**ADDENDUM NO. 2**

Date: September 29, 2015

for

**Site Work for Portable Classrooms and Restroom**  
Saddleback College - BID No. 2039

South Orange County Community College District

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General - All project documents including contract documents, drawings, and specifications, shall remain unchanged with the exception of those elements added, revised, deleted, or clarified by this addendum.

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**ADDENDUM ITEMS**

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2-1 Revise Notice Calling for Bids

2-1.1 The Bid Deadline has been extended to 2:00 p.m., October 6, 2015.

2-1.2 Notwithstanding Information for Bidders, Paragraph 10, the deadline for pre-bid questions has been extended to 2:00 p.m. October 1, 2015. Pre-bid questions will not be accepted after the deadline.

2-2 Revise Supplemental Conditions

2-2.1 For Supplemental Conditions, Exhibit 3. INCLUDED SCOPE OF WORK AND CONSTRUCTION PHASING, Part II. EXPANDED DESCRIPTION, Paragraph 2, add Subparagraph 2.b. as follows, "Contractor shall provide asphalt transition landing at the end of each Portable Manufacturer's ramp. Elevations as indicated on contract drawing Sheet AS-02 to achieve maximum cross slope of 2 percent in the direction of the path of travel."

2-3 Revise Contract Drawings

2-3.1 Revise Contract Drawing Sheet AS-03 as indicated on attached 8-1/2x11 Sheet AR-2.01 dated 9/29/15.

2.3.2 For Contract Drawings Sheet E001, General Notes, Legend, Abbreviations and Sheet Index, revise Site Utility Note 2 in its entirety to read as follows: "Upon Notice to Proceed, District will provide to the Contractor a map indicating the location of existing underground utilities prepared by an electronic locator service company to be used as a guide during excavation for new utilities. Contractor shall pot hole to locate exact location and depth of existing utilities prior to starting excavation or trenching."

2-3.3 Replace Contract Drawing Sheet E101 with revised Sheet E101, Rev.1 dated 9/29/15.


2-3.5 Replace Contract Drawing Sheet FA001 with revised Sheet F, Rev.1 dated 9/29/15.

2-3.7 Add Contract Drawing Sheet T001, Rev. 1 dated 9/29/15
2-3.8 Add Contract Drawing Sheet T101, Rev. 1 dated 9/29/15
2-3.9 Add Contract Drawing Sheet T102, Rev. 1 dated 9/29/15

2-4 Revise Project Manual
2-4.1 The following new specification sections are a part of Addendum No. 2:

2705 26 Grounding and Bonding for Communications System
27 05 28 Pathways for Communications System
27 11 00 Communications Equipment Room fittings
27 13 13 Communications Copper Backbone Cabling
27 13 23 Communications Optical Fiber Backbone Cabling

2-5 Questions and Answers
Q1: Description: AS-02 general note 20 calls for the contractor to level out surfaces at the ramp locations. There is not a note as to who procures the ramp system at the new modular villages or installs them. Please confirm that the access ramps are a part of the modular system and will not be provided by the contractor.
A1: Refer to item 2-1.1.

Q2: The portable units do not show any penetrations through the flooring, however, the portables are completely installed by another company. Are there any pre-installed points of entry for utilities in the modular buildings? Please confirm if the portables have pre manufactured/pre designated penetrations for utilities (MEP).
A2:

For 24X40 units: An exterior mounted (18” AFF - rear of building) gutter box (6x6x4) with 3/4” conduit stubbed into attic space is provided and meant for FA hook up only. (Box is located in the rear 24’ wall of building near elect panel stub-outs.) Any other means of entry into the building for low voltage, data, etc. will be provided by the Site Work contractor. All connections/conduits/devices by Site Work contractor. Electrical panel feeds/stubs are through the rear of the panel.

For 24X60 unit: An exterior mounted recessed J-BOX with 3/4” conduit stubbed into attic space is provided and meant for FA hook up only. (J-BOX is located in the side 24’ wall of the building near elect panel stub-outs.) Any other means of entry into the building for low voltage, data, etc. will be provided by the Site Work contractor. All connections/conduits/devices by Site Work contractor. Electrical panel feeds/stubs are thru the rear of the panel.
For 12X40 unit: An exterior mounted recessed J-BOX (18" AFF) with 3/4" conduit stubbed into attic space is provided and meant for FA hook up only. (J-BOX is located in the side 12' wall of the building near elect panel stub-outs.) Any other means of entry into the building for low voltage, data, etc. will be provided by the Site Work contractor. All connections/conduits/devices by Site Work contractor. Electrical panel feeds/stubs are thru the rear of the panel.

Q3: Plans do not show a scope for asphalt replacement or repair at new modular buildings or for installation of new parking at buildings. Please provide a scope of work for any asphalt replacement required.

A3: New parking is not a part of the scope of work. Provisions are met with the existing parking lot 2. Asphalt is existing to remain with a new slurry coat over existing as indicated on sheet AS-02.

Q4: Testing of any spoils (environmental testing) or testing requirements of any soil at the modular buildings locations was not found in the plans. Please advise to any soil testing requirements for the project. If testing is required, who is responsible for the required testing of soils at the modular building location?

A4: Should the Contractor discover any soils or other material that they expect to be hazardous, the Contractor shall notify the District.

Q5: Exhibit 2 says Renovation, transportation, and installation of the portables will be done by others on separate agreements. The modular building drawings show two doors being relocated and one interior door added and electrical boxes and receptacles added in Village 12. Is this work by portable manufacture or by Contractor? Also electrical boxes and receptacles are shown added in Modtech 24 x 40 classroom. Is this work by others or by Contractor? In general our question is are the modular building drawings for reference only or is there work required by Contractor included in the modular building drawings? Renovation is by others per Exhibit 2.

A5: All work within the relocatables shall be done by the portable manufacturer, including the relocation and addition of doors. Installation of electrical outlet circuits and J-boxes are also provided by the portable manufacturer. (J-boxes for data and A/V are provided by the portable manufacturer with conduits stubbed into attic only). Site Work Contractor shall make all power connections from the power panels to the substation. All data wiring connections to be done by the Site Work Contractor.

Q6: Do you know of any subcontractors that will supply and install the required Air blown fiber optics for the new portables on this project that was mentioned at the Job walk? Please advise.

A6: The subcontractor shall be a manufacturer authorized/licensed air blown fiber installation
Contractor. The manufacturer of the fiber optic cable is Sumitomo Electric Lightwave. Determination of qualified subcontractors shall be by contractor.

Q7: Plan sheet AS-03 Keynote 5 (address of building). Is this item to be included in our bid? If yes please supply detail and address for each building.

A7: All signage shall be done by Contractor. Coordinate with campus standard for style, lettering and mounting height. For reference, refer to existing signage on adjacent portables.

Q8: Note 1 on plan sheets E501 calls for new 200 amp 3 pole breakers to be installed in an existing distribution board. Pages e1.0 and 8A of the stockpile drawings indicate the panel provided by the building manufacturer will be 150 amp single phase panels. Please verify if the building feeders are indeed 3 phase.

A8: Electrical panels in modular buildings are single phase.

Q9: Page A8 of the stockpile drawings does not reflect accurate fire alarm device configuration. Please verify if this will be corrected by the building manufacturer or part of our work.

A9: Required fire alarm devices are shown on Sheet FA 101 and are to be provided by the Site Work Contractor. Conduit and J-Boxes are by portable manufacturer.

Q10: Page FA001 indicates we will be adding on to an existing Notifier fire system. Does the college utilize a sole source for connection and programming of this system that we would be limited to using, or can we list any certified Notifier installer?

A10: Fire Alarm installation shall be by Site Work Contractor. Programming of new Fire Alarm system will be performed by Pyro-Comm through the District.

Q11: On page E501 detail 1, will the area we are trenching and providing duct bank in be regarded as roadway due to being a parking area, or will it not be required to lace the trench with #4 rebar?

A11: No roadway sections are present.

Q12: Please provide a requirement for sack ratio and color of encasement concrete.

A12: 2-sack slurry & red coloring for fire alarm encasing concrete.

Q13: Is the work described on page AS-03 notes 1 and 6, signage and curb painting already in place?

A13: Contractor to provide painted red curb per keynote 1; post mounted signs per keynotes 2 & 6; and building signage per keynote 5.
PROVIDE (4) 2" UNDERGROUND CONDUIT DUCT BANK.  SEE DETAIL 1 ON SHEET E501 FOR MORE INFORMATION.

PROVIDE (1) 2" UNDERGROUND CONDUIT, BURIED MINIMUM 24" BELOW GRADE.

PROVIDE MINIMUM 8" X 8" NEMA 3R WIREWAY, MOUNTED ON EXISTING CONCRETE PAD, CONDUIT STUB-UP CONNECTING DUCT BANK TO DISTRIBUTION PANEL 'DP3'.  SEE DETAIL 2 ON SHEET E501 FOR STUB-UP INFORMATION.

CONDUIT STUB-UP TO MINIMUM 6" X 6" X 6" NEMA 3R JUNCTION BOX.  CONNECT THROUGH EXTERIOR WALL TO RECESSED ELECTRICAL PANEL PROVIDED BY TRAILER MANUFACTURER.  CONFIRM EXACT LOCATIONS WITH TRAILER MANUFACTURER PRIOR TO SITE WORK.  REFER TO DETAIL 2 ON SHEET E501 FOR RISER INFORMATION.

PROVIDE TRAFFIC-RATED ROUND CONCRETE GROUND WELL BOX, J&R MODEL#E1-RC.  SEE DETAIL 3 ON SHEET E501 FOR MORE INFORMATION.

PROVIDE (3) 2" UNDERGROUND CONDUIT DUCT BANK.  SEE DETAIL 1 ON SHEET E501 FOR MORE INFORMATION.

PROVIDE 1" UNDERGROUND CONDUIT TO GROUND WELL, BURIED MINIMUM 24" BELOW GRADE.

PROVIDE TRAFFIC-RATED CONCRETE ELECTRICAL PULLBOX, MINIMUM 12" X 24" X 12" DEEP.

POWER TO FIRE ALARM POWER SUPPLY 'FA-V12'.  SEE SHEET FA 001 AND FA101 FOR MORE INFORMATION.
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NOTES:
- GENERAL NOTES:
  1. CONDUIT FOLLOWS COMMUNICATION AND POWER CONDUITS IN SHARED DUCT BANK WHERE POSSIBLE. SEE UNDERGROUND CONDUIT TRENCH DETAIL 1 ON SHEET E501.
  2. DISTRICT TO PROVIDE 3RD PARTY SOIL TESTING TO VERIFY 95% COMPACTION OF TRENCHES PER THE REQUIREMENTS OF THE DSA TESTING AND INSPECTION FORMS. COORDINATE WITH INSPECTOR OF RECORD FOR MORE INFORMATION.

SITE PLAN:
- NORTH SITE PLAN
- FA101
- 1/8" = 1'-0"
NOTES

VILLAGE 12 BUILDING DISTRIBUTION FRAME (BDF). PATCH PANELS PROVIDED BY THE CONTRACTOR, SWITCHES AND DATA RACK PROVIDED BY THE DISTRICT, INSTALLED BY COMMUNICATIONS CONTRACTOR. COMMUNICATIONS CONTRACTOR TO PROVIDE AND INSTALL AIR BLOWN FIBER (ABF) TERMINAL DISTRIBUTION UNIT (TDU) AND SUPPORTING FIBER TERMINATION HARDWARE FOR ALL NEW PROJECT FIBER OPTIC CABLES. (1) 12-STRAND SINGLE-MODE FIBER OPTIC CABLE CONNECTS VILLAGE 12 BDF TO MAIN DISTRIBUTION FRAME IN LIBRARY. (1) 12-STRAND SINGLE-MODE FIBER OPTIC CABLE ROUTED IN ACCESSIBLE CEILING SPACE TO VILLAGE 12 BDF. PROVIDE 2" UNDERGROUND CONDUIT WITH 2-CELL AIR BLOWN FIBER DUCT. ROUTE UNDERGROUND CONDUIT IN DUCT BANK WITH POWER AND FIRE ALARM CONDUITS WHERE POSSIBLE. SEE UNDERGROUND CONDUIT TRENCH DETAIL 1 ON SHEET E501. PROVIDE 2-CELL AIR BLOWN FIBER DUCT TO MH-39 VIA HH-34, HH-35 AND HH-36. CONNECTION TO EXISTING ABF NETWORK IN MH-39 VIA HANDHOLES 34, 35 & 36. ROUTE FIBER OPTIC CABLE BACK TO MDF VIA EXISTING SPARE CELL IN 19-CELL ABF CABLE. EXISTING MAIN DISTRIBUTION FRAME (MDF) IN LIBRARY.
NOTES

LOCATION OF VILLAGE 12 BDF.

PLENUM RATED SINGLE-MODE FIBER OPTIC CABLE, HUNG ABOVE CEILING. CABLE CONNECTS VILLAGE 12 BDF AND CAMPUS MDF.

PROVIDE MINIMUM 6" X 6" X 4" NEMA 3R PULLBOX FOR CONNECTION TO TRAILER CEILING SPACE. 2" RGS CONDUIT WITH 2-CELL ABF DUCT DOWN TO UNDERGROUND COMMUNICATIONS CONDUIT.

PROVIDE 2" UNDERGROUND CONDUIT WITH 2-CELL ABF DUCT FOR FIBER OPTIC ROUTING TO CAMPUS MDF ROOM. CONDUIT FOLLOWS UNDERGROUND FIRE ALARM CONDUIT WHERE POSSIBLE.

SHARED FIRE ALARM/COMMUNICATIONS PULLBOX. COORDINATE WITH FIRE ALARM.

PROVIDE 2-CELL ABF DUCT IN EXISITNG 4" UNDERGROUND CONDUIT.

PROVIDE MINIMUM 8" X 12" X 18" NEMA 3R PULLBOX FOR CAT 5E CONNECTIONS BETWEEN VILLAGE 12 BDF AND VILLAGE 11.

PROVIDE (2) 4" UNDERGROUND CONDUIT. SEE UNDERGROUND CONDUIT TRENCH DETAIL 1 ON SHEET E501.

ROUTE CAT 5E CABLES FROM VILLAGE 12 BDF SWITCH TO COMMUNICATIONS DEVICES VIA DEVICE STUB-UPS IN ACCESSIBLE CEILING SPACE. QUANTITY OF CABLES TO EACH DEVICE AS SHOWN.

PROVIDE 4" RGS CONDUIT IN ACCESSIBLE CEILING SPACE BETWEEN VILLAGE 11 DEMISING WALLS FOR ROUTING OF CAT5E CABLES.

PROVIDE (1) HDMI AND (1) VGA CONNECTIONS TO PROJECTION SYSTEM DEVICES. CABLE SHALL BE PLENUM RATED AND SHALL RUN THROUGH STUBBED-UP CONDUIT FROM DEVICE TO ACCESSIBLE CEILING SPACE. CONNECTION TO CEILING-MOUNTED HDMI/VGA DEVICE.

PROVIDE (1) USB-B AND (1) AUDIO COAX DEVICES, CONNECTED TO PRESENTATION SYSTEM.

