractor will perform an attenuation test with an OTDR 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.

(3) 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.

(4) Optical fiber bundle shall be tested before utilization as follows:

a. Perform all tests and provide copies of all test results to the engineer/Owner's Representative.

b. 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.

c. 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.

d. The contractor shall offer adequate advance notice (at least one week) to the Owner' Representative as to allow for such participation.

e. 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.

(5) All fibers shall be initially tested with a light source and OTDR utilizing procedures as stated in ANSI/TIA/EIA-526-14A: OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant and ANSI/TIA/EIA-526-7: OFSTP-7 Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant. 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.

a. 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.

b. Testing procedures shall utilize "Method B" – One jumper reference.

c. Bi-directional testing of optical fibers is required.

SAMPLE

(6) 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).

(7) 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.

(8) 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.

(9) 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.

(10) 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.

(11) Refer to Part 1.7-E Submittals.

APPENDIX 1

FutureFLEX® ABF® Product List

FutureFLEX® Product Descriptions

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SAMPLE

INDOOR TUBE CABLES

SEL PART NUMBER DESCRIPTION

"TC01TBX"	**Sumitomo Part Number (typical)**
"TC"	Tube Cable
"01, 02, etc."	Number of Individual Tubes
"TBX"	Tube Cable Description

SAMPLE

SECTION 16721
AIR BLOWN FIBER

NON-RATED INDOOR TUBE CABLES

INDOOR NON-RATED TUBE CABLE DESCRIPTIONS & APPLICATIONS

TBX	TXX
Black tube	Semi-transparent tube
No fire rating	No fire rating
For general tube drops or interconnections	For general tube drops or interconnections

INDOOR NON-RATED TUBE CABLE TYPES & SIZES AVAILABLE

TYPE	SINGLE-TUBE
Black Tube	TC01TBX
Semi-Transparent Tube	TC01TXX

INDOOR NON-RATED TUBE CABLE SPECIFICATIONS

PROPERTY	SPECIFICATION
Operation Temperature Range	-40° to +158°F (TBX & TXX only)
Minimum Bend Radius (During and After Installation) for Single Tubes:	7” (Radius) when installing 2mm OD Fiber Bundles 9” (Radius) when installing 3mm OD Fiber Bundles

FIRE-RATED INDOOR TUBE CABLES

INDOOR RATED TUBE CABLE DESCRIPTIONS & APPLICATIONS

TGX	TRX	TPX
OFN General Purpose Fire Rated	OFNR Riser-Rated	OFNP Plenum-Rated
Individual black tubes No outer jacket	Inner fire retardant jacket and fire blocking tape wrap	Individual black tubes No outer jacket
Multiple tubes wrapped with Kevlar string binder	Orange-colored fire blocking outer jacket	Multiple tubes wrapped with Kevlar string binder

SAMPLE

SECTION 16721
AIR BLOWN FIBER

INDOOR RATED TUBE CABLE TYPES & SIZES AVAILABLE

TYPE	1-TUBE	2-TUBE	3-TUBE	7-TUBE	19-TUBE
OFN	TC01TGX	TC02TGX	---	TC07TGX	TC19TGX
OFNR	---	TC02TRX	TC03TRX	TC07TRX	TC19TRX
OFNP	TC01TPX	TC02TPX	TC03TPX	TC07TPX	TC19TPX

Notes:

- Armored Plenum-Rated tube cables (TC03TPA, TC07TPA, and TC19TPA) available upon request.

INDOOR RATED TUBE CABLE SPECIFICATIONS

PROPERTY	SPECIFICATION
OFN General Purpose Fire Rated	UL 1581
OFNR Riser-Rated	UL 1666
OFNP Plenum-Rated	UL 910
Operation Temperature Range	-20° to +158°F
Minimum Bend Radius for Multi-Tube Cables (During Installation):	20X cable diameter
Minimum Bend Radius for Multi-Tube Cables (After Installation)	10X cable diameter **or** 9" Radius whichever is greater
Minimum Bend Radius for Single Tubes (During and After Installation):	7" Radius when installing 2mm Fiber Bundles **or** 9" Radius when installing 3mm Fiber Bundles

INDOOR TUBE CABLE PHYSICAL CHARACTERISTICS

Sumitomo Part No.	Cable OD (in)	Max. Weight (lbs/kft)	Max. Tensile Load (lbs.)
TC01TBX	0.315	**15**	**60**
TC01TGX	0.315	**17**	**60**
TC01TPX	0.315	**27**	**60**
TC01TXX	0.315	**15**	**60**
TC02TGX	0.6	**70**	**100**
TC02TPX	0.6	**53**	**120**
TC02TRX	1.0	**229**	**200**
TC03TPX	0.6	**80**	**180**
TC03TRX	1.0	**282**	**200**
TC07TGX	1.0	**119**	**150**
TC07TPX	1.0	**189**	**360**
TC07TRX	1.3	**437**	**400**
TC19TGX	1.6	**325**	**250**
TC19TPX	1.6	**513**	**400**
TC19TRX	1.9	**806**	**500**