EXISTING 11'-7" X 6'-2" WIRE MESH ENCLOSURE TO BE TRANSPORTED FROM OWNER STORAGE AND INSTALLED AT LOCATION SHOWN BY THE CONTRACTOR. ANY ADDITIONAL REQUIRED FITTINGS AND ANCHORAGE TO BE OBTAINED FROM ENCLOSURE MANUFACTURER (KING WIRE PARTITIONS INC).
PROJECT MANUAL
for:

Relocatables 11, 12 & 13 Addendum No. 2

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15018.00
09/28/2015
Seals Page

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Expiration Date: 03/2016
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SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS.
B. SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.
C. SECTION 27 13 13 - COMMUNICATION COPPER BACKBONE CABLING.
D. SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING.

1.2 WORK INCLUDED

A. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents

1.3 SCOPE OF WORK

A. This document describes the products and execution requirements relating to furnishing and installing Grounding/Earthing and Bonding for Communications Systems.
B. This section includes minimum requirements for the following:
   • Grounding/Earthing System
   • Telecommunications Grounding Busbar (TGB)
   • Telecommunications Main Grounding Busbar (TMGB)
   • Telecommunications Bonding Backbone (TBB)
   • Rack Grounding/Earthing and Bonding
C. All cables and related terminations, support and grounding/earthing hardware shall be furnished, installed, wired, tested, labeled, and documented by the telecommunications contractor as detailed in this document.
D. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities grounding/earthing products, typical installation details and cable routing will be provided as an attachment to this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

1.4 REGULATORY REFERENCES
A. The following industry standards are the basis for the grounding/earthing and bonding system described in this document.

1. TIA/EIA
   - TIA-942 Telecommunications Infrastructure Standard for Data Centers
   - J-STD-607-B Commercial Building Grounding/Bonding Requirements
   - TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

2. IEEE
   - Std 1100 IEEE Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book)

3. NFPA
   - NFPA-70 National Electric Code (NEC)

B. Federal, state, local codes, rules, regulations and ordinances governing the work, as well as S.O.C.C.C.D. guidelines and practices may apply and shall be incorporated as part of these specifications.

C. In reviewing the various Contract Documents, the Structured Telecommunications Cable Contractor shall be responsible for noting conflicts between proposed design/concepts and the applicable standards, guidelines and practices. A written Request for Information (RFI) shall be developed by the Structured Telecommunications Cable Contractor and submitted to S.O.C.C.C.D prior to commencing any work impacted by such conflicts. Such RFIs shall describe the conflict/violation and, if appropriate, recommend alternative solutions with associated costs. S.O.C.C.C.D warrants that they will diligently strive to address such RFIs in order to minimize negative impact on each SCCS installation completion schedule.

D. Where the requirements of the Contract Documents are more stringent than applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the Contract Documents shall apply. In all other instances, the most current standards, guidelines and practices shall apply.

1.5 QUALITY ASSURANCE

A. See the Panduit Electrical Product Warranty on www.panduit.com/warranty

1.6 APPROVED PRODUCTS

A. Approved grounding/earthing system manufacturer: PANDUIT
B. Approved telecommunications grounding busbar manufacturer: PANDUIT
C. Approved rack grounding kit manufacturer: PANDUIT
D. Approved retrofit rack grounding kit manufacturer: PANDUIT

1.7 DEFINITIONS

A. Bonding – The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

B. Common Bonding Network (CBN) – The principal means for affecting bonding and earthing inside a building.

C. Ground/Earth – A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent that serves in place of the earth.

D. Retrofit Rack Grounding/Earthing – The application of grounding/earthing products and technology where equipment is already deployed and functioning.

1.8 OVERVIEW

A. The purpose of the grounding/earthing system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge are common causes of these surges and transient voltages. An effective grounding/earthing system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.

B. The grounding/earthing system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding/earthing must be purposeful in its design and installation. Four issues require special consideration:

1. Although AC powered equipment typically has a power cord that contains a ground/earth wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding/earthing above and beyond that which is specified by local electrical codes, such as the National Electrical Code, etcetera. Always follow the grounding/earthing recommendations of the manufacturer when installing equipment.
2. While the building steel and metallic water piping must be bonded to the grounding/earthing system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).

3. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding/earthing purposes. Additionally, most racks are painted. Paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.

4. Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding/earthing system.

1.9 WORKMANSHIP

A. The ground/earth system must be designed for high reliability. Therefore, the grounding/earthing system shall meet following criteria:

1. Local electrical codes shall be adhered to.

2. The grounding/earthing system shall comply with ANSI/TIA-942 and J-STD-607-A.

3. All grounding/earthing conductors shall be copper.

4. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.

5. Wherever possible, two-hole lugs shall be used because they resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).

6. Die index numbers shall be embossed on all compression connections to allow crimp inspection.

7. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.
PART 2 - PRODUCTS

2.1 EQUIVALENT PRODUCTS

A.  *PANDUIT* shall manufacture all products, including but not limited to grounding/earthing and bonding for communications systems.

B. Products of equal performance and warranty will be allowed.

2.2 GROUNDING/EARTHING AND BONDING

A. The Telecommunications Grounding Busbar (TGB) in each telecommunications space will be grounded/earthed to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting ground/earth cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below.

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<td>4-6 (14-20)</td>
<td>4</td>
</tr>
<tr>
<td>6-8 (21-26)</td>
<td>3</td>
</tr>
<tr>
<td>8-10 (27-33)</td>
<td>2</td>
</tr>
<tr>
<td>10-13 (34-41)</td>
<td>1</td>
</tr>
<tr>
<td>13-16 (42-52)</td>
<td>1/0</td>
</tr>
<tr>
<td>16-20 (53-66)</td>
<td>2/0</td>
</tr>
<tr>
<td>Greater than 20 (66)</td>
<td>3/0</td>
</tr>
</tbody>
</table>

B. The TMGB will be bonded to building steel and grounded/earthed to the electrical service ground according to BICSI TDM Manual and J-STD-607-B guidelines. Local codes may supersede these requirements. In telecommunications spaces with only one rack, the rack jumper cable can be connected directly to the TGB.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Copper Code Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aisle grounds (overhead or under floor) of the common bonding network</td>
<td>#2 AWG or larger (1/0 preferred)</td>
</tr>
<tr>
<td>Bonding conductor to each PDU or panel board serving the room.</td>
<td>Size per NEC 250.122 &amp; manufacturer recommendations</td>
</tr>
<tr>
<td>Bonding conductor to HVAC equipment</td>
<td>6 AWG</td>
</tr>
<tr>
<td>Building columns</td>
<td>4 AWG</td>
</tr>
<tr>
<td>Cable ladders and trays</td>
<td>6 AWG</td>
</tr>
<tr>
<td>Conduit, water pipe, duct</td>
<td>6 AWG</td>
</tr>
</tbody>
</table>
2.3 COMPONENTS, KITS AND HARDWARE

A. PANDUIT® StructuredGround™ Grounding System (StructuredEarth™ Earthing System) kits, components, and hardware shall be used to construct the grounding/earthing system.

B. Use PANDUIT GB4 series BICSI/J-STD-607-A telecommunications grounding busbars for the TMGB, which is ideally located at the AC service entrance. Use a PANDUIT GB2 series busbar for the TGB in each of the other telecommunications/equipment spaces throughout the building. Use PANDUIT LCC-W series lugs when connecting conductors to the TMGB and TGB.

C. Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. Use PANDUIT HTAP kits, family HTWC, to provide a tap from the TBB to each TGB. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a Grounding Equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).

D. Avoid routing grounding/earthing conductors in metal conduits. If the grounding/earthing conductor must be routed through a metal conduit, bond each end of the conduit to the grounding/earthing conductor. Use PANDUIT GPL series grounding clamps to bond to the conduit, a PANDUIT HTWC HTAP with clear cover to bond to the grounding/earthing conductor, and a #6 AWG copper conductor to connect the GPL grounding clamp to the HTWC HTAP.

2.4 RACK GROUNDING/EARTHING

A. Equipment and racks shall be bonded in accordance with the methods prescribed in ANSI/TIA-942, as is shown in the figure below.
B. To provide electrical continuity between rack elements, PANDUIT paint piercing grounding washers, series RGW, shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

C. All racks shall utilize a full-length rack ground strip, PANDUIT part number RGS134, attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact.
D. Mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGESD-1 directly to the rack grounding strip on the back of the rack at approximately 48 inches from the floor. Mount a second RGESD-1 directly to the vertical mounting rail of the rack in the front at approximately the same height. Use the thread-forming screws provided to form a bond to the rack. Place the ESD protection identification stickers directly above the ESD ports.

E. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate PANDUIT RG series jumper for the equipment being installed and the thread-forming screws provided in the kit.

F. Use PANDUIT part number RGCBNJ660P (common bonding network to rack jumper) to attach the rack ground strip to the common bonding network. Do not bond racks or cabinets serially. Use the copper compression HTAP that comes with the kit to bond the conductor to the common bonding network.

G. Patch panels will be bonded to racks using the PANDUIT bonding screws, part number RGTBS-C for racks having #12-24 equipment mounting holes, and RGTBSM6-C for racks having M6 equipment mounting holes.

2.5 RETROFIT RACK GROUNDING/EARTHING

A. If the racks already have network equipment installed, it may not be feasible to install the rack ground strip without disrupting data cables. Further, it may be undesirable to disassemble rack hardware to install paint piercing grounding washers. In these circumstances, the PANDUIT retrofit rack grounding kits, PANDUIT part family RGR, are to be installed.

B. For retrofit rack grounding/earthing installations, use PANDUIT part number RGRCBNJ to ground/earth the rack to the common bonding network. Use PANDUIT part number RGEJ696 (provided with #6 AWG grounding conductor) or PANDUIT part number RGEJ1096 (provided with #10 AWG grounding conductor) to ground/earth equipment chassis to the rack grounding busbar provided with the RGRCBNJ as is shown in the figure below.
C. RGW paint piercing grounding washers are not used in this scenario. Thus, the grounding busbar provides continuity through the vertical channels of the rack, but not the top and bottom of the rack. Thus, wherever practical, the solution using the RGS rack grounding strip and the RGW paint piercing washers shall be used instead of the retrofit rack grounding kits.

D. All other grounding/earthing requirements apply to retrofit installations without exception.

E. Use PANDUIT® STRUCTUREDGROUND™ Grounding System (STRUCTUREDEARTH™ Earthing System) in every application possible. See http://www.panduit.com for the latest grounding and bonding solutions.
PART 3 - EXECUTION

3.1 GROUNDING SYSTEM

The communications grounding system shall be designed and/or approved by a qualified PE, or RCDD. The communications grounding system shall adhere to the recommendations of the ANSI/TIA-942 and J-STD-607-B standards, and shall be installed in accordance with best industry practice.

A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.

END OF SECTION 27 05 26
SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

B. SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.

C. SECTION 27 11 16 - COMMUNICATIONS CABINETS AND ENCLOSURES.

D. SECTION 27 13 13 - COMMUNICATION COPPER BACKBONE CABLING.

E. SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING.

1.2 WORK INCLUDED

A. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.

1.3 SCOPE OF WORK

A. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling pathways. Communication cabling support is covered under this document.

B. This section includes minimum requirements for the following:

   1. Non-Continuous Cable Support
   2. Underground Pull Boxes
   3. Pull Boxes
   4. Communications Dust Banks and Conduit

C. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the telecommunications contractor as detailed in this document.

D. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types will be provided as an attachment to this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall
meet or exceed all requirements for the cable system described in this document.

1.4 REGULATORY REFERENCES

A. The following industry standards are the basis for the structured cabling system described in this document.

1. TIA/EIA
   • TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
   • TIA/EIA-569-A Commercial Building Standard for Telecom Pathways And Spaces
   • TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   • TIA/EIA-607 Commercial Building Grounding/Bonding Requirements

2. NFPA
   • NFPA-70 National Electric Code (NEC)-1999

3. ISO/IEC
   • ISO/IEC 11801 Generic Cabling for Customer Premises

4. PUBLIC WORKS STANDARDS, INC.
   • GREENBOOK; Green Book Standard Specifications for Public Works Construction 2012.

B. Federal, state, local codes, rules, regulations, ordinances governing the work, as well as S.O.C.C.C.D. guidelines and practices may apply and shall be incorporated as part of these specifications.

C. In reviewing the various Contract Documents, the Structured Telecommunications Cable Contractor shall be responsible for noting conflicts between proposed design/concepts and the applicable standards, guidelines and practices. A written Request for Information (RFI) shall be developed by the Structured Telecommunications Cable Contractor and submitted to S.O.C.C.C.D prior to commencing any work impacted by such conflicts. Such RFIs shall describe the conflict/violation and, if appropriate, recommend alternative solutions with associated costs. S.O.C.C.C.D warrants that they will diligently strive to address such RFIs in order to minimize negative impact on each SCCS installation completion schedule.

D. Where the requirements of the Contract Documents are more stringent than applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the Contract Documents shall apply. In all other instances, the most current standards, guidelines and practices shall apply.
1.5 QUALITY ASSURANCE

A. Structured Communications Cabling System pathways, raceways and supports shall be installed per the following:
   1. Meet all TIA and BICSI commercial building wiring standards.

B. All Networks shall be installed per applicable standards and manufacturer's guidelines.

1.5 PATHWAY INSTALLATIONS

A. Comply with TIA/EIA-569-A, NEC and CEC.

B. Shall be installed in accordance with NEC Article 314 and Article 800.51 (J), (K), or (L), as applicable, and installed in accordance with Articles 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing apply.

C. Conceal interior conduit under floor slabs and within finished walls, ceilings, and floors where possible.

D. Keep conduit minimum 6 inches away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.

E. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit is visible after completion of project.

F. Run conduits in crawl spaces and under floor slabs as if cable is exposed.

G. Install no more than two 90-degree bends for a single horizontal cable run.

H. Run conduits and surface mounted raceway as determined by site survey or as noted on drawings.

I. Provide Pullboxes with “Sealtight” flex conduit only where flexible connections are required. S.O.C.C.C.D approval required prior to all “Sealtight” flex conduit installations.

J. Provide all coring, patching and painting as needed for Intra-Building and Inter-Building pathways. Caulking is not an acceptable patching method for conduit penetrations into exterior walls. Coordinate with S.O.C.C.C.D for acceptable patching methods.
PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORT

A. Material

1. Contractor shall provide and install all non-continuous cable supporting hardware.

2. Non-continuous cable supporting hardware consists of J-hooks, multifunction clips, beam clamps, etc. Bridle rings are not permitted.

3. Non-continuous cable supports shall provide a load bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed. Bridle rings are not permitted.

4. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

5. Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

6. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.

7. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL Listed.

8. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips, etc.

9. Tee-bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.

10. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.

11. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL Listed.
12. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL Listed.

13. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL Listed.

14. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, UL Listed.