SAMPLE

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AIR BLOWN FIBER

INDOOR TUBE CABLE STANDARD REEL DATA

Sumitomo Part No.	Std Reel Length (ft)	Std Reel H x W (in)	Minimum Drum Diameter (in)	Std Reel Weight (lbs) Empty	Std Reel Weight (lbs) Full
TC01TBX	---	---	---	---	---
TC01TGX	1000	25 x 13	20	17	34
TC01TPX	1000	41 x 6	36	33	60
TC01TXX	500	17 x 5	5	1	16
TC02TGX	1000	36 x 34	18	66	136
TC02TPX	1000	54 x 10	40	105	158
TC02TRX	1000	54 x 20	40	116	345
TC03TPX	1000	54 x 20	40	116	196
TC03TRX	1000	54 x 36	40	137	419
TC07TGX	1000	54 x 20	40	116	235
TC07TPX	1000	54 x 20	40	116	305
TC07TRX	1000	54 x 36	40	137	574
TC19TGX	1000	64 x 40	46	248	573
TC19TPX	1000	64 x 40	46	248	761
TC19TRX	1000	60 x 48	40	246	1052

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Maximum Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.
- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.

INDOOR TUBE CABLE MAXIMUM REEL DATA

Sumitomo Part No.	Max Reel Length (ft)	Max Reel H x W (in)	Minimum Drum Diameter (in)	Max Reel Weight (lbs) Empty	Max Reel Weight (lbs) Full
TC01TBX	3300	28 x 20	20	18	68
TC01TGX	3000	28 x 20	20	18	69
TC01TPX	3000	54 x 10	40	105	186
TC01TXX	---	---	---	---	---
TC02TGX	3000	36 x 34	18	66	276
TC02TPX	3000	54 x 36	40	137	296
TC02TRX	3000	60 x 48	40	246	933

SAMPLE

TC03TPX	3000	54 x 36	40	137	377
TC03TRX	3000	60 x 48	40	246	1092
TC07TGX	3000	60 x 48	40	246	603
TC07TPX	3000	60 x 48	40	246	813
TC07TRX	3000	72 x 40	46	309	1620
TC19TGX	3000	72 x 50	46	333	1308
TC19TPX	3000	72 x 50	46	333	1872
TC19TRX	3000	84 x 50	30	288	2706

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Maximum Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.
- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.

OUTDOOR TUBE CABLES

SEL PART NUMBER DESCRIPTION

"TC02TOX"	**Sumitomo Part Number (typical)**
"TC"	Tube Cable
"01, 02, etc."	Number of Individual Tubes
"TOX"	Tube Cable Description

OUTDOOR "DIELECTRIC CORE" TUBE CABLE DESCRIPTIONS & APPLICATIONS

TOX	**TOD**	**MSOS**	**AOX**	**TAX ***
Dry to damp environments	Dry to damp environments	Dry to damp environments	Dry to damp environments	Dry to damp environments
Duct, direct buried applications	Duct, direct buried applications	Aerial, duct, direct buried applications	Duct, direct buried applications	Duct, direct buried applications Extremely rugged, high crush resistance
Dielectric core Water-blocking tape	Dielectric core Water-blocking tape	Dielectric core Water-blocking tape	Dielectric core Water-blocking tape	Dielectric core Water-blocking tape Polyethylene outer

SAMPLE

Polyethylene outer jacket	Polyethylene outer jacket	High-performance outer jacket for enhanced thermal stability	Polyethylene outer jacket	jacket
	FRP (fiber reinforced plastic) central strength member	Ultra-high performance tubes with low friction liners	Corrugated steel tape armor for rodent protection	Extra heavy duty interlocked galvanized steel armor jacket
			Grounding & Bonding required	Grounding & Bonding required

Notes:

- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.

OUTDOOR "METALLIC CORE" TUBE CABLE DESCRIPTIONS & APPLICATIONS

TLW	LWS	TLA
Flooded environments	Flooded environments	Flooded environments
Duct, direct buried applications	Duct, direct buried applications	Duct, direct buried applications Extremely rugged, high crush resistance
Metallic core Water blocking tape Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket	Metallic core Water blocking tape Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket	Metallic core Water blocking tape Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket
	Corrugated steel tape armor for rodent protection	Extra heavy duty interlocked galvanized steel armor jacket
Grounding & Bonding recommended	Grounding & Bonding recommended	Grounding & Bonding recommended

OUTDOOR TUBE CABLE TYPES & SIZES AVAILABLE

TYPE	2-TUBE	4-TUBE	7-TUBE	19-TUBE
OSP	---	---	TC07AOX	---
OSP	---	---	TC07LWS	---
OSP - AERIAL	TC02MSOS	TC04MSOS	TC07MSOS	TC19MSOS
OSP	---	---	TC07TAX *	TC19TAX *

SAMPLE

OSP	---	---	TC07TLA	TC19TLA
OSP	---	---	TC07TLW	TC19TLW
OSP	---	TC04TOD	---	---
OSP	TC02TOX	---	TC07TOX	TC19TOX

Notes:

- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.

OUTDOOR RATED TUBE CABLE SPECIFICATIONS

PROPERTY	**SPECIFICATION**
Operation Temperature Range	-40° to +158°F
Minimum Bend Radius for Multi-Tube Cables (During Installation):	20X cable diameter
Minimum Bend Radius for Multi-Tube Cables (After Installation):	10X cable diameter

OUTDOOR TUBE CABLE PHYSICAL CHARACTERISTICS

Sumitomo Part No.	**Cable OD (in)**	**Max. Weight (lbs/kft)**	**Max. Tensile Load (lbs.)**
TC02MSOS	0.9	89	200
TC02TOX	0.9	87	200
TC04MSOS	0.9	141	200 with standard basket-weave grip, 500 with pulling eye
TC04TOD	0.9	137	200 with standard basket-weave grip, 500 with pulling eye
TC07AOX	1.4	438	500
TC07LWS	1.4	479	400
TC07MSOS	1.1	196	400
TC07TAX *	1.5	825	500
TC07TLA	1.5	870	400
TC07TLW	1.1	223	400
TC07TOX	1.1	205	400
TC19MSOS	1.7	399	500
TC19TAX *	2.1	1152	500
TC19TLA	2.1	1650	500
TC19TLW	1.8	463	500
TC19TOX	1.7	443	500

Notes:

- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.

SAMPLE

OUTDOOR TUBE CABLE STANDARD REEL DATA

Sumitomo Part No.	Std Reel Length (ft)	Std Reel H x W (in)	Minimum Drum Diameter (in)	Std Reel Weight (lbs) Empty	Std Reel Weight (lbs) Full
TC02MSOS	1000	36 x 17	18	55	144
TC02TOX	1000	36 x 17	18	55	142
TC04MSOS	1000	54 x 36	40	137	278
TC04TOD	1000	54 x 36	40	137	274
TC07AOX	1000	60 x 48	40	246	684
TC07LWS	1000	60 x 48	40	246	725
TC07MSOS	1000	54 x 36	40	137	333
TC07TAX *	1000	64 x 40	46	248	1073
TC07TLA	1000	64 x 40	46	248	1118
TC07TLW	1000	54 x 36	40	137	360
TC07TOX	1000	54 x 36	40	137	342
TC19MSOS	1000	64 x 40	46	248	647
TC19TAX *	1000	72 x 40	46	309	1461
TC19TLA	1000	72 x 40	46	309	1959
TC19TLW	1000	72 x 40	46	309	772
TC19TOX	1000	60 x 48	40	246	689

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Standard Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.
- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.
- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.

OUTDOOR TUBE CABLE MAXIMUM REEL DATA

Sumitomo Part No.	Max Reel Length (ft)	Max Reel H x W (in)	Minimum Drum Diameter (in)	Max Reel Weight (lbs) Empty	Max Reel Weight (lbs) Full
TC02MSOS	3000	60 x 48	40	246	513
TC02TOX	3000	60 x 48	40	246	507
TC04MSOS	3000	60 x 48	40	246	669
TC04TOD	3000	60 x 48	40	246	657
TC07AOX	3000	72 x 50	46	333	1647
TC07LWS	3000	72 x 50	46	333	1770
TC07MSOS	3000	60 x 48	40	246	834
TC07TAX *	3000	72 x 50	46	333	2808

SAMPLE

TC07TLA	3000	72 x 50	46	333	2943
TC07TLW	3000	60 x 48	40	246	915
TC07TOX	3000	60 x 48	40	246	861
TC19MSOS	3000	72 x 50	30	288	1485
TC19TAX *	2300	72 x 50	30	288	2938
TC19TLA	2300	72 x 50	30	288	4083
TC19TLW	3000	72 x 50	30	288	1677
TC19TOX	3000	72 x 50	30	288	1617

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Maximum Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.
- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.
- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.

LOW SMOKE / ZERO HALOGEN (LS / ZH) TUBE CABLES

SEL PART NUMBER DESCRIPTION

"TC01NA4"	**Sumitomo Part Number (typical)**
"TC"	Tube Cable
"01, 02, etc."	Number of Individual Tubes
"NA4"	Tube Cable Description

LS / ZH TUBE CABLE DESCRIPTIONS & APPLICATIONS

NA3
Designed for US Navy LS/ZH shipboard applications
Made from highly fire retardant; low smoke materials
Single tube design: Each tube wrapped with tensile yarns and a TPN (Thermo Plastic Non-halogen) outer jacket
Multiple tube cable designs: Each tube wrapped with salt water blocking tape and Kevlar yarn, filler rods placed between tubes, outer layer tubes overall wrapped with salt water blocking tape and Kevlar yarn, and a TPN (Thermo Plastic Non-halogen) outer jacket