15. The multi-tiered support bracket shall have a static load limit of 300 lbs.

16. U-hooks and double J-hooks shall attach directly to threaded rod using standard nuts.

B. Manufacturer: Panduit, Copper B-Line, or S.O.C.C.C.D approved equal.

2.2 UNDERGROUND PULL BOXES AND PULLBOXES

A. Underground pull boxes shall be made of concrete and the minimum size shall be 2'-10" x 4'-10" x 4'-0" I.D...

B. Underground pull covers shall be rated for traffic (type T.05) and shall be marked communications.

C. Metal covers shall be used in all location subject to vehicle traffic.

D. Gravel shall be installed below all ground boxes for drainage.

E. Ground boxes and pull boxes shall not be placed in areas subject to flooding.

F. Establish drainage to meet Public Works Construction Standards (Green Book).

G. Unless otherwise noted, pull boxes shall have minimum dimensions of 20" x 20" x 6".

1. Interior pull boxes shall consist of 16 gauge steel minimum, unless otherwise noted on plans.

2. Indoor enclosures shall conform to NEMA Type 4, unless otherwise noted.

3. Size pull boxes to not less than minimum Code requirements. Increase size above Code requirements where necessary to provide space for
pulling, racking or splicing enclosed conductors, or where specified or indicated dimensions exceed Code requirements.

4. Exterior metal pull boxes exposed to weather (and not installed in or below grade) shall be equipped with rain-tight or weatherproof-hinged doors.

5. Exterior pull boxes shall have 16 gauge steel bodies and 14 gauge steel doors.

6. Exterior pull boxes shall be equipped with external mounting feet.

7. Exterior pull boxes shall be equipped with stainless steel door clamps on three sides and a removable stainless steel continuous hinge pin.

8. Exterior pull boxes shall be equipped with a hasp and staple for padlocking.

9. Enclosures installed on vertical exterior walls shall conform to NEMA Type 3R.

10. Enclosures installed on exterior horizontal surfaces such as rooftops or breezeways shall conform to NEMA Type 4 unless otherwise noted.

11. Rain tight or weatherproof boxes shall use threaded watertight hubs for top or side entry and may use knockout for bottom entry only.

12. Exterior pull boxes shall conform to these industry standards:

   • UL 508 Type 4
   • NEMA/EEMAC Type 3, Type 4, Type 12, Type 13
   • JIC standard EGP-1-1967
   • CSA Type 4
   • IEC 529, IP66

13. Tamper resistant screws shall be used on all exterior, aboveground junction/pull boxes that are exposed to public/student areas.

14. Exterior pull boxes shall be manufactured by Hoffman or S.O.C.C.C.D approved equal.

### 2.5 COMMUNICATION DUCT-BANKS AND CONDUITS

#### A. Trenches

1. All underground trenches shall be minimum 24" wide by 30" deep.
2. Trenches shall be back-filled at 95% compaction.

3. Contractor shall restore surface to same or better condition.

4. Contractor shall contact Dig Alert a minimum of 48 hours prior to excavation to verify the location of existing underground utilities.

5. Modifications to pathway design may be dictated by field conditions subject to approval by S.O.C.C.C.D.

6. Compaction testing notification must be provided to the District, 48 hours prior to testing so that a District inspector may be present.

7. Slurry fill trenches to within three inches (3") of finished grade whenever crossing paved areas. “Two Sack” slurry shall be used.

8. Pavement removal and patching shall conform to specifications and standards listed in the Public Works Standards (Green Book 2006).

B. Conduit

1. Underground conduit shall consist of Schedule 40 PVC - 2 inch or 4" inside diameter or type C telephone conduit - 2 inch inside diameter (if concrete encased)

2. Conduit shall have a factory formed bell on one end for interconnecting segments.

3. Conduit located under heavy use highways or railroad rights-of-ways shall be encased in steel casing consistent with the AASHTO or AREA specifications. The thickness of the steel casing shall be engineered for each specific application. This may vary based on campus codes.

4. Spacers: High impact spacers shall be used in all multi-duct systems, for either solely owned or joint telecommunications/power construction. They shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512 dimensions.

5. All fittings shall be designed specifically for use with the type of conduit placed.

6. All conduits shall be equipped with seal plugs in all ground boxes and expansion rubber seal plugs within all buildings.

7. A horizontal and vertical separation of 1 inch shall between the ducts be maintained by installing high impact spacers with horizontal and vertical locking intervals of ten feet.

8. All communications conduits shall be placed in a uniform manner between ground boxes and pull boxes. Conduit in position #1 at one ground box or pull box shall maintain its position within the duct run and terminate in the #1 position at the next box. The position of all conduits between ground boxes and pull boxes shall be maintained.
9. Long radius bends (over 30 feet) shall be used whenever possible to make changes in direction. If it is found to be necessary to place a 90-degree bend in the conduit run, a factory-made sweep of no less than 60-inch radius shall be used.

10. No conduit run shall exceed a total of 180 degrees of bend between any two points (such as manholes or buildings) considering both vertical and horizontal sweeps.

11. Cold-formed trench bends shall have a radius of not less than 60 inches and shall pass mandrel integrity. Bend radius criterion is 2" or less 6 times the diameter of the conduit and any conduit larger than 2" is 10 times the diameter of the conduit.

12. The length and destination of all conduits shall be identified in each ground box, pull box and building. Embossed metal or heavy plastic tags strapped to each conduit shall be used.

13. After installation of communications conduits, the contractor shall prove all conduits by pulling a mandrel with a diameter ¼ inch smaller than the conduit and 6 inches long through each conduit end-to-end. An inspector designated by the contractor and S.O.C.C.C.D shall be notified 24 hours before this procedure. Each conduit shall be cleaned with a bristle brush to remove any debris.

14. Utility marking tape shall be buried 12 inches below the surface directly above the conduit.

15. Where communications and power conduits occupy the same trench, all conduit structures shall be built with the telecommunications conduits placed above the power conduits and separated by a minimum of 12" of compact earth or 3" of concrete encasement, unless otherwise called out on the construction drawings and approved by S.O.C.C.C.D. If this type of construction is required, it shall receive the prior approval of the contractor and S.O.C.C.C.D.

16. Contractor shall install new ¼” pull rope in all conduits placed.

C. Overhead Conduit

1. Where overhead conduit is required within buildings, Contractor shall utilize EMT conduit with an inside diameter of 2” or 4”, unless otherwise specified.

2. All fittings shall be compression type connectors and couplers designed specifically for use with the type of conduit placed.

3. All fittings shall be watertight. Fitting types shall be pre-approved by the designated District representative. Unless pre-approved by the designated District representative, all conduits shall be installed by a qualified electrical contractor who has at least five years experience in similar installations within the Southern California area.
4. Contractor shall install conduit at roof locations utilizing the current District approved methodology and process. All conduit pathways and locations must be approved by S.O.C.C.C.D prior to installation.

5. All roof penetrations must be approved by S.O.C.C.C.D prior to installation.

6. Contractor shall install new ¼” pull rope in all conduits placed.

D. Communications Entrance Conduit

1. To prevent shear, all inter-building conduit (either underground or aerial) shall transition from PVC or metal to Sealtite flex conduit when attaching to a permanent structure. The contractor and S.O.C.C.C.D shall determine the placement of all entrance conduits. All applicable standards shall be adhered to, i.e., S.O.C.C.C.D, NEC, BICSI or G.O. 128.

2. Contractor shall install new ¼” pull rope in all conduits placed.

E. Vertical Conduit

1. Where vertical conduit is required between pull boxes or within buildings, Contractor shall utilize EMT conduit with an inside diameter of 2” or 4” unless otherwise specified.

F. Duct-bank locating cable (electronically detectable warning tape)

1. Warning tape shall be a minimum of 3” wide, orange in color, and shall have a nondegradable imprint as follows:
   - “Caution fiber optic cable buried below”
   - The tape shall be electronically detectable.

G. Pull Rope

1. Pull rope shall be new ¼” polypropylene over polyester rope with a minimum 1700 lb. Tensile strength.

2. Pull rope shall be new material that is free of knots, kinks, and abrasions and shall be placed as a single continuous length in every new conduit.

3. Pull rope shall be secured at each end.

2.7 FIRESTOPPING MATERIAL

A. Contractor shall provide all necessary fire stopping of openings through which cable is installed under this specification, in accordance with NFPA 70 and all local codes. This includes installation in conduits, raceways, or bare
penetrations. Provide and install UL 1479 approved firestop systems

2.8 DUCT SEALANT

A. Contractor shall provide Polywater® Duct Sealant kit #FST-kit to seal each end of all underground communications duct bank conduits.

B. Duct sealant shall be a two-part, “water-blown” urethane foam that cures to a strong, rigid closed-cell structure.

C. Duct sealant shall be capable of wetting and adhesion to metal, concrete and plastic surfaces.

D. Duct sealant shall be 100% water tight, holding 15-foot (5 meters) waterhead, and acts as a barrier to smoke and air.

PART 3 - EXECUTION

3.1 OPEN CABLE INSTALLATION

A. Use only where specifically indicated on plans or determined during site surveys.

B. When not run in surface mounted raceway or conduit, utilize non-continuous cable support above suspended ceilings and in all ceiling spaces.

C. Install cabling above suspended ceilings 6 to 12 inches above ceiling T-bar using non-continuous cable support spaced on 24 to 48 inch centers and securely attached to structural ceiling.

D. Do not exceed cable pull tensions recommended by the manufacturer.

1. Avoid routing copper cable in areas where there may be high levels of electromagnetic interference (EMI). EMI is caused by AC power lines, broadcast signals, X-ray equipment, motors, generators, and fluorescent lights. UTP cables shall be routed at least 5 inches away from fluorescent lighting fixtures.

2. Cables shall be placed in the non-continuous cable support located every 2 to 4 feet, as long as they are separately bundled and tie-wrapped using Velcro ties.

3. Cabling shall be organized and identified so as to facilitate locating and handling individual sheaths for maintenance functions.

4. Each bundle shall be neatly tied without over cinching or stressing cable.
5. Bundles shall be clearly marked identifying the IDF and room to which routed, the station numbers served by the bundle, and any other information that may assist in administration.

6. Great care shall be taken to protect all cabling from physical damage.

7. A 20’ service loop shall be installed above ceiling on each cable installation where possible.

3.2 FIRESTOP

A. A firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item (i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc.) shall be properly fire stopped.

C. All firestop systems shall be installed in accordance with the manufacturer’s recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

3.3 DUCT SEALANT

A. Contractor shall install duct sealant in each end of underground duct bank conduits.

B. All occupied and vacant communications duct bank conduits shall be sealed.

C. Each underground duct bank conduit entering underground pull boxes shall have duct sealant installed.

D. Each underground duct bank conduit stubbing up through building foundation shall have duct sealant installed.

E. Each underground duct bank conduit through building wall shall have duct sealant installed.

F. Each underground duct bank conduit end shall be sealed to be 100% water tight.

END OF SECTION 27 05 28
SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.1 SUBMITTALS
A. Refer to Division 01 33 00 for submittal procedures.
B. Provide submittals for materials required by this section.
C. Submittals shall consist of catalogue cut sheets and/or engineering specification sheets provided by the manufacturer.
D. Contractor shall submit for approval all proposed materials and equipment prior to installation.

1.2 SECTION INCLUDES
A. Installation of Equipment Racks, Brackets
B. Installation of Cable Management – Vertical and Horizontal
C. Installation of Overhead Cable Runway (Ladder racking)
D. Installation of Cable Tray

1.3 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all Specification Sections, apply to this section.
B. SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
C. SECTION 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS
D. SECTION 27 13 13 - COMMUNICATION COPPER BACKBONE CABLING
E. SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING.

1.4 REFERENCES
A. American Society for Testing and Materials (ASTM):
2. A 569 - Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.


B. National Fire Protection Association (NFPA) 70 - National Electrical Code.

C. National Electrical Manufacturers Association (NEMA):
   1. VE 1 - Metallic Cable Tray Systems.
   2. VE 2 – Metallic Cable Tray Installation Guidelines.


1.3 SYSTEM REQUIREMENTS

A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

B. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in backbone cables, and provide spare positions in cross-connects, patch panels and terminal strips to accommodate 20 percent future increase in active workstations.

1.4 MOUNTING ELEMENTS

A. Pathways: Comply with Section 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS.

B. Backboards: 0.75-inch, interior-grade, fire-retardant-treated plywood.

C. Where appropriate, racks shall be secured to the concrete floor and/or plywood backboard using minimum 0.125-inch hardware or as required by local codes.

D. Stand alone equipment racks shall be placed with a minimum of 36 inches clearance between front and back of racks and walls.
E. All racks and cable runways shall be grounded to the telecommunications ground bus bar in accordance with Section 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

F. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

G. General Contractor provided plywood shall be mounted vertically 6 inches above the finished floor.

H. Wall mounted termination blocks field shall be installed with the lowest edge of the mounting frame a minimum 18 inches above the finished floor.

PART 2 - PRODUCTS

2.1 2-POST DISTRIBUTION RACKS

A. Freestanding modular aluminum units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

B. MATERIAL:

1. Approximate Module Dimensions: 84 inches high by 19 inches wide by 6 inches channel depth.

2. Racks shall be all high strength, lightweight 6061-T6 aluminum extrusion construction.

3. Racks shall be equipped with two top angles or top bars and heavy-duty assembly hardware.

4. Racks shall have ANSI/TIA hole pattern on front and rear.

5. Racks shall assemble as 19 inches with no additional hardware required to assemble.

6. Racks shall have ANSI/TIA Channel: 6 inches x 1.265 inch x 0.25 inch thick flange.

7. Racks shall have Base Angles: 3.5 inches by 6 inches by 0.125 inch thick (pair).

8. Racks shall have Top Angles: 1.5 inch by 1.5 inch by 0.25 inch (pair).

9. Racks shall have Top Bars: 1.5 inch by 0.25 inch (pair).

10. Racks shall have a weight capacity of 1000 lbs. Weight must be evenly distributed.

11. Racks shall be black over a brushed aluminum finish.

12. Racks shall provide floor and ceiling access for cable management and distribution.
13. Racks shall provide pre-drilled base for floor attachment of rack.

14. Racks shall be seismic/earthquake braced.

15. Racks shall be black in color.

C. MANUFACTURERS:

1. Chatsworth Products #66353-703 (Equipment Rack)

2. Or ACC Approved Equal
2.2 EQUIPMENT RACKS (WALL-MOUNTED)

A. Standard Swing Gate Wall Rack units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

B. Material:

Approximate Module Dimensions: 36 inches high by 19 inches wide by 25 inches depth.

1. Racks shall have EIA hole pattern on front.
2. Racks shall assemble as 19 inches with no additional hardware.
3. Racks shall have a load rating of 150 lbs. Weight must be evenly distributed.
4. Racks shall be black over a brushed aluminum finish.
5. Racks shall provide floor and ceiling access for cable management and distribution.
6. Racks shall provide pre-drilled base for wall attachment of rack.
7. Racks shall be seismic/earthquake braced.
8. Racks shall be black in color.
9. Opens to right or left, stopping in 90° position
10. Racks shall be EIA-310-E compliant
11. Racks shall have universal 5/8”-5/8”-1/2” alternating hole pattern.
12. Racks shall contain (50) each #12-24 mounting screws.
13. Support 150 lbs of equipment in the open and closed position when securely mounted.
15. Include all installation hardware.

C. Rack Manufacturer:

1. Cooper B-Line Part Number SB708197925.
2. Or S.O.C.C.C.D. Approved Equal

2.3 CABLE RUNWAY (LADDER RACKING)
A. Cable support ladder racks shall be installed in the Telecommunication Rooms as shown on the drawings. Size: 18 inches wide, plus side channel, as needed.

B. Classified by Underwriters Laboratories (UL) as suitable for equipment grounding.

C. Ladder rack shall be used for voice, data and video communications cabling only. No electrical wiring shall be placed on ladder rack with voice and data cabling.

D. Wall angle supports shall be steel angles. Ends to be smooth without hooks or projections. Brackets shall be able to support an end load of 600 lb. with a safety factor of 1.65.

E. Elbows, Tees, 90 degree bends and crosses: All horizontal and vertical 90 degree elbows, tees, 90 degree bends and crosses, shall be made with right angle couplings which clamps to the runway without the need for drilling or cutting.

F. At all horizontal 90-degree bends, tees, and crosses, provide adjustable junction splice kits for large radius cable bends.

G. Seismically supported by end wall supports, angular wall supports and communications equipment racks.

H. Black baked enamel finish.

I. Contractor shall provide cable runway elevation kit for each installed rack.

J. Contractor shall provide cable runway end caps to protect edges.

K. Contractor shall install Cable Runway Radius Drops above each vertical wire manager installed.

L. MANUFACTURERS:

1. Chatsworth Products #10250-718 (18")
2. Chatsworth Products #10506-706 (Runway Elevation Kit)
3. Chatsworth Products #12100-718 (Radius Drop, Cross Member)
4. Chatsworth Products #10642-001 (End Caps)
5. Chatsworth Products #10608-701 (Vertical wall bracket)
6. Chatsworth Products #11301-701 (Butt-Splice Kit)
7. Chatsworth Products #11302-701 (Junction-Splice Kit)
8. Chatsworth Products #11421-718 (Wall angle support Kit)
9. Or S.O.C.C.C.D. Approved Equal
2.4 WIRE MANAGEMENT

A. Materials: All equipment racks shall be equipped with vertical and horizontal wire management organizers. All horizontal wire managers shall be heavy duty painted black metal units designed specifically to connect to equipment frames. All vertical wire managers shall be aluminum with a black finish. All wire managers shall be secured to the frames and shall provide a clear and unobstructed pathway in which to route the cables.

B. VERTICAL WIRE MANAGERS:

1. Single-sided vertical cable managers shall be constructed of metal backbone with pass through holes and plastic cable management fingers.

2. The cable management fingers shall be molded out of plastic and incorporate bend radius control throughout the entire length.

3. The panel shall have a metal door that will be capable of opening to the left or right when mounted.

4. The panel shall be capable of mounting to ANSI/TIA standard channel, deep channel and Telco style racks.

5. Vertical wire managers shall be 6 inches wide by 7 feet tall. Vertical wire managers shall have evenly spaced 1 RMU wire rings designed to maintain jumper, patch, or cross-connect wire in place.

6. Vertical wire managers shall be designed to extend past the frame to allow placement of equipment in any position within the rack. When mounted between equipment frames, they shall be designed to direct cables into either frame and shall be securely mounted to both units.

7. Wide cable rings, purchased separately, shall be installed at the rear of the vertical manager.

8. Vertical wire managers shall be black in color.

C. HORIZONTAL WIRE MANAGERS:

1. The in-frame horizontal managers shall be 2 and 3 RMU in height and shall extend from side rail to side rail.

2. Single-sided design and pass-through slots for easy organization of front and rear cables.

3. Include cable guide fingers at 1.75” intervals for proper cable bend radius and organization of patch cords.

4. Flanged pass-through slots to route cables from front to back.
5. Include Snap-on, hinged door/cover.

6. Horizontal wire managers shall be black in color.

D. MANUFACTURERS:

1. Chatsworth Products: 12831-703 (Vertical)
2. Chatsworth Products: 3013x-719 (Horizontal)
3. Or S.O.C.C.C.D. Approved Equal

2.5 PLYWOOD BACKBOARD

A. General Contractor shall provide .75-inch thick high A/C grade void-free, fire rated plywood, on all TR and MDF walls as noted on construction drawings.

B. Backboards shall be mounted vertically, starting 6 inches above the finished floor, and secured to the walls.

C. All backboards are to be constructed of 4 feet by 8 feet plywood.

D. All plywood panels must be mounted vertically in contact with one another, leaving no gaps between sheets.

E. All exposed edges must be chamfered. Screws, bolts, washers and/or nuts are to be counter sunk to be flush with the surface of the plywood.

2.6 CABLE TRAY

A. GENERAL

1. Provide cable tray of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. MATERIALS AND FINISHES

1. Materials: All cable tray sections, fittings and accessories shall be made from corrosion resistant metal or metal with a factory applied corrosion resistant finish. All materials shall be as indicated on drawings and in accordance with NEMA Standard VE1 Sections 4.1 and 4.:
   b. Duty: Medium.
   c. Steel Sheet: ASTM A 569.
d. Bottom: Sheet perforated for ventilation, minimum 60 percent solid plane for support.


f. Minimum Inside Depth: 4 inches
g. Minimum Inside Width: 12 inches
h. Minimum Section Lengths: 12 feet

2. Fittings: Manufacturer's standard splice plates, elbows, risers, tees, crosses, Y, reducer plates, blind ends, barrier strips, radiused drop-outs, divider strips with resilient PVC cap strip; ventilated. Each item plated or coated same as cable tray.

3. Attachment Accessories: Manufacturer's standard bolt and nut fasteners, clamps, J-bolts, hangers, and connectors. Each item electro-zinc plated or coated same as cable tray.


5. Warning Signs: Manufacturer's standard self-adhering label, black letters on white background, identified with following:
   a. "WARNING: NOT TO BE USED AS WALKWAY."
   b. Manufacturer name and address.
   c. UL Classification.
   d. Minimum area, catalog number with code descriptions, and customer order number.

6. Cable Tray (Rung Bottom):
   a. Length of Straight Sections: Actual lengths and quantities shall be as indicated on drawings. Standard manufacturer lengths shall be 12 ft or 24 ft not including connectors if attached. Straight section lengths shall be greater than or equal to the support span length. Straight section lengths shall be used such that a maximum of one splice joint is between any two-tray supports.
   b. Widths: Actual widths shall be as indicated on drawings. Standard manufacturer widths shall be in accordance with NEMA Standard VE1 Section 4.3.3.1 and shall be 12 inches.
   c. Side Rail Height: Actual tray side rail height shall be 4 inches. Standard manufacturer heights shall be in accordance with NEMA Standard VE1 Section 4.3.4.3 and shall be 4 inches.
   d. Traverse Elements: The maximum open spacing between traverse elements shall be 4 inches measured in the direction parallel to the side rails.
e. **Rung Spacing:** Standard manufacturer rung spacing on straight sections shall be 4-inch wide channels on 8-inch centers for aluminum trays. Rung spacing on fittings shall be 1-inch wide on 5-inch centers for steel trays. Rungs shall be attached to side rails by welding.

f. **Bottoms:** Standard manufacturer bottoms shall include solid corrugated bottoms welded to the side rails. Corrugated bottom shall be 0.5" high with 0.875" top rib spaced 2.185" on center along tray length.

g. **Tray Fittings:** Tray fittings types and quantities shall be as indicated on the drawings. All tray fittings shall be constructed of same material as straight tray sections. Manufacturer tray fittings shall include the following minimum standard fittings types:

h. **Horizontal elbow fittings** in 30, 45, 60, and 90-degree angles.
   - Vertical elbow fittings in 30, 45, 60 and 90-degree angles with inside and outside radius options.
   - Horizontal adjustable elbow fittings with adjustable angle.
   - Horizontal and vertical tee fittings, branch at 90-degree angle.
   - Horizontal wye fittings, branch at 45-degree angle.
   - Horizontal and vertical cross fittings, branch at 90-degree angles.

1. **Fitting Radius:** The nominal bend radius of all fittings shall be 12 inches as measured on the smallest side as indicated on the drawings and shall be appropriate for the allowable bending radius of the cables to be installed in the fitting. Standard manufacturers fitting radii in accordance with Working (Allowable) Load Capacity:

2. **Working (Allowable) Load Capacity:** Working load capacity shall be in accordance with NEMA Standard VE1 Sections 4.8, 5.2, and Table 1. NEMA Load/Class designation per Table 1 shall be Class 20A. Tray deflection shall not exceed manufacturers published engineering data for project cable tray working load capacity and minimum support span requirements.

3. **Safety Factor:** Minimum load capacity safety factor shall be 1.5 in accordance with NEMA Standard VE1 Section 5.2.8.

4. **Aluminum (ALUM.):** Cable tray straight section side rails shall be constructed from copper free alloy type 6063-T6. All fittings and accessories shall be constructed from corrosion resistant aluminum alloy that is compatible with alloy 6063 such as type 5052 or type 3003.

5. **Connectors:** Connector splice shall have less than 0.00033 ohms electrical resistance. Expansion connectors shall provide for minimum 1" tray expansion and shall be placed as shown on drawings or as required to prevent damage to the tray system from thermal expansion and contraction. Grounding bonding jumpers shall be installed at all adjustable connectors and expansion connectors.
6. Connector Hardware: 3/8" diameter, truss head, ribbed neck steel screw with phillips recess and a free spinning, lock type steel nut which does not need a washer. Connector hardware finish shall be protected against corrosion. Connector hardware finish shall be cadmium plated with yellow iridite finish.

7. Grounding: Provide continuous ground from cable tray to building ground in accordance with Grounding section of specifications. The cable tray system shall be capable of being used as equipment grounding conductor in accordance with the National Electric Code (NEC) Article 318-7(b). Cable tray sections and fittings shall be marked to show the minimum cross sectional area in accordance with the National Electric Code (NEC) Article 318-7. Bonding jumpers shall be constructed of laminated aluminum or insulated copper wire with a minimum of 200 rated amperes or in accordance with NEC 250-95.

8. Accessories:
   a. Covers: Tray covers shall be provided as indicated on drawings. Covers for fittings shall be available in same configuration as covers for straight tray. Covers for tray shall be supplied of the same material as straight tray and fittings or as indicated on drawings. Manufacturers standard tray covers shall include flat covers with side flanges. Provide standard manufacturer's hardware as required to hold covers to cable tray sections. "Clip Type" clamps may be used on indoor, horizontal cable trays. Heavy duty "Strap Type" clamps shall be used on all vertical cable tray sections.
   b. Blind End Plates: Blind end plates shall be provided as indicated on drawings. Blind end plates shall be supplied of the same material as straight tray and fittings.
   c. Cable Dropouts: Cable dropouts shall be provided as indicated on drawings. Cable dropouts shall be supplied of the same material as straight tray and fittings.
   d. Wall Penetration Sleeves: Provide wall penetration sleeves for all wall penetrations where indicated on drawings. Wall penetration sleeves shall be fabricated from steel, hot dipped galvanized after fabrication material per ASTM A-123. The penetration sleeve shall be designed for a single run of cable tray in standard overall tray widths and overall tray depths. In fire rated locations, install Nelson PLW firestop pillows in sufficient quantities to meet maximum 2 hour wall fire rating.
   e. Conduit and Pipe Clamps: Provide standard manufacturer designed conduit and pipe clamps and/or brackets as required by code to clamp conduit and pipe.

C. SUPPORT COMPONENTS

1. Product: Support Components must be provided from the same manufacturer as Cable Tray.

2. Hanger Channels:
   a. Configuration: Regular channel type.
b. Material: Plain steel, ASTM A 570, Grade 33.

c. Finish: G90 galvanized.

3. Accessories: Brackets, anti-sway devices, seismic bracing, attachments, and others to suit project conditions. Each item plated or coated same as cable tray.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS

A. Coordinate all work for final mounting locations of all equipment.

B. Provide and install all cable runways as defined in the Telecommunications Drawings and Specifications.

C. Provide and install all equipment racks as indicated on the Telecommunication Drawings.

D. Provide and install all vertical and horizontal wire managers as indicated on the Telecommunication Drawings.

E. Provide and install all grounding as identified within Telecommunications Drawings and Specifications.

F. Provide and install dedicated #6 AWG grounding conductors from each rack to the TGB/TMGB in each Telecommunications Room. “Daisy Chaining” of conductors between equipment racks is not acceptable.

3.2 CABLE MANAGEMENT

A. Provide and install 6” single-sided vertical wire management panels to each 19” x 7’ equipment rack installed.

B. Within the stand alone equipment racks, provide and install horizontal wire management panels for each rack as indicated on the Telecommunication Drawings.

3.3 CABLE RUNWAY (LADDER RACKING)

A. Provide and install all ladder racking as defined within the Telecommunications Drawings.

B. Provide and install runway elevation kits.

C. Provide and install runway radius drops at each vertical wire manager location.

D. Provide and install #6 AWG grounding conductor from ladder racking system to TGB/TMGB.

E. Provide #6 AWG bonding conductors between all ladder racking junction points.
F. Provide and install protective end caps.

G. Provide and install all required mounting/supporting hardware required.

3.4 VELCRO TIE WRAPS

A. Provide and install Velcro tie wraps to manage and secure all installed cables.

B. Where placed on ladder racking, all cables shall be neatly bundled and routed to designated location.

C. Installation of plastic ties is not acceptable.

3.5 CABLE TRAY

A. Install cable tray in accordance with NEMA VE 2, manufacturer's instructions, and DSA requirements.

B. Support trays in accordance with NUSIG requirements for seismic stabilization and to meet Zone 4 and DSA seismic bracing standards.

C. Cable trays will not be placed within 5 inches of any overhead light fixture and within 12 inches of any electrical ballast. A minimum of 8 inches above the cable tray must be maintained at all times. All bends and T-joints in the cable trays must be fully accessible from above. Provide sufficient space encompassing cable runways to permit access for installing and maintaining cables.

D. Cable trays shall not extend more than 2 feet over a fixed ceiling area.

E. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 8 feet maximum.

F. Use expansion connectors where required; install per NEMA VE1 and VE2.

G. Provide firestopping to requirements to sustain ratings when passing cable tray through fire rated construction.

H. Cable tray shall start and end at each fire rated wall. Four-inch EMT conduit shall be installed through each fire rated wall penetration.

I. A U.L. listed firestop system shall be used on the outside and inside perimeters of the four-inch EMT conduit that makes up the fire rated wall penetration.

J. Ground and bond cable tray to requirements of Section 27 05 26 Telecommunications Grounding and Bonding.

K. Provide continuity between tray components.

L. Use antioxidant compound to prepare and coat aluminum contact surfaces before assembly.
M. Provide equipment-grounding conductor through entire length of tray; bond to each component.

N. Connections to tray may be made using mechanical or exothermic connectors.

O. Install warning signs at 24-foot centers along cable tray; locate in location that is visible after surrounding components are installed or placed.