SAMPLE

SECTION 16721
AIR BLOWN FIBER

LS / ZH TUBE CABLE TYPES & SIZES AVAILABLE

TYPE	1-TUBE	7-TUBE	19-TUBE
LS / ZH	TC01NA4	TC07NA4	TC19NA4

LS / ZH TUBE CABLE SPECIFICATIONS

PROPERTY	SPECIFICATION
NA3 Burn Test	IEEE 383
NA3 Operation Temperature Range	-20° to +158°F
Minimum Bend Radius for Multi-Tube Cables (During Installation):	20X cable diameter
Minimum Bend Radius for Multi-Tube Cables (After Installation):	10X cable diameter
Minimum Bend Radius for Single Tubes (During Installation):	20X cable diameter
Minimum Bend Radius for Single Tubes (After Installation):	7" Radius when installing 2mm Fiber Bundles **or** 9" Radius when installing 3mm Fiber Bundles

LS / ZH TUBE CABLE PHYSICAL CHARACTERISTICS

Sumitomo Part No.	Cable OD (in)	Max. Weight (lbs/kft)	Max. Tensile Load (lbs.)
TC01NA4	0.455	65	60
TC07NA4	1.2	438	400
TC19NA4	2.0	895	500

LS / ZH TUBE CABLE STANDARD REEL DATA

Sumitomo Part No.	Std Reel Length (ft)	Std Reel H x W (in)	Minimum Drum Diameter (in)	Std Reel Weight (lbs) Empty	Std Reel Weight (lbs) Full
TC01NA4	1000	30 x 13	20	18	83
TC07NA4	1000	54 x 36	40	137	575
TC19NA4	1000	60 x 48	40	246	1141

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Standard and Maximum Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.

SAMPLE

- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.

LS / ZH TUBE CABLE MAXIMUM REEL DATA

Sumitomo Part No.	Max Reel Length (ft)	Max Reel H x W (in)	Minimum Drum Diameter (in)	Max Reel Weight (lbs) Empty	Max Reel Weight (lbs) Full
TC01NA4	3000	54 x 20	40	116	311
TC07NA4	3000	72 x 40	46	309	1623
TC19NA4	3000	84 x 50	30	444	3129

Notes:

- Cut Lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Standard and Maximum Reel Length tolerances are ±5%.
- All Reel Widths shown are approximate values only and measured from outside-of-flange to outside-of-flange.
- If tube cable is re-spooled, the Minimum Drum Diameter of the new reel **SHALL** be as shown to avoid damaging tube cable product
- All Empty and Full Reel Weights shown are approximate values only.

TUBE DISTRIBUTION HARDWARE

P/N	DESCRIPTION
DE06MDU	Wall-mount, indoor tube distribution unit (TDU). Key-locked hinged door. Modular design; wall-mount fiber termination units (FT24WFM & FT48WFM) can be attached to front of unit. Four knockouts per horizontal side and two knockouts per vertical side for tube cable entry. Includes instructions, four (4) tube clip organizers (DETC008), knockout bushings, and hose clamps for mounting tube cables. Unit Dimensions: 16”H x 16”W x 4”D. Weight: 18 lbs. Capacity: 42 tubes.
DE12IDU	Wall-mount, indoor NEMA 12-rated tube distribution unit (TDU). Gray color. Hole punch & cable clamps required for mounting tube cables; not included. Unit Dimensions: 24”H x 20”W x 7”D. Weight: 35 lbs. Capacity: 84 tubes.

SAMPLE

DE24IDU	Wall-mount, indoor NEMA 12-rated tube distribution unit (TDU). Gray color. Hole punch & cable clamps required for mounting tube cables; not included. Unit Dimensions: 36"H x 30"W x 9"D. Weight: 86 lbs. Capacity: 168 tubes.
DEDTTP	Steel bracket and aluminum bar with plastic tube clip organizers for organizing individual tubes. All mounting hardware and instructions included. Capacity: Twelve 7-tube cables.
DEDTTP2	Steel bracket and aluminum bar with plastic tube clip organizers for organizing individual tubes. All mounting hardware and instructions included. Capacity: Six 19-tube cables.
DETC008	Black plastic tube clip organizer for up to 8 tubes. Mounts using screws provided.
DETCTB	L-bracket for mounting up to two tube clip organizers (DETC008).

TUBE DISTRIBUTION HARDWARE (Continued)

P/N	DESCRIPTION
DE08MC2	Clear plastic push/pull quick release pneumatic tube coupling for 8mm OD tube. 200 psi pressure rated. Ten couplings per pack.
DE08MB	Brass push/pull quick release bulkhead pneumatic tube coupling for 8mm OD tube for panel mounting. 200 psi pressure rated. Ten bulkhead couplings per pack.
DE08MT	Black plastic push/pull quick release pneumatic tube tee coupling for 8mm OD

SAMPLE

	tube. 200 psi pressure rated. Available individually.
DE08MA	Slate plastic push/pull quick release pneumatic tube cap for 8mm OD tube. 200 psi pressure rated. Seals opening of unoccupied tube. Recommended for indoor or outdoor application. Ten caps per pack.
DE06MP	Orange plastic pneumatic tube plug for 6mm ID tube. Seals opening of unoccupied tube. Recommended for indoor application. Ten plugs per pack.