END OF SECTION 27 11 00
SECTION 27 13 13

COMMUNICATIONS COPPER BACKBONE CABLELING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work as called for in the Contract Documents

1.2 SCOPE

A. This section includes the copper cable installation and splicing requirements for inter-building backbone cabling. Also included in this section will be the installation of cable racking hardware and racking of cable in designated manholes and pullboxes.

1. Communications contractor shall coordinate specific pair counts to be transferred from existing 600-pair cable to new 50-pair cable.

2. Communications contractor shall install new 50-pair OSP rated cable in existing conduit, alongside existing 600-pair.

3. Communications contractor shall provide and install all work required in MH 11 and HH 27. Work includes splice cases, splice case end pieces, splice modules, bonding, grounding, labeling and duct seal.

4. Campus IT shall rearrange telephone circuit cross-connects to re-assign existing telephone circuits into sequential 50-pair count within existing 600-pair cable.

5. Communications contractor splicing and cable pair transfer work shall take place in MH 11 and HH 27.

6. Communications contractor shall demo existing 600-pair cable between MH 11 and HH 28 to make room for new tube cell ducts for air blown fiber. This work shall take place after normal business hours.

7. Communications contractor shall confirm with campus IT, that all telephone circuits are working prior to closing up splice cases.

B. This section includes minimum requirements for the following:

1. Inter-building Backbone Cabling (Outside Plant)
   a) Twisted multi-pair OSP-rated (type PE-39/CM) copper cable (voice).
   b) Splice case
   c) Splice modules
1.2 SUBMITTALS
   A. Provide submittals for materials required by this section.
   B. Submittals shall consist of catalogue cut sheets and/or engineering specification sheets provided by the manufacturer.
   C. Contractor shall submit for approval all proposed materials and equipment prior to installation.

1.2 RELATED DOCUMENTS
   A. Section 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
   B. SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS.
   B. SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS.
   C. SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING.

1.3 SECTION INCLUDES
   A. Copper UTP Backbone Cables

PART 2 – PRODUCTS

2.1 COPPER BACKBONE CABLE
   A. Application: Use for voice backbone connectivity between the MDF and each IDF.
   B. Materials – 24-gauge, twisted pair, solid conductor, black polyethylene sheath, shielded of corrugated aluminum. Pair counts as indicated on the drawings.
   C. Shall be 300-pair
   D. Manufacturer – General Cable, Superior Essex (SEALPIC-F, Type REA PE39) or equal.

2.2 MISCELLANEOUS COPPER BACKBONE TERMINATION CONSUMABLES
   A. Provide all miscellaneous consumables necessary to support, and terminate copper backbone cable.

2.3 OSP COPPER SPLICE CASE AND SPLICE MODULES
A. Materials – OSP rated multiple entries, straight in-line type with 900 pair capacity. Complete with appropriately sized and fitted endplates, 710-type connecting modules and grounding hardware. Installed in manhole and handhole locations.

B. Manufacturer – Superior Modular Products (Preformed Line Products)

2.4 MANHOLE RACKING HARDWARE

A. Materials – Hot dipped galvanized steel cable racks equipped with 24 support holes. Installed in designated manhole locations.

B. Manufacturer – Inwesco Incorporated (P/N 10A12)

C. Materials – Hot dipped, galvanized steel cable rack hooks. To be installed in designated manhole locations.

D. Manufacturer – Inwesco Incorporated (P/N 10A36 or 10A37)

PART 3 – EXECUTION

3.1 OSP-RATED CABLELING

A. Backbone cabling shall be rated to meet building combustible and non-combustible requirements as well as local building codes.

3.2 BACKBONE CABLE INSTALLATION

A. Backbone cables shall be installed in existing conduits.

B. A nylon pull cord, 0.125 inch (3.175 mm) minimum shall be co-installed with all cable installed in any conduit.

C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.

D. All backbone cables shall be securely fastened to the sidewall and near room corners.

E. Vertical runs of cable shall be supported with D-rings, J Hooks, cable tray, or other method to provide proper support for the weight of the cable.

F. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to provide proper support for the weight of the cables.

G. Contractor shall install mounting/racking hardware within vaults and hand holes as required. All cable shall be neatly dressed and secured in Maintenance and Hand holes.

3.3 BACKBONE CABLE SPLICING
A. Communications contractor shall coordinate specific pair counts to be transferred from existing 600-pair cable to new 50-pair cable.

B. Communications contractor shall install new 50-pair OSP rated cable in existing conduit, alongside existing 600-pair.

C. Communications contractor shall provide and install all work required in MH 11 and HH 27. Work includes splice cases, splice case end pieces, splice modules, bonding, grounding, labeling and duct seal.

D. Campus IT shall rearrange telephone circuit cross-connects to re-assign existing telephone circuits into sequential 50-pair count within existing 600-pair cable.

E. Communications contractor splicing and cable pair transfer work shall take place in MH 11 and HH 27.

F. Communications contractor shall demo existing 600-pair cable between MH 11 and HH 28 to make room for new tube cell ducts for air blown fiber. This work shall take place after normal business hours.

G. Communications contractor shall confirm with campus IT, that all telephone circuits are working prior to closing up splice cases.

END OF SECTION 27 13 13
SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The work under this section includes all design, material, equipment, supplies, labor, testing, and accessories required to furnish and install a complete and factory warranted campus wide air blown fiber optic data backbone system as specified herein.

B. The campus wide fiber optic data backbone system shall be defined as:

1. all cables,
2. equipment,
3. products, etc, as mentioned in these specifications and to include requirements of related documents.
4. Please note, for this project, that the campus wide fiber optic data backbone system includes underground conduit duct bank installations and communications vault replacements.

C. All miscellaneous system components including, but not limited to, cables, termination equipment, patch panels, ladder racks, equipment racks, support, seismic bracing as required and any other related items shall be furnished and installed.

D. Schedule is paramount to the project’s success. With this, the authorized/licensed FutureFLEX contractor will have to continually work with the team to facilitate expeditious design, procurement, and construction processes.

E. Provide all necessary labor, material, and equipment, including but not limited to the following requirements of this section.

F. Fiber Upgrade Project will be completed in three phases as detailed below:

1. Phase 1 – Installation of new factory warranted campus wide air blown fiber optic data backbone system by a manufacturer authorized/licensed contractor.
2. Phase 2 – S.O.C.C.C.D. migration of network to new factory warranted campus wide air blown fiber optic data backbone system.
3. Phase 3 - The manufacturer authorized/licensed contractor shall remove and dispose of all existing fiber optic data backbone systems.
Removal scope of work shall include cleanup of all communications pull-boxes, vaults and handholes. Removal scope of work shall included installation of OSP rated duct plugs and conduit seals.

1.2 RELATED DOCUMENTS

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

B. SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. SECTION 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

D. SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

E. SECTION 27 13 13 - COMMUNICATION COPPER BACKBONE CABLING

1.3 SUMMARY

A. For performance criteria, Sumitomo Electric Lightwave (SEL) FutureFLEX air blow fiber is stated in this specifications section Appendix 1

B. The manufacturer authorized/licensed air blown fiber installation 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 riser backbone cable and terminations.

(2) Fiber optic 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 and Outdoor Enclosures

(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, system O&M documents, and product documentation.
(11) Extended warranty and manufacturer’s certification of systems, products, and labor.

C. 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.

1.4 REFERENCES

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

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

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

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

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


M. National Electrical Manufacturers Association (NEMA).

N. National Fire Protection association (NFPA) 72, National Electrical Code (NEC).
P. Each agency’s relative codes, standards, and recommended practices apply to the voice / data cabling systems and their components as specified herein:

1. Building Industry Consulting Service International (BICSI)

1.5 PERMITS, FEES, AND CERTIFICATES OF APPROVAL

A. The contractor 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

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. 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 (62.5/125µm multimode and single mode) optical fiber cable installed from the main distribution frame (MDF) to building distribution frame (BDF), to the intermediate distribution frame (IDF).

C. Provide cable runway (as indicated by construction documents).

D. Provide communications grounding system (as indicated by construction documents).

E. Reflect as separate bid alternate costs for 62.5/125µm multimode.

1.7 SUBMITTALS

A. General:

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

(2) Submit additional copies to Owner (South Orange County Community College District) and Owner representatives.
B. Shop Drawings:
   (1) Show PEF jacketed, bundled optical fiber cable numbering and labeling.
   (2) Provide a schedule of materials list with quantities and manufactures indicated for all materials installed in the project.
   (3) Provide Tube cable system block diagram including interconnection and numbering of all tube cabling.
   (4) Provide fabrication drawings for any proposed custom-built equipment.
   (5) Submit for initial review 3 weeks after notice to proceed and for final review at substantial Completion.

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 work.
      c. Start and duration of tube cable installation, connection, and routing.
      d. Start and duration of air-blown fiber optics installation and termination.
      e. Punch List.
      f. Final Punch List.

E. Cable Test Results:
   (1) Tube Cable Tests
      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
R2A Architecture
Costa Mesa, CA
09/28/2015

Communications Optical Fiber Backbone Cabling

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 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.

F. Project Record Drawings

(1) Submit project record documents at Contract Closeout.

(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 with the bid that states the Contractor is authorized and certified by the manufacturer to provide the 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 manufacturer representatives. Bids from non-compliant firms will be rejected.

C. Complete all above Quality Assurance requirements.

1.9 WARRANTY REQUIREMENTS

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

B. Submit, at "notice to proceed", the most current copy of the Manufacturer certificate of registration and the warranty terms and conditions that apply to the Manufacturer 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.

D. Twenty-Five (25) Year Premium Warranty

E. SEL warrants the FutureFLEX products to be free of defects in material and workmanship for a period of twenty-five (25) years from the date of shipment.

F. This warranty shall be available for installations utilizing FutureFLEX tube
cables, fiber bundles, fiber termination equipment and which have been accepted by SEL into the Extended Warranty Program.

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

1. Complete the Warranty registration Form on the FutureFLEX website and submit to SEL.

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

3. Sample Test Data Sheets are available on the SEL FutureFLEX website.

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

5. Electronic copies of all end to end fiber test results, using an optical power meter or OTDR with fiber spans identified per As-Built Drawing.

6. Power Meter - measurements at the highest wavelength.

7. OTDR - Bi-Directional measurements at the highest wavelength. Viewing software for OTDR results required.

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

9. Copies of as built drawings must be submitted to SEL via electronic or hard copy to SEL (Drawings must be in AutoCAD 2013).

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

H. For the Premium Warranty program, SEL will evaluate the data supplied by the Licensed FutureFLEX Installer (LFI). SEL engineers will review the data and make a determination as to whether the installation will be accepted and an extended warranty granted.

I. If the application is accepted SEL will issue a warranty certificate to the LFI in the name of the end-user. The LFI must sign the certificate and send it to the End User.

J. If the application is rejected, a letter explaining the reason for the rejection will be issued to the LFI who applied for the extended warranty.

1.10 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Do not store equipment where conditions fall outside manufacturer’s recommendations for environmental conditions.

C. Follow manufacturer's recommended procedures for storage of materials & equipment.

D. 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.

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.

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 required in individual specifications sections.

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

C. See APPENDIX 1 FutureFLEX® ABF® Product List for specific product part numbers and description.

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.

   (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.

(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. 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.

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

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

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. 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 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.

2.6 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. 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.
   (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 and single mode) fiber utilizing tight buffer construction.

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

C. Connectors - SM/MM

(1) The connector type shall be LC.

(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:

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Maximum Attenuation Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Retention</td>
<td>FOTP-6</td>
<td>0.2 dB</td>
</tr>
<tr>
<td>Durability</td>
<td>FOTP-21</td>
<td>0.2 dB</td>
</tr>
<tr>
<td>Impact</td>
<td>FOTP-2</td>
<td>0.2 dB</td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>FOTP-3</td>
<td>0.2 dB</td>
</tr>
<tr>
<td>Humidity</td>
<td>FOTP-5</td>
<td>0.2 dB</td>
</tr>
</tbody>
</table>

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.

(4) 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 shall not be used.

(5) 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.

(6) 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.

(7) 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.

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

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

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

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

(12) 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 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.

B. Bundled Fiber Optic Testing

(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 end to end 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’s 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, end to end, 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.


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

(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.

### 3.7 GENERAL INSTALLATION DESCRIPTION

**A.** The structured cabling system shall consist of any or all of the following subsystems:

1. Administration Subsystem
2. Backbone Subsystem
3. Support Subsystem

**B.** Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labels, diagrams, drawings, manuals, and
tools necessary to manage the Structured Cabling System after installation. The Administration Subsystem includes:

1. Labels
2. As-built drawings
3. Operations manuals
4. Record drawings
5. Test results
6. Warranty documents

C. Backbone Subsystem: The main cable route within a building is called the Backbone Subsystem. It links the main cross connect (MDF) in the equipment room to intermediate cross connects (IC) in the BDFs and/or IDFs. It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology with first-level backbone cables beginning at the main cross connect. If needed, a second-level backbone cables begin at intermediate cross connects.

D. A Backbone Subsystem in a single building will consist of a single MDF connected to one or more IDFs on a single floor or on multiple floors. The backbone will also connect the MDF to a Main Point of Entry (MPOE) which houses the incoming telecommunications services for the building.

E. A Backbone Subsystem in a multi-building campus will consist of a single MDF connected to more than one BDF (one per building). Each BDF will be connected to the IDFs of each respective building. The MDF will also connect to the campus MPOE. Additional MPOEs may connect to the campus backbone through the BDFs.

F. The Backbone Subsystem includes:

1. OSP/Riser/Plenum rated fiber optic cable
2. Patch panels
3. Wall and rack mounted termination fields
4. Patch cables
5. Cross-connect wire

G. Support Subsystem: The Support Subsystem consists of hardware and equipment required to facilitate and sustain the Structured Cabling System. The Support Subsystem includes the cabling pathways, cabinets, and racks that hold the structured cabling in place. The Support Subsystem includes:

1. Cable tray
2. Ladder Rack
3. Fire Stop systems
4. Conduit
5. Data Equipment Racks
6. Cabinets
7. Vertical and Horizontal Wire Managers
8. Backboards

3.8 INSTALLATION REQUIREMENTS

A. All materials shall be new. No used or re-manufactured parts or components shall be accepted.

B. All communications cabling used throughout this project shall comply with the requirements as outlined in the NEC Articles 725, 760, 770, and 800 and the appropriate local codes. All fiber optic cabling shall bear OFNP (Plenum Rated) and/or OFNR (Riser Rated). The contractor is responsible for installing appropriately rated cable for the environment in which it is installed.

C. Cable Storage: Do not roll or store cable reels without an appropriate underlay and the prior written approval of District's Project Manager.

D. All installation shall be done in conformance with ANSI/TIA/EIA 568-C standards and manufacturers installation guidelines. Ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

E. The system must meet all local and other prevailing codes.

F. All cabling installations shall be performed by qualified technicians. The labor employed shall be regularly employed in the installation and repair of communication systems and shall be acceptable to the District’s Project Manager to engage in the installation and service of this system.

G. Special Equipment and Tools: In order to ensure the least amount of cable untwisting, it is required that all cables shall be stripped using a cable manufacturer’s recognized special tool. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the System. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable winches.