TUBE DISTRIBUTION HARDWARE (Continued)

P/N	DESCRIPTION
DE04HS1	Heat shrink end cap for 2- to 4-tube cables. Seals tube cable end to prevent contamination entry. Heat gun or torch required for installation.
DE07HS1	Heat shrink end cap for 7-tube cables. Seals tube cable end to prevent contamination entry. Heat gun or torch required for installation.
DE19HS1	Heat shrink end cap for 19-tube cables (except riser tube cable TC19TRX). Seals tube cable end to prevent contamination entry. Heat gun or torch required for installation.
DE19HS2	Heat shrink end cap for 19-tube riser cable TC19TRX. Seals tube cable end to prevent contamination entry. Heat gun or torch required for installation.
DE02T0X	Tapered rubber insert for 2-tube (TC02TOX) cable installation using Hubbell Grip No. 074011251.
DE04T0D	Tapered rubber insert for 4-tube (TC04TOD) cable installation using Hubbell Grip No. 07401026.

SAMPLE

DE5KCAP	Aluminum end cap sealing disc for unoccupied 2-, 4-, and 7-tube Kellems® Grips with Form 5 Size compression nut: 074011251 (TC02TOX) 07401026 (TC04TOD) 07401027 (TC07TOX) 07401028 (TC07NA3) 07401032 (TC07AOX & TC07LWS)
DE6KCAP	Aluminum end cap sealing disc for unoccupied 7- and 19-tube Kellems® Grips with Form 6 Size compression nut: 07401033 (TC07TAX & TC07TLA) 07401034 (TC19TOX & TC19TLW)
DE7KCAP	Aluminum end cap sealing disc for unoccupied 19-tube Kellems® Grips with Form 7 Size compression nut: 074011032 (TC19NA3) 074011033 (TC19TAX & TC19TLA)

TUBE DISTRIBUTION HARDWARE (Continued)

P/N	DESCRIPTION
DE00SPL	Tube cable splice kit for 2- to 4-tube cables. Includes cold shrink splice sleeve, mastic tape, water-blocking tape, four tube couplings (DE08MC2), and instructions.
DE01SPL	Tube cable splice kit for 7- tube cables. Includes cold shrink splice sleeve, mastic tape, water-blocking tape, seven tube couplings (DE08MC2), and instructions.
DE02SPL	Tube cable splice kit for 19-tube cables. Includes cold shrink splice sleeve, mastic tape, water-blocking tape, nineteen tube couplings (DE08MC2), and instructions.

SAMPLE

SECTION 16721
AIR BLOWN FIBER

FIBER AND FIBER BUNDLES

SEL PART NUMBER DESCRIPTION

FB02SX	**Sumitomo Part Number (typical)**
"FB"	Fiber "Bundle"
"FR"	Fiber "Ribbon"
"02, 04, etc."	Number of Individual Fibers
"SX"	Single Mode Fiber
"SR"	Radiation Hardened Single Mode Fiber
"M5"	50 / 125 Multi-mode Fiber (Standard Grade; 1 Gigabit))
"G53"	50 / 125 Multi-mode Fiber (Extended Grade; 10 Gigabit 300 m)
"G55"	50 / 125 Multi-mode Fiber (Maximum Grade; 10 Gigabit 500 m)
"M6"	62.5 / 125 Multi-mode Fiber (Standard Grade)
"R6"	Radiation Hardened 62.5 / 125 Multi-mode Fiber

FIBER BUNDLE TYPES & SIZES AVAILABLE

TYPE	**2-FIBER**	**4-FIBER**	**6-FIBER**	**12-FIBER**	**18-FIBER**
SX	FR02SX	FB04SX	FB06SX	FB12SX	FB18SX
SR	FR02SR	FB04SR	FB06SR	FB12SR	FB18SR
M5	FB02M5	FB04M5	FB06M5	FB12M5	FB18M5
G53	FB02G53	FB04G53	FB06G53	FB12G53	FB18G53
G55	FB02G55	FB04G55	FB06G55	FB12G55	FB18G55
M6	FR02M6	FB04M6	FB06M6	FB12M6	FB18M6
R6	FB02R6	FB04R6	FB06R6	FB12R6	FB18R6

SINGLE MODE FIBER & FIBER BUNDLE SPECIFICATIONS

PROPERTY	**SPECIFICATION**	
Fiber Bundle Jacket material	Polyethylene Extruded Foam (PEF)	
Fiber Bundle Jacket color	Yellow	
Core diameter	8.3 micron	
Cladding diameter	**125 micron**	
Buffer / acrylate diameter	**250 micron**	
Maximum Dispersion at 1310 / 1550 nm	≤ 3.2 / 18.0 ps/nm-km	
Index of Refraction EIA/TIA-455-44 Test Procedure	1310 nm 1550 nm	1.466 1.467
Operation Temperature Range	-40° to +158°F	

SAMPLE

(for Fiber Bundle Assembly)	
Minimum Fiber Bundle Bend Radius	1.5”

FIBER AND FIBER BUNDLES (Continued)

50 MICRON MULTI-MODE FIBER & FIBER BUNDLE SPECIFICATIONS

PROPERTY	SPECIFICATION		
Fiber Bundle Jacket material	Polyethylene Extruded Foam (PEF)		
Fiber Bundle Jacket color	White		
Core diameter	50 micron		
Cladding diameter	**125 micron**		
Buffer / acrylate diameter	**250 micron**		
Maximum Attenuation at 850 / 1300 nm	< 3.5 / 1.5 dB/km		
Fiber Bandwidth at 850 / 1300 nm	≥ 500 / 500 MHz-km		
Min. Bandwidth (overfilled launch)	Std. Grade	850 nm 1300 nm	500 MHz*km 500 MHz*km
	Ext. Grade	850 nm 1300 nm	1500 MHz*km 500 MHz*km
	Max. Grade	850 nm 1300 nm	3000 MHz*km 500 MHz*km
Min. Gigabit Ethernet Distance	Std. Grade	850 nm 1310 nm	550 m 550 m
	Ext. Grade	850 nm 1310 nm	1000 m 600 m
	Max. Grade	850 nm 1310 nm	1000 m 600 m
Min. 10-Gigabit Ethernet Distance	Std. Grade	850 nm 1310 nm	N/A N/A
	Ext. Grade	850 nm 1310 nm	300 m 300 m
	Max. Grade	850 nm 1310 nm	500 m 300 m
Group Index of Refraction EIA/TIA-455-44 Test Procedure	850 nm 1300 nm		1.483 1.479

SAMPLE

Operation Temperature Range (for Fiber Bundle Assembly)	-40° to +158°F
Minimum Fiber Bundle Bend Radius	1.5”

FIBER AND FIBER BUNDLES (Continued)

62.5 MICRON MULTI-MODE FIBER & FIBER BUNDLE SPECIFICATIONS

PROPERTY	SPECIFICATION		
Fiber Bundle Jacket material	Polyethylene Extruded Foam (PEF)		
Fiber Bundle Jacket color	Blue		
Core diameter	62.5 micron		
Cladding diameter	**125 micron**		
Buffer / acrylate diameter	**250 micron**		
Maximum Attenuation at 850 / 1300 nm	< 3.5 / 1.5 dB/km		
Minimum Bandwidth at 850 / 1300 nm	≥ 220 / 600 MHz-km		
Min. Gigabit Ethernet Distance	Std. Grade	850 nm 1300 nm	300 m 500 m
	Ext. Grade	850 nm 1300 nm	500 m 1000 m
Group Index of Refraction EIA/TIA-455-44 Test Procedure	850 nm 1300 nm	1.496 1.491	
Operation Temperature Range (for Fiber Bundle Assembly)	-40° to +158°F		
Minimum Fiber Bundle Bend Radius	1.5”		

FIBER BUNDLE REEL DATA

Sumitomo Part No.	Fiber Bundle OD (mm)	Small Reel Length (ft)	Small Reel Weight (lbs)	Small Reel H x W (in)	Large Reel Length (ft)	Large Reel Weight (lbs)	Large Reel H x W (in)
FB02XX or FR02XX	2	7000	16.5	16 x 11	14000	36	20 x 12
FB04XX	2	7000	16.5	16 x 11	14000	36	20 x 12
FB06XX	2	7000	16.5	16 x 11	14000	36	20 x 12
FB12XX	3	3500	19	16 x 11	7000	41	20 x 12
FB18XX	3	3500	19	16 x 11	7000	41	20 x 12

Notes:

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- Cut lengths are also available. Contact SEL or FutureFLEX® Distributor for additional information.
- Standard reel length tolerances are +2% / -0%.

FIBER AND FIBER BUNDLES (Continued

ABF FIBER COLORS

2-Fiber Ribbon (Standard Ribbonized Coating)

1st Pos	2nd Pos	
Blue	Orange	No Ripcord

2-Fiber Bundles (1 Nylon Sub-Unit)

1st Pos	2nd Pos	3rd Pos	4th Pos	5th Pos	6th Pos	7th Pos
Blue	Ripcord	Ripcord	Orange	Ripcord	Ripcord	Ripcord

4-Fiber Bundles (1 Nylon Sub-Unit)

1st Pos	2nd Pos	3rd Pos	4th Pos	5th Pos	6th Pos	7th Pos
Blue	Orange	Ripcord	Green	Brown	Ripcord	Ripcord

6-Fiber Bundles (1 Nylon Sub-Unit)

1st Pos	2nd Pos	3rd Pos	4th Pos	5th Pos	6th Pos	7th Pos
Blue	Orange	Green	Brown	Slate	Ripcord	White

12-Fiber Bundles (3 Nylon Sub-Units)

1st Pos	2nd Pos	3rd Pos	4th Pos	5th Pos	6th Pos	7th Pos
Blue	Orange	Ripcord	Green	Brown	Ripcord	Ripcord
Slate	White	Ripcord	Red	Black	Ripcord	Ripcord
Yellow	Violet	Ripcord	Rose	Aqua	Ripcord	Ripcord

18-Fiber Bundles (3 Nylon Sub-Units)

1st Pos	2nd Pos	3rd Pos	4th Pos	5th Pos	6th Pos	7th Pos
Blue	Orange	Green	Brown	Slate	Ripcord	Red
Blue	Orange	Green	Brown	Slate	Ripcord	Yellow
Blue	Orange	Green	Brown	Slate	Ripcord	Violet