H. The cable’s minimum bend radius and maximum pulling tension shall not be exceeded.

I. No cable is to be pulled through a conduit “L-bend” (condulets).

J. Conduit runs shall not exceed 100 feet or contain more than two 90 degree bends without utilizing appropriately sized pull boxes. Pull boxes are not to be used in lieu of a bend.

K. Reinstate all pull-wires in conduits and ducts after use to facilitate future addition of cables.

L. Cable raceways and conduits shall not be filled greater than the TIA/EIA recommended fill for the particular raceway or conduit size.

M. The use of lubricants (i.e. Yellow 77, Polywater) to facilitate the installation of cables in conduits is highly discouraged, however, if such a lubricant must be used, a lubricant specifically designed for the environment and type of cable being installed shall be used. (E.G. the use of outside plant, low temperature...
cable lubricants shall not be acceptable in an indoor plenum environment.) Under no circumstances shall cable pulling lubricant be allowed to accumulate on walls, floors, backboards, or other surfaces outside the conduit.

N. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced before final acceptance at no cost to the District.

O. Power Separation: No distribution cabling shall be placed alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. At no point shall the communications cables be tied to power cables or other building services. Station cables and tie cables installed within ceiling spaces shall be routed through these spaces at right angles to electrical power circuits.

P. Avoid electromagnetic interference (EMI) by maintaining adequate physical separation between telecommunications cabling and possible sources such as, but not limited to, electric motors, electric pencil sharpeners, transformers, fluorescent lights that share distribution space with telecommunications cabling, copiers that share work area space with line cords and terminals, large fax machines and power cords that supports such equipment.

Q. All cable or innerduct shall run parallel or at right angles to building wall structures.

R. Within walls, all cabling shall be installed within conduit to an elevation of + 6" above the accessible ceiling space.

S. Cable tray shall be provided as designated by drawings in the telecommunications room. The cable tray shall be basket type and sized per code to accommodate all cabling to be installed plus spare.

T. In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, cable bundles shall be supported via "J" hooks attached to the building structure and framework at a maximum of five (5) foot intervals. Minimum 1" wide J-hooks shall be appropriately sized to allow a minimum of 50% spare capacity for future cable installation. The Contractor shall include all costs in base bid for any additional supports/seismic bracing required by the Local Authority having Jurisdiction.

U. Cables shall be bundled, in groups of 18 or less, station or other cabling with half inch hook and loop (Velcro®) strips tight enough to hold the bundle together in a cylindrical shape, but not so tight as to deform the cable geometry. It shall be possible to completely rotate all cable ties around all cable bundles. Plenum rated hook and loop ties will be used in all plenum areas.

V. Cables or J hooks shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.

W. Cables or J hooks shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.

X. Conduit(s) and sleeve(s) shall be of suitable material, sized, installed, fire-stopped, and grounded as required by the NEC, ANSI/TIA/EIA standards and all other applicable codes and standards. Any conduit(s) and sleeve(s) added shall be approved by the District’s Project Manager prior to rough-in.
Y. Removal of the ceiling grid must be coordinated with the District's Project Manager. All insulation shall be replaced in its original location.

Z. Cabling and Termination Identifications: A numbering and marking scheme must be used to identify all cable and cabling terminations. All cables, regardless of length, shall be marked and/or numbered at both ends. Marking codes and methodologies shall correspond to the instructions in this specification.

AA. Ensure that all waste materials are disposed of in a safe manner. Pay particular attention to waste materials produced during the termination of optical fiber cabling. Ensure that all used components and fiber cut-offs are collected in purpose-made containers and disposed of properly.

BB. Ladder tray mounting brackets shall be screwed to studs or to the properly mounted plywood wall field, not to drywall.

CC. Seismic Requirements: All equipment racks, equipment cabinet enclosures, cable runways, etc. shall be installed according to the local, state and/or federal seismic code.

DD. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc.

EE. Conduits: All backbone cabling will run through dedicated conduits. All new conduits will be supplied with a pull string. Existing conduits shall be proven to be clear prior to pulling of cables. Supply pull string and pull rope for the installation of all cables in existing conduits. For all conduits left with available capacity, replace pull strings with ¼-inch pull rope during the course of his work. The installing contractor must seal all conduits with an approved sealing compound.

FF. Use purpose-built pulling grips during cable installation. Do not pull cables by attaching pull wires to cable jackets, elements or reinforcement. The cable pulling tension shall be applied smoothly without jerks. Use strain gauges or equivalent measures to ensure that the maximum manufacturer recommended tensile load rating of the cables is not exceeded during installation.

GG. The number of cables in each conduit shall be controlled to allow for future cable installation and to stay within the manufacturer's maximum allowable cable pulling tension. Conduit fill ratios shall not exceed the current requirements of the NEC.

HH. Provide expansion plugs in all ducts/conduits entering the building. Seal all unused ducts/conduits with plugs that allow the pull-string to be tied off on the inside.

II. All cabling shall be splice free unless otherwise noted on drawings.

JJ. All grounds shall consist of #6 AWG copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground. All cable sheaths and splice cases shall be grounded to a Telecommunications Ground Bus. Grounding must be in accordance with the NEC, NFPA, ANSI/TIA-607-B-2011 and all local codes and practices. Bond all metallic sheath communications
cables entering the building per manufacturer specifications and NEC 770-33, 800-33 and 800-40.

KK. Each equipment cabinet and rack requires its own dedicated grounding connection to the grounding infrastructure. Grounding infrastructure can consist of either an “aisle ground” conductor placed at the ladder tray above each rack/cabinet, or by providing every rack/cabinet with its own dedicated #6 AWG (min.) green conductor back to the TMGB/TGB. All ground conductor attachments to the TMGB/TGB shall utilize 2-hole compression lugs.

LL. Rack mounted equipment shall be grounded via the chassis, in accordance with manufacturer’s instructions. The equipment chassis shall be bonded to the rack/cabinet using one of the following methods:

1. If the equipment has a separate grounding hole or stud, use a #6AWG ground wire from the chassis ground hole/stud to the rack grounding bus.
2. If the manufacturer suggests grounding via the chassis mounting flanges, use tri-lobular thread-forming screws (not self-tapping or sheet metal screws) to attach the equipment to the rack/cabinet rails. If the equipment mounting flanges are painted, remove the paint and apply an anti-oxidant, or use tri-lobular thread-forming screws and two (2) “Type B” internal-external tooth lock washers to safely ground equipment to the rack.

MM. Bonding of ladder tray sections- Attach bonding straps to each ladder tray section by utilizing either two (2) tri-lobular thread-forming screws (not self-tapping or sheet metal screws) or by using two (2) standard bolts with two (2) “Type B” internal-external tooth lock washers per bolt. If thread-forming screws are not used, remove paint at each connection point and use an approved anti-oxidant prior to attaching the bonding strap.

3.9 PENETRATIONS OF WALLS FLOORS AND CEILINGS

A. Any penetrations through acoustical walls or other walls for cable pathways / cables shall be sealed in compliance with applicable code requirements and as directed by District’s Project Manager.

B. Replace all moisture and fire barrier material in ducts, conduits and other penetrations disturbed during installation of communications cabling.

C. Any penetrations through fire-rated walls for cable pathways / cables shall be sealed by use of a non-permanent fire blanket or other method in compliance with the current edition of NFPA and the NEC or other prevailing code and must be an approved UL Listed system. Do not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. This requirement also applies to maintaining fire ratings of all floors penetrated by conduits or devices designated for use by voice and data cabling.

D. Sealing material and application shall be an approved UL Listed system and shall be accomplished in such a manner that is acceptable to the local fire and building
authors having jurisdiction over this work. Any openings left unused shall also be sealed as part of this work.

1. Firestopping work shall be performed by a single contractor to maintain consistency and accountability on the project.

2. Firestop installer shall be certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements.

3. All installed through penetration firestops shall be identified via label, or stencil. Label shall state that the fill material around the penetrating item is a firestop, and that it shall not be disturbed unless by an authorized contractor. The label shall include the firestop brand name, and the classified system number for which it was installed.

### 3.10 LABELING REQUIREMENTS

A. Labeling: Provide printed labels for all cables and cords, distribution frames, and outlet locations, according to the specifications. No labels are to be written by hand.

B. Riser Cable Labeling. All riser cables will be labeled to reflect the origin and destination abbreviation for the cable and pair counts on large font (16 pitch) self-laminating labels, which shall be located within 18 inches of each end of the cable. Labels shall be placed on the cable to be visible without relocating surrounding cables.

Example #1: BDF1/IDF31/SM1/01-06

<table>
<thead>
<tr>
<th>BDF1</th>
<th>Cable Origination</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF31</td>
<td>Cable Destination</td>
</tr>
<tr>
<td>SM1</td>
<td>Cable Type &amp; Pair or Strand Count (ex. SM1 for single-mode fiber). Other possibilities include HB for hybrid fiber cable, MM for multimode cable, and SM for singlemode cable.)</td>
</tr>
<tr>
<td>01-06</td>
<td>Cable pair or strand identification number (ex. cable 01-01, indicates a 6-strand fiber cable)</td>
</tr>
</tbody>
</table>

C. Patch Panel Labels, Horizontal. All patch panels will be labeled using self-laminating laser patch panel label markers.

Example: 001A

<table>
<thead>
<tr>
<th>001</th>
<th>Station Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cable Identification (“A” for data cable #1, “B” for data cable #2)</td>
</tr>
</tbody>
</table>
1. Data cable #1 shall be terminated adjacent to data cable #2 moving left to right and top to bottom.

D. Fiber Patch Panel Labels. All fiber patch panels will be labeled using self-laminating laser patch panel label markers. The scheme shall indicate: destination of connected cables on the patch panel followed by a slash (/), origination of connected cables on the patch panel followed by a slash (/), and the port number adjacent to the port.

Example: BDF/IDF2/01

BDF  Destination Patch Panel Location Designation
IDF22  Origination Patch Panel Location Designation
01  Indicates port number on both origin and destination patch panels.

E. Equipment Rack Labeling: All equipment racks shall be labeled according to their room identifier and a two-digit number. The labels will be engraved plastic plates, with 1"-high white letters on black background. The labels will be attached to the crossmember at the top front of each frame or rack with appropriately-sized sheet metal screws. Self-adhesive strips, glues, etc. are unacceptable.

Example: BDF1-01

BDF  Room Designation
01  Rack Identifier

F. MDF/BDF/IDF Floor Plan Mounting Frame: Provide wall mountable floor plan mounting frame with removable Plexiglas front cover in each MDF/BDF/IDF. Frame and cover shall be sized to house 30"x42" floor plan drawing. Coordinate location of frame with District’s Project Manager prior to installation.

3.11 TESTING/WARRANTY

A. The testing is to show that there are no errors, damaged or incorrectly installed components, that the installation is correctly labeled and that all the installed components meet or exceed the criteria detailed in these specifications. Any test that does not show that a component is satisfactorily installed, as per these specifications, shall be repeated. If a test procedure needs to be modified to satisfactorily test some components, the modification shall be submitted for approval of the District’s Project Manager prior to the tests being conducted.

B. All cables, patch panels and associated components shall be fully assembled and labeled prior to testing. Any testing performed on incomplete systems shall
be redone on completion of the work.

C. Provide the Districts’ Project Manager with the opportunity to witness all testing. On reasonable request, the installer shall demonstrate that the test procedure competently identifies the fault conditions being tested for.

D. Complete all of the tests identified in these specifications.

E. Ensure that all test equipment is in calibration before delivery to site and throughout the testing period. The Installer shall be responsible for ensuring that any necessary tests and rework to maintain equipment's calibration status is carried out. Any tests performed on uncalibrated test equipment shall be repeated at the Installer's cost.

F. The test documentation shall be available for inspection by the Districts' Project Manager during the installation period and copies shall be submitted to the Districts' Project Manager within fourteen days of completion of tests on cables in each area. The Installer shall retain a copy to aid preparation of Record Documents information. See Records Documents details under submittals section.

G. If on submittal of the Record documentation there are any missing test results or incorrectly named files, the test shall be repeated at the Installer's expense.

H. Provide competent, factory-trained engineers and/or technicians, authorized by the manufacturer of the cabling system, to technically supervise and participate during all tests for the systems. Personnel shall be competent in and qualified by experience or training for comprehensive TDR and OTDR operation and troubleshooting, for optical fiber testing.

I. All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified usable by the installing contractor before system acceptance. Any defect in the cable system installation including but not limited to cable, connectors, feed-through couplers, patch panels, splices, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

J. Each installed cable shall be tested for installed length using a Time Domain Reflectometer (TDR) device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number.

K. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be collocated in the binder. Correction of all damaged cables shall include replacing damaged cables with new cables in complete runs, replacing damaged connectors or remaking poor terminations. In-line cable joints, splices or distribution points will not be acceptable except where specified in this document. All damaged cables shall be removed from site.

L. Manufacturer Warranty: Provide a Manufacturer (25) Year Premium Warranty.
M. **Optical Fiber Cable Testing:** All fiber testing shall be performed on all fibers in the completed end to end system including any and all fusion splices.

1. Testing shall consist of a bi-directional end to end power meter test performed per TIA-526-7. The system loss measurements shall be provided at 1310 and 1550 for single mode fibers.

2. Loss Budget: Fiber links shall have a maximum loss of: (allowable cable loss per km)*(km of fiber in link) + (.4dB)*(number of connectors) = maximum allowable loss.

3. For all end to end fiber runs greater than 300 ft. in length, and any run less than 300 ft. in length that does not meet the minimum loss requirement, testing shall also include a bi-directional end to end OTDR trace.

4. Graphical printouts shall be taken of OTDR trace tests for each element. These printouts shall be stapled or otherwise attached to 11" x 8.5" size sheets. They shall be printed at an appropriate scale, such as 0.5 dB per division for the attenuation axis. Provide electronic copies of the OTDR traces to the District on completion of the testing. Provide a copy of the emulation software and the appropriate license to the client.

5. Pre-installation cable testing: It is recommended that all fiber cable be tested prior to the installation.

6. Any link not meeting the requirements of the standard shall be brought into compliance at no additional charge to District.