Note: All Ripcords are Black Polyester

FIBER TERMINATION HARDWARE

P/N	DESCRIPTION
FT24WFM	24-port wall-mount, indoor fiber termination unit (FTU). Key locked maintenance door and magnetic user access door. Modular design; can be

SAMPLE

	attached to front of small tube distribution unit (TDU) (DE06MDU). Unit Dimensions: 16”H x 16”W x 4”D. Weight: 20 lbs. Capacity: Four EIA standard 6-pack panels/four splice trays (not included).
FT48WFM	48-port wall-mount, indoor fiber termination unit (FTU). Key locked maintenance door and 1/4 turn latched access door. Modular design – can be attached to front of small tube distribution unit (TDU) (DE06MDU). Unit Dimensions: 16”H x 16”W x 6”D. Weight: 22 lbs. Capacity: Eight EIA standard 6-pack panels/four splice trays (not included).

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FIBER TERMINATION HARDWARE (Continued)

P/N	DESCRIPTION
FT18RFS	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. Low profile. Includes one 24-fiber splice tray. Unit dimensions: 1.75"H x 17"W x 12"D. Weight: 10 lbs. Capacity: 18 fibers.
FT36RFS	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. Includes three 12-fiber splice trays. Unit dimensions: 3.5"H x 17"W x 12"D. Weight: 13 lbs. Capacity: 36 fibers.
FT48RFS	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. Includes four 12-fiber splice trays. Unit dimensions: 7"H x 17"W x 12"D. Weight: 20 lbs. Capacity: 48 fibers.
FT72RFS	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. 72-fiber capacity. Includes six 12-fiber splice trays. Unit dimensions: 10.5"H x 17"W x 12"D. Weight: 25 lbs. Capacity: 72 fibers.

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FIBER TERMINATION HARDWARE (Continued)

P/N	DESCRIPTION
FT18RFT	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. Low profile. For field termination only. Unit dimensions: 1.75"H x 17"W x 12"D. Weight: 9 lbs. Capacity: 18 fibers.
FT36RFT	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. For field termination only. Unit dimensions: 3.5"H x 17"W x 12"D. Weight: 11 lbs. Capacity: 36 fibers.
FT72RFT	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. For field termination only. Unit dimensions: 5.25"H x 17"W x 12"D. Weight: 17 lbs. Capacity: 72 fibers.
FT144RFT	Rack-mount fiber termination unit. Fits both 19" and 23" equipment racks. For field termination only. Unit dimensions: 10.5"H x 17"W x 12"D. Weight: 24 lbs. Capacity: 144 fibers.

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FIBER TERMINATION HARDWARE (Continued)

P/N	DESCRIPTION
FT6SCS2	EIA standard push/pull-mount SC 6-pack panel for fiber termination units.
FT6SCS2	EIA standard push/pull-mount SC 6-pack panel for fiber termination units.
FT6FCS2	EIA standard push/pull-mount FC 6-pack panel for fiber termination units.
FTBLNK2	EIA standard push/pull-mount blank plate panel for fiber termination units.
FT12FHL	Twelve position splice tray for heat-shrink or mechanical splices. Aluminum with clear plastic cover.
FT18FHL	Eighteen position splice tray for standard fusion splices. Aluminum with clear plastic cover.
FT24SPL	Adhesive mount splice tray holder for four splice trays.

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FIBER TERMINATION HARDWARE (Continued)

P/N	DESCRIPTION
FTFLD1	Field termination kit for 6-fiber bundle. Includes bushing, tube, and splitter with six 3mm color-coded sub-units. Kevlar and outer PVC jacket bonded to splitter. Includes instructions.
FTFLD3	Field termination kit for 18-fiber bundle. Includes bushing, tube, and splitter with eighteen 3mm color-coded sub-units. Kevlar and outer PVC jacket bonded to splitter. Includes instructions.
FTFLD06	Field termination kit for 6-fiber bundle. Includes splitter with six 900 micron color-coded sub-units. Includes instructions.
FTFLD12	Field termination kit for 12-fiber bundle. Includes splitter with twelve 900 micron clear sub-units. Includes instructions.
FTFLD18	Field termination kit for 18-fiber bundle. Includes splitter with eighteen 900 micron color-coded sub-units. Includes instructions.
FT2MFB	Red rubber tapered fiber bushing for 2-, 4-, or 6-fiber bundles (2mm OD). Seals opening of occupied tube at termination locations. Available individually.
FT3MFB	Black rubber tapered fiber bushing for 12- and 18-fiber bundles (3mm OD). Seals opening of occupied tube at termination locations. Available individually.

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FIBER TERMINATION HARDWARE (Continued)

P/N	DESCRIPTION
FTSSC1M	Simplex SC pigtail. Single-mode fiber. One meter length.
FT6SC1M	Simplex SC pigtail. 62.5 micron multimode fiber. One meter length.
FT6ST1M	Simplex ST pigtail. 62.5 micron multimode fiber. One meter length.
FTSSC3M	Simplex SC pigtail. Single-mode fiber. Three meters length.
FT6SC3M	Simplex SC pigtail. 62.5 micron multimode fiber. Three meters length.
FT6ST3M	Simplex ST pigtail. 62.5 micron multimode fiber. Three meters length.
FTSSC3J	Simplex SC to SC jumper. Single-mode fiber. Three meters length.
FT6SC3J	Simplex SC to SC jumper. 62.5 micron multimode fiber. Three meters length.
FT6ST3J	Simplex ST to ST jumper. 62.5 micron multimode fiber. Three meters length.

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SECTION 16721
AIR BLOWN FIBER

BLOWING EQUIPMENT, TOOLS, & MISCELLANEOUS ACCESSORIES

P/N	DESCRIPTION
BE200RM	Blowing equipment monthly lease. Includes transit case with blowing head and payoff stand assembly and the following items: • One pressure regulator assembly with quick-release 8mm tubing adapter (BEREG01) • One filter/regulator assembly with payoff counter • One motor rate control valve • One exhaust muffler • One ½" x 14" steel shaft • Two reel payoff cams (fit large and small fiber reels) • One fiber bundle guide assembly • One toolbox • Two red 2- to 6-fiber bundle (2mm OD) drive wheels (BE02DW) • Two black 12- or 18-fiber bundle (3mm OD) drive wheels (BE03DW) • One black 2- to 6-fiber bundle (2mm OD) air seal (BE02SL) • One black 12- or 18-fiber bundle (3mm OD) air seal (BE03SL) • One red 2- to 6-fiber bundle (2mm OD) blowing tip (BE2MFT) • One black 12- or 18-fiber bundle (3mm OD) blowing tip (BE3MFT) • One tubing cutter (BETC001) • Two tee couplings (DE08MT) • Two Allen wrenches (3/32" & 7/64") • One bottle air motor cleaner fluid • Two 2-feet ¼ in. red tubing • One 6-feet ¼ in. white tubing • One 1-foot 8 mm clear tubing • Instructions included
BE200RY	Blowing equipment yearly lease. Contents same as BE200RM.

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BLOWING EQUIPMENT, TOOLS, & MISCELLANEOUS ACCESSORIES (Continued)

P/N	DESCRIPTION
BE02DW	Replacement blowing head red fiber bundle drive wheels for installing 2- to 6-fiber bundles (2mm OD). Available in pairs.
BE03DW	Replacement blowing head black fiber bundle drive wheels for installing 12- and 18-fiber bundles (3mm OD). Available in pairs.
BE02SL	Replacement blowing head black rubber air seal for installing 2- to 6-fiber bundles (2mm OD). Available individually.
BE03SL	Replacement blowing head black rubber air seal for installing 12- and 18-fiber bundles (3mm OD). Available individually.
BE2MFT	Replacement red, reusable, threaded, aluminum fiber bundle blowing tip for installing 2- to 6-fiber bundles (2mm OD). Available individually.
BE3MFT	Replacement black, reusable, threaded, aluminum fiber bundle blowing tip for installing 12- and 18-fiber bundles (3mm OD). Available individually.

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BLOWING EQUIPMENT, TOOLS, & MISCELLANEOUS ACCESSORIES (Continued)

P/N	DESCRIPTION
BEPT001	Tube test kit. Includes bypass switch/valve, 0-200 psi portable hand-held pressure gage, and one hundred (100) 5mm plastic beads. (Tube Test Kit is not included in BE200RM or BE200RY.)
BEBB01P	Replacement 5mm plastic beads for obstruction testing. One hundred (100) per pack.
BEREG01	Two-stage pressure regulator assembly. Includes quick release adapter with ¼" NPT (male and female) Type 15 connectors and ¼" NPT adapter to plastic push/pull quick release pneumatic coupling for 8 mm OD tube.
BETC001	Tubing cutter for individual tubes.
BETC00B	Replacement blade for tubing cutter (BETC001). Available individually.
BETL01	Tube cable cutter for cutting up to 2-inch diameter tube cables. (Not to be used to cut steel strength members.)
BETL02	Replacement blade for tube cable cutter (BETL01). Available individually.

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SECTION 16721
AIR BLOWN FIBER

STANDARD FIBER BUNDLE BLOWING DISTANCES

2-, 4- & 6-FIBER BUNDLES (2mm OD)	APPROX. DISTANCE
OSP MSO Aerial tube cable	1200 meters or 4000 feet
All other OSP & TRX tube cables	1000 meters or 3300 feet
TGX, TPX, & NA3 tube cables	600 meters or 1950 feet

12- & 18-FIBER BUNDLES (3mm OD)	APPROX. DISTANCE
OSP MSO Aerial tube cable	600 meters or 1950 feet
All other OSP & TRX tube cables	500 meters or 1650 feet
TGX, TPX & NA3 tube cables	300 meters or 1000 feet

Notes:

- All distances given are approximate using one (1) Blowing Head.
- Several factors heavily influence actual blowing distances:
  1. The location, number, and severity of bends in a tube cable run,
  2. The fiber bundle size installed (2mm OD or 3mm OD), and
  3. The tube cable type

SAMPLE