END OF SECTION 27 13 23
APPENDIX 1
FutureFLEX® ABF® Product List

INDOOR TUBE CABLES

SEL PART NUMBER DESCRIPTION

<table>
<thead>
<tr>
<th>“TC01TBX”</th>
<th>Sumitomo Part Number (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“TC”</td>
<td>Tube Cable</td>
</tr>
<tr>
<td>“01, 02, etc.”</td>
<td>Number of Individual Tubes</td>
</tr>
<tr>
<td>TBX”</td>
<td>Tube Cable Description</td>
</tr>
</tbody>
</table>

NON-RATED INDOOR TUBE CABLES

INDOOR NON-RATED TUBE CABLE DESCRIPTIONS & APPLICATIONS

<table>
<thead>
<tr>
<th>TBX</th>
<th>TXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black tube</td>
<td>Semi-transparent tube</td>
</tr>
<tr>
<td>No fire rating</td>
<td>No fire rating</td>
</tr>
<tr>
<td>For general tube drops</td>
<td>For general tube drops or</td>
</tr>
<tr>
<td></td>
<td>interconnections</td>
</tr>
</tbody>
</table>

INDOOR NON-RATED TUBE CABLE TYPES & SIZES AVAILABLE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SINGLE-TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Tube</td>
<td>TC01TBX</td>
</tr>
<tr>
<td>Semi-Transparent Tube</td>
<td>TC01TXX</td>
</tr>
</tbody>
</table>

INDOOR NON-RATED TUBE CABLE SPECIFICATIONS

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Temperature Range</td>
<td>-40° to +158°F (TBX &amp; TXX only)</td>
</tr>
<tr>
<td>Minimum Bend Radius (During and After Installation) for Single Tubes:</td>
<td>7” (Radius) when installing 2mm OD Fiber Bundles</td>
</tr>
<tr>
<td></td>
<td>9” (Radius) when installing 3mm OD Fiber Bundles</td>
</tr>
</tbody>
</table>
**FIRE-RATED INDOOR TUBE CABLES**

**INDOOR RATED TUBE CABLE DESCRIPTIONS & APPLICATIONS**

<table>
<thead>
<tr>
<th>TGX</th>
<th>TRX</th>
<th>TPX</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFN</td>
<td>OFNR</td>
<td>OFNP</td>
</tr>
<tr>
<td>General Purpose Fire Rated</td>
<td>Riser-Rated</td>
<td>Plenum-Rated</td>
</tr>
<tr>
<td>Individual black tubes</td>
<td>Inner fire retardant jacket and</td>
<td>Individual black tubes</td>
</tr>
<tr>
<td>No outer jacket</td>
<td></td>
<td>No outer jacket</td>
</tr>
<tr>
<td>Multiple tubes wrapped with Kevlar string binder</td>
<td>Orange-colored fire blocking outer jacket</td>
<td>Multiple tubes wrapped with Kevlar string binder</td>
</tr>
</tbody>
</table>

**INDOOR RATED TUBE CABLE TYPES & SIZES AVAILABLE**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>1-TUBE</th>
<th>2-TUBE</th>
<th>3-TUBE</th>
<th>7-TUBE</th>
<th>19-TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFN</td>
<td>TC01TGX</td>
<td>TC02TGX</td>
<td>---</td>
<td>TC07TGX</td>
<td>TC19TGX</td>
</tr>
<tr>
<td>OFNR</td>
<td>---</td>
<td>TC02TRX</td>
<td>TC03TRX</td>
<td>TC07TRX</td>
<td>TC19TRX</td>
</tr>
<tr>
<td>OFNP</td>
<td>TC01TPX</td>
<td>TC02TPX</td>
<td>TC03TPX</td>
<td>TC07TPX</td>
<td>TC19TPX</td>
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**INDOOR RATED TUBE CABLE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFN General Purpose Fire Rated</td>
<td>UL 1581</td>
</tr>
<tr>
<td>OFNR Riser-Rated</td>
<td>UL 1666</td>
</tr>
<tr>
<td>OFNP Plenum-Rated</td>
<td>UL 910</td>
</tr>
<tr>
<td>Operation Temperature Range</td>
<td>-20° to +158°F</td>
</tr>
<tr>
<td>Minimum Bend Radius for Multi-Tube Cables</td>
<td>20X cable diameter</td>
</tr>
<tr>
<td>Minimum Bend Radius for Multi-Tube Cables</td>
<td>10X cable diameter or</td>
</tr>
<tr>
<td>Minimum Bend Radius for Single Tubes (During and After Installation):</td>
<td>9” Radius whichever is greater</td>
</tr>
<tr>
<td></td>
<td>7” Radius when installing 2mm Fiber Bundles</td>
</tr>
</tbody>
</table>
### INDOOR TUBE CABLE PHYSICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Cable OD (in)</th>
<th>Max. Weight (lbs/kft)</th>
<th>Max. Tensile Load (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC01TBX</td>
<td>0.31</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>TC01TGX</td>
<td>0.31</td>
<td>17</td>
<td>60</td>
</tr>
<tr>
<td>TC01TPX</td>
<td>0.31</td>
<td>27</td>
<td>60</td>
</tr>
<tr>
<td>TC01TXX</td>
<td>0.31</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>TC02TGX</td>
<td>0.6</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>TC02TPX</td>
<td>0.6</td>
<td>53</td>
<td>120</td>
</tr>
<tr>
<td>TC02TRX</td>
<td>1.0</td>
<td>229</td>
<td>200</td>
</tr>
<tr>
<td>TC03TPX</td>
<td>0.6</td>
<td>80</td>
<td>180</td>
</tr>
<tr>
<td>TC03TRX</td>
<td>1.0</td>
<td>282</td>
<td>200</td>
</tr>
<tr>
<td>TC07TGX</td>
<td>1.0</td>
<td>119</td>
<td>150</td>
</tr>
<tr>
<td>TC07TPX</td>
<td>1.0</td>
<td>189</td>
<td>360</td>
</tr>
<tr>
<td>TC07TRX</td>
<td>1.3</td>
<td>437</td>
<td>400</td>
</tr>
<tr>
<td>TC19TGX</td>
<td>1.6</td>
<td>325</td>
<td>250</td>
</tr>
<tr>
<td>TC19TPX</td>
<td>1.6</td>
<td>513</td>
<td>400</td>
</tr>
<tr>
<td>TC19TRX</td>
<td>1.9</td>
<td>806</td>
<td>500</td>
</tr>
</tbody>
</table>

### INDOOR TUBE CABLE STANDARD REEL DATA

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Std Reel Length (ft)</th>
<th>Std Reel H x W (in)</th>
<th>Minimum Drum Diameter (in)</th>
<th>Std Reel Weight (lbs) Empty</th>
<th>Std Reel Weight (lbs) Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC01TBX</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>TC01TGX</td>
<td>100</td>
<td>25 x 13</td>
<td>20</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>TC01TPX</td>
<td>1000</td>
<td>41 x 6</td>
<td>36</td>
<td>33</td>
<td>60</td>
</tr>
<tr>
<td>TC01TXX</td>
<td>500</td>
<td>17 x 5</td>
<td>5</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>TC02TGX</td>
<td>100</td>
<td>36 x 34</td>
<td>18</td>
<td>66</td>
<td>136</td>
</tr>
<tr>
<td>TC02TPX</td>
<td>100</td>
<td>54 x 10</td>
<td>40</td>
<td>105</td>
<td>158</td>
</tr>
<tr>
<td>TC02TRX</td>
<td>100</td>
<td>54 x 20</td>
<td>40</td>
<td>116</td>
<td>345</td>
</tr>
<tr>
<td>TC03TPX</td>
<td>100</td>
<td>54 x 20</td>
<td>40</td>
<td>116</td>
<td>196</td>
</tr>
<tr>
<td>TC03TRX</td>
<td>100</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>419</td>
</tr>
<tr>
<td>TC07TGX</td>
<td>1000</td>
<td>54 x 20</td>
<td>40</td>
<td>116</td>
<td>235</td>
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<tr>
<td>TC07TPX</td>
<td>100</td>
<td>54 x 20</td>
<td>40</td>
<td>116</td>
<td>305</td>
</tr>
<tr>
<td>TC07TRX</td>
<td>100</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
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</tr>
<tr>
<td>TC19TGX</td>
<td>1000</td>
<td>64 x 40</td>
<td>46</td>
<td>248</td>
<td>573</td>
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<tr>
<td>TC19TPX</td>
<td>100</td>
<td>64 x 40</td>
<td>46</td>
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<tr>
<td>TC19TRX</td>
<td>100</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>1052</td>
</tr>
</tbody>
</table>

**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

---

Communications Optical Fiber Backbone Cabling
27 13 23 - 31
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

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Max Reel Length (ft)</th>
<th>Max Reel H x W (in)</th>
<th>Minimum Drum Diameter (in)</th>
<th>Max Reel Weight (lbs) Empty</th>
<th>Max Reel Weight (lbs) Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC01TBX</td>
<td>330</td>
<td>28 x 20</td>
<td>20</td>
<td>18</td>
<td>68</td>
</tr>
<tr>
<td>TC01TGX</td>
<td>3000</td>
<td>28 x 20</td>
<td>20</td>
<td>18</td>
<td>69</td>
</tr>
<tr>
<td>TC01TPX</td>
<td>300</td>
<td>54 x 10</td>
<td>40</td>
<td>105</td>
<td>186</td>
</tr>
<tr>
<td>TC01TXX</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>TC02TGX</td>
<td>3000</td>
<td>36 x 34</td>
<td>18</td>
<td>66</td>
<td>276</td>
</tr>
<tr>
<td>TC02TPX</td>
<td>300</td>
<td>54 x 36</td>
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<td>137</td>
<td>296</td>
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<tr>
<td>TC02TRX</td>
<td>300</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>933</td>
</tr>
<tr>
<td>TC03TPX</td>
<td>300</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>377</td>
</tr>
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<td>TC03TRX</td>
<td>300</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>1092</td>
</tr>
<tr>
<td>TC07TGX</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>603</td>
</tr>
<tr>
<td>TC07TPX</td>
<td>300</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>813</td>
</tr>
<tr>
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<td>300</td>
<td>72 x 40</td>
<td>46</td>
<td>309</td>
<td>1620</td>
</tr>
<tr>
<td>TC19TGX</td>
<td>3000</td>
<td>72 x 50</td>
<td>46</td>
<td>333</td>
<td>130</td>
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<td>TC19TPX</td>
<td>300</td>
<td>72 x 50</td>
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<td>TC19TRX</td>
<td>300</td>
<td>84 x 50</td>
<td>30</td>
<td>288</td>
<td>2706</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>SEL PART NUMBER DESCRIPTION</th>
<th>Sumitomo Part Number (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“TC02TOX”</td>
<td>Sumitomo Part Number (typical)</td>
</tr>
<tr>
<td>“TC”</td>
<td>Tube Cable</td>
</tr>
<tr>
<td>“01, 02, etc.”</td>
<td>Number of Individual Tubes</td>
</tr>
<tr>
<td>“TOX”</td>
<td>Tube Cable Description</td>
</tr>
</tbody>
</table>
# OUTDOOR “DIELECTRIC CORE” TUBE CABLE DESCRIPTIONS & APPLICATIONS

<table>
<thead>
<tr>
<th>TOX</th>
<th>TOD</th>
<th>MSOS</th>
<th>AOX</th>
<th>TAX *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry to damp environment</td>
<td>Dry to damp environments</td>
<td>Dry to damp environments</td>
<td>Dry to damp environments</td>
<td>Dry to damp environment</td>
</tr>
<tr>
<td>Duct, direct buried applications</td>
<td>Duct, direct buried applications</td>
<td>Aerial, duct, direct buried applications</td>
<td>Duct, direct buried applications</td>
<td>Duct, direct buried applications Extremely rugged, high crush resistance</td>
</tr>
<tr>
<td>Dielectric c or e Water-blocking tape</td>
<td>Dielectric c or e Water-blocking tape</td>
<td>Dielectric c or e Water-blocking tape</td>
<td>Dielectric c or e Water-blocking tape</td>
<td>Dielectric c or e Water-blocking tape</td>
</tr>
<tr>
<td>Polyethylene outer jacket</td>
<td>Polyethylene outer jacket</td>
<td>High-performance outer jacket for enhanced thermal stability</td>
<td>Polyethylene outer jacket</td>
<td>Polyethylene outer jacket</td>
</tr>
<tr>
<td>FRP (fiber reinforced plastic) central strength member</td>
<td>Ultra-high performance tubes with low friction liners</td>
<td>Corrugated steel tape armor for rodent protection</td>
<td>Extra heavy duty interlocked galvanized steel armor jacket</td>
<td></td>
</tr>
<tr>
<td>Grounding &amp; Bonding required</td>
<td>Grounding &amp; Bonding required</td>
<td></td>
<td>Grounding &amp; Bonding required</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.
# OUTDOOR “METALLIC CORE” TUBE CABLE DESCRIPTIONS & APPLICATIONS

<table>
<thead>
<tr>
<th>TLW</th>
<th>LWS</th>
<th>TLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooded environments</td>
<td>Flooded environments</td>
<td>Flooded environments</td>
</tr>
<tr>
<td>Duct, direct buried applications</td>
<td>Duct, direct buried applications</td>
<td>Duct, direct buried applications</td>
</tr>
<tr>
<td>Metallic core Water blocking tape</td>
<td>Metallic core Water blocking tape</td>
<td>Metallic core Water blocking tape</td>
</tr>
<tr>
<td>Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket</td>
<td>Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket</td>
<td>Laminated Aluminum Polyethylene (LAP) wrap Polyethylene outer jacket</td>
</tr>
<tr>
<td>Corrugated steel tape armor for rodent protection</td>
<td>Extra heavy duty interlocked galvanized steel armor jacket</td>
<td>Grounding &amp; Bonding recommended</td>
</tr>
<tr>
<td>Grounding &amp; Bonding recommended</td>
<td>Grounding &amp; Bonding recommended</td>
<td>Grounding &amp; Bonding recommended</td>
</tr>
</tbody>
</table>

## OUTDOOR TUBE CABLE TYPES & SIZES AVAILABLE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>2-TUBE</th>
<th>4-TUBE</th>
<th>7-TUBE</th>
<th>19-TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSP</td>
<td>---</td>
<td>---</td>
<td>TC07AOX</td>
<td>---</td>
</tr>
<tr>
<td>OSP</td>
<td>---</td>
<td>---</td>
<td>TC07LWS</td>
<td>---</td>
</tr>
<tr>
<td>OSP - AERIAL</td>
<td>TC02MSOS</td>
<td>TC04MSOS</td>
<td>TC07MSOS</td>
<td>TC19MSOS</td>
</tr>
<tr>
<td>OSP</td>
<td>---</td>
<td>---</td>
<td>TC07TAX*</td>
<td>TC19TAX*</td>
</tr>
<tr>
<td>OSP</td>
<td>---</td>
<td>---</td>
<td>TC07TLA</td>
<td>TC19TLA</td>
</tr>
<tr>
<td>OSP</td>
<td>---</td>
<td>TC04TOD</td>
<td>---</td>
<td>---</td>
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<tr>
<td>OSP</td>
<td>TC02TOX</td>
<td>---</td>
<td>TC07TOX</td>
<td>TC19TOX</td>
</tr>
</tbody>
</table>

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

## OUTDOOR RATED TUBE CABLE SPECIFICATIONS

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Temperature Range</td>
<td>-40° to +158°F</td>
</tr>
<tr>
<td>Minimum Bend Radius for Multi-Tube Cables</td>
<td>20X cable diameter</td>
</tr>
<tr>
<td>Minimum Bend Radius for Multi-Tube Cables</td>
<td>10X cable diameter</td>
</tr>
</tbody>
</table>
## OUTDOOR TUBE CABLE PHYSICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Cable OD (in)</th>
<th>Max. Weight (lbs/kft)</th>
<th>Max. Tensile Load (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC02MSOS</td>
<td>0.9</td>
<td>89</td>
<td>200</td>
</tr>
<tr>
<td>TC02TOX</td>
<td>0.9</td>
<td>87</td>
<td>200</td>
</tr>
<tr>
<td>TC04MSOS</td>
<td>0.9</td>
<td>141</td>
<td>200 with standard basket-weave grip, 500 with pulling eye</td>
</tr>
<tr>
<td>TC04TOD</td>
<td>0.9</td>
<td>137</td>
<td>200 with standard basket-weave grip, 500 with pulling eye</td>
</tr>
<tr>
<td>TC07AOX</td>
<td>1.4</td>
<td>438</td>
<td>500</td>
</tr>
<tr>
<td>TC07LWS</td>
<td>1.4</td>
<td>479</td>
<td>400</td>
</tr>
<tr>
<td>TC07MSOS</td>
<td>1.1</td>
<td>196</td>
<td>400</td>
</tr>
<tr>
<td>TC07TAX *</td>
<td>1.5</td>
<td>825</td>
<td>500</td>
</tr>
<tr>
<td>TC07TLA</td>
<td>1.5</td>
<td>870</td>
<td>400</td>
</tr>
<tr>
<td>TC07TLW</td>
<td>1.1</td>
<td>223</td>
<td>400</td>
</tr>
<tr>
<td>TC07TOX</td>
<td>1.1</td>
<td>205</td>
<td>400</td>
</tr>
<tr>
<td>TC19MSOS</td>
<td>1.7</td>
<td>399</td>
<td>500</td>
</tr>
<tr>
<td>TC19TAX *</td>
<td>2.1</td>
<td>115</td>
<td>500</td>
</tr>
<tr>
<td>TC19TLA</td>
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<td>1650</td>
<td>500</td>
</tr>
<tr>
<td>TC19TLW</td>
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<td>463</td>
<td>500</td>
</tr>
<tr>
<td>TC19TOX</td>
<td>1.7</td>
<td>443</td>
<td>500</td>
</tr>
</tbody>
</table>

**Notes:**
- TAX-type Tube Cable is a non-standard product. Use TLA-type Tube Cable as alternative.
**OUTDOOR TUBE CABLE STANDARD REEL DATA**

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Std Reel Length (ft)</th>
<th>Std Reel H x W (in)</th>
<th>Minimum Drum Diameter (in)</th>
<th>Std Reel Weight (lbs) Empty</th>
<th>Std Reel Weight (lbs) Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC02MSOS</td>
<td>1000</td>
<td>36 x 17</td>
<td>18</td>
<td>55</td>
<td>144</td>
</tr>
<tr>
<td>TC02TOX</td>
<td>1000</td>
<td>36 x 17</td>
<td>18</td>
<td>55</td>
<td>142</td>
</tr>
<tr>
<td>TC04MSOS</td>
<td>100</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>278</td>
</tr>
<tr>
<td>TC04TOD</td>
<td>100</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>274</td>
</tr>
<tr>
<td>TC07AOX</td>
<td>100</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>684</td>
</tr>
<tr>
<td>TC07LWS</td>
<td>100</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>725</td>
</tr>
<tr>
<td>TC07MSOS</td>
<td>100</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>333</td>
</tr>
<tr>
<td>TC07TAX *</td>
<td>100</td>
<td>64 x 40</td>
<td>46</td>
<td>248</td>
<td>1073</td>
</tr>
<tr>
<td>TC07TLA</td>
<td>100</td>
<td>64 x 40</td>
<td>46</td>
<td>248</td>
<td>1118</td>
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<tr>
<td>TC07TLW</td>
<td>1000</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>360</td>
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<tr>
<td>TC07TOX</td>
<td>1000</td>
<td>54 x 36</td>
<td>40</td>
<td>137</td>
<td>342</td>
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<tr>
<td>TC19MSOS</td>
<td>100</td>
<td>64 x 40</td>
<td>46</td>
<td>248</td>
<td>647</td>
</tr>
<tr>
<td>TC19TAX *</td>
<td>100</td>
<td>72 x 40</td>
<td>46</td>
<td>309</td>
<td>1461</td>
</tr>
<tr>
<td>TC19TLA</td>
<td>100</td>
<td>72 x 40</td>
<td>46</td>
<td>309</td>
<td>1959</td>
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<tr>
<td>TC19TLW</td>
<td>1000</td>
<td>72 x 40</td>
<td>46</td>
<td>309</td>
<td>772</td>
</tr>
<tr>
<td>TC19TOX</td>
<td>1000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>689</td>
</tr>
</tbody>
</table>

**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-spool, 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

<table>
<thead>
<tr>
<th>Sumitomo Part No.</th>
<th>Max Reel Length (ft)</th>
<th>Max Reel H x W (in)</th>
<th>Minimum Drum Diameter (in)</th>
<th>Max Reel Weight (lbs) Empty</th>
<th>Max Reel Weight (lbs) Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC02MSOS</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>513</td>
</tr>
<tr>
<td>TC02TOX</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>507</td>
</tr>
<tr>
<td>TC04MSOS</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>669</td>
</tr>
<tr>
<td>TC04TOD</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>657</td>
</tr>
<tr>
<td>TC07AOX</td>
<td>3000</td>
<td>72 x 50</td>
<td>46</td>
<td>333</td>
<td>1647</td>
</tr>
<tr>
<td>TC07LWS</td>
<td>3000</td>
<td>72 x 50</td>
<td>46</td>
<td>333</td>
<td>1770</td>
</tr>
<tr>
<td>TC07MSOS</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>834</td>
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<tr>
<td>TC07TAX *</td>
<td>3000</td>
<td>72 x 50</td>
<td>46</td>
<td>333</td>
<td>2808</td>
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<td>TC07TLA</td>
<td>3000</td>
<td>72 x 50</td>
<td>46</td>
<td>333</td>
<td>2943</td>
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<tr>
<td>TC07TLW</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>915</td>
</tr>
<tr>
<td>TC07TOX</td>
<td>3000</td>
<td>60 x 48</td>
<td>40</td>
<td>246</td>
<td>861</td>
</tr>
<tr>
<td>TC19MSOS</td>
<td>3000</td>
<td>72 x 50</td>
<td>30</td>
<td>288</td>
<td>1485</td>
</tr>
<tr>
<td>TC19TAX *</td>
<td>2300</td>
<td>72 x 50</td>
<td>30</td>
<td>288</td>
<td>2938</td>
</tr>
<tr>
<td>TC19TLA</td>
<td>2300</td>
<td>72 x 50</td>
<td>30</td>
<td>288</td>
<td>4083</td>
</tr>
<tr>
<td>TC19TLW</td>
<td>3000</td>
<td>72 x 50</td>
<td>30</td>
<td>288</td>
<td>1677</td>
</tr>
<tr>
<td>TC19TOX</td>
<td>3000</td>
<td>72 x 50</td>
<td>30</td>
<td>288</td>
<td>1617</td>
</tr>
</tbody>
</table>

**Notes:**
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- 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.
# TUBE DISTRIBUTION HARDWARE

<table>
<thead>
<tr>
<th>P/N</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE06MDU</td>
<td>Wall-mount, indoor tube distribution unit (TDU). Key-locked hinged door. Modular design; wall-mount fiber termination units (FT24WFM &amp; 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.</td>
</tr>
<tr>
<td>DE12IDU</td>
<td>Wall-mount, indoor NEMA 12-rated tube distribution unit (TDU). Gray color. Hole punch &amp; cable clamps required for mounting tube cables; not included. Unit Dimensions: 24”H x 20”W x 7”D. Weight: 35 lbs.</td>
</tr>
<tr>
<td>DEDTTP</td>
<td>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.</td>
</tr>
<tr>
<td>DEDTTP2</td>
<td>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.</td>
</tr>
<tr>
<td>DETC008</td>
<td>Black plastic tube clip organizer for up to 8 tubes. Mounts using screws provided.</td>
</tr>
<tr>
<td>DETCTB</td>
<td>L-bracket for mounting up to two tube clip organizers (DETC008).</td>
</tr>
<tr>
<td>DE08MC2</td>
<td>Clear plastic push/pull quick release pneumatic tube coupling for 8mm OD tube. 200 psi pressure rated. Ten couplings per pack.</td>
</tr>
<tr>
<td>Part Code</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>DE08MB</td>
<td>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.</td>
</tr>
<tr>
<td>DE08MT</td>
<td>Black plastic push/pull quick release pneumatic tube tee coupling for 8mm OD tube. 200 psi pressure rated. Available individually.</td>
</tr>
<tr>
<td>DE08MA</td>
<td>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.</td>
</tr>
<tr>
<td>DE06MP</td>
<td>Orange plastic pneumatic tube plug for 6mm ID tube. Seals opening of unoccupied tube. Recommended for indoor application. Ten plugs per pack.</td>
</tr>
<tr>
<td>DE04HS1</td>
<td>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.</td>
</tr>
<tr>
<td>DE07HS1</td>
<td>Heat shrink end cap for 7-tube cables. Seals tube cable end to prevent contamination entry. Heat gun or torch required for installation.</td>
</tr>
<tr>
<td>DE19HS1</td>
<td>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.</td>
</tr>
<tr>
<td>DE19HS2</td>
<td>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.</td>
</tr>
<tr>
<td>DE02T0X</td>
<td>Tapered rubber insert for 2-tube (TC02TOX) cable installation using Hubbell Grip No. 074011251.</td>
</tr>
<tr>
<td>DE04T0D</td>
<td>Tapered rubber insert for 4-tube (TC04TOD) cable installation using Hubbell Grip No. 07401026.</td>
</tr>
<tr>
<td>DE5KCAP</td>
<td>Aluminum end cap sealing disc for unoccupied 2-, 4-, and 7-tube Kellem's® Grips with Form 5 Size compression nut: 074011251 (TC02TOX) 07401026 (TC04TOD) 07401027 (TC07TOX) 07401028 (TC07NA3) 07401032 (TC07AOX &amp; TC07LWS)</td>
</tr>
</tbody>
</table>
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)

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.

FIBER AND FIBER BUNDLES

SEL PART NUMBER DESCRIPTION

<table>
<thead>
<tr>
<th>FB02SX</th>
<th>Sumitomo Part Number (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“FB”</td>
<td>Fiber “Bundle”</td>
</tr>
<tr>
<td>“FR”</td>
<td>Fiber “Ribbon”</td>
</tr>
<tr>
<td>“02, 04, etc.”</td>
<td>Number of Individual Fibers</td>
</tr>
<tr>
<td>“SX”</td>
<td>Single Mode Fiber</td>
</tr>
<tr>
<td>“SR”</td>
<td>Radiation Hardened Single Mode Fiber</td>
</tr>
<tr>
<td>“M5”</td>
<td>50 / 125 Multi-mode Fiber (Standard Grade; 1 Gigabit))</td>
</tr>
<tr>
<td>“G53”</td>
<td>50 / 125 Multi-mode Fiber (Extended Grade; 10 Gigabit 300 m)</td>
</tr>
<tr>
<td>“G55”</td>
<td>50 / 125 Multi-mode Fiber (Maximum Grade; 10 Gigabit 500 m)</td>
</tr>
<tr>
<td>“M6”</td>
<td>62.5 / 125 Multi-mode Fiber (Standard Grade)</td>
</tr>
<tr>
<td>“R6”</td>
<td>Radiation Hardened 62.5 / 125 Multi-mode Fiber</td>
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</table>
FIBER BUNDLE TYPES & SIZES AVAILABLE

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

SINGLE MODE FIBER & FIBER BUNDLE SPECIFICATIONS

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Bundle Jacket material</td>
<td>Polyethylene Extruded Foam (PEF)</td>
</tr>
<tr>
<td>Fiber Bundle Jacket color</td>
<td>Yellow</td>
</tr>
<tr>
<td>Core diameter</td>
<td>8.3 micron</td>
</tr>
<tr>
<td>Cladding diameter</td>
<td>125 micron</td>
</tr>
<tr>
<td>Buffer / acrylate diameter</td>
<td>250 micron</td>
</tr>
<tr>
<td>Maximum Dispersion at 1310 / 1550 nm</td>
<td>(&lt; 3.2 / 18.0 \text{ps/nm-km})</td>
</tr>
<tr>
<td>Index of Refraction</td>
<td>(1310 \text{ nm} \quad 1550 \text{ nm}) (1.46 \quad 6)</td>
</tr>
<tr>
<td>Operation Temperature Range (for Fiber Bundle Assembly)</td>
<td>-40° to +158°F</td>
</tr>
<tr>
<td>Minimum Fiber Bundle Bend Radius</td>
<td>1.5”</td>
</tr>
</tbody>
</table>
62.5 MICRON MULTI-MODE FIBER & FIBER BUNDLE SPECIFICATIONS

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

FIBER BUNDLE REEL DATA

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

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

2-Fiber Ribbon (Standard Ribbonized Coating)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>No Ripcord</td>
</tr>
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</table>

2-Fiber Bundles (1 Nylon Sub-Unit)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th>3rd Pos</th>
<th>4th Pos</th>
<th>5th Pos</th>
<th>6th Pos</th>
<th>7th Pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Ripcord</td>
<td>Ripcord</td>
<td>Orange</td>
<td>Ripcord</td>
<td>Ripcord</td>
<td>Ripcord</td>
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</tbody>
</table>

4-Fiber Bundles (1 Nylon Sub-Unit)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th>3rd Pos</th>
<th>4th Pos</th>
<th>5th Pos</th>
<th>6th Pos</th>
<th>7th Pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Ripcord</td>
<td>Green</td>
<td>Brown</td>
<td>Ripcord</td>
<td>Ripcord</td>
</tr>
</tbody>
</table>

6-Fiber Bundles (1 Nylon Sub-Unit)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th>3rd Pos</th>
<th>4th Pos</th>
<th>5th Pos</th>
<th>6th Pos</th>
<th>7th Pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Green</td>
<td>Brown</td>
<td>Slate</td>
<td>Ripcord</td>
<td>White</td>
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</table>

12-Fiber Bundles (3 Nylon Sub-Units)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th>3rd Pos</th>
<th>4th Pos</th>
<th>5th Pos</th>
<th>6th Pos</th>
<th>7th Pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Ripcord</td>
<td>Green</td>
<td>Brown</td>
<td>Ripcord</td>
<td>Ripcord</td>
</tr>
<tr>
<td>Slate</td>
<td>White</td>
<td>Ripcord</td>
<td>Red</td>
<td>Black</td>
<td>Ripcord</td>
<td>Ripcord</td>
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<tr>
<td>Yellow</td>
<td>Violet</td>
<td>Ripcord</td>
<td>Rose</td>
<td>Aqua</td>
<td>Ripcord</td>
<td>Ripcord</td>
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</table>

18-Fiber Bundles (3 Nylon Sub-Units)

<table>
<thead>
<tr>
<th>1st Pos</th>
<th>2nd Pos</th>
<th>3rd Pos</th>
<th>4th Pos</th>
<th>5th Pos</th>
<th>6th Pos</th>
<th>7th Pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Green</td>
<td>Brown</td>
<td>Slate</td>
<td>Ripcord</td>
<td>Red</td>
</tr>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Green</td>
<td>Brown</td>
<td>Slate</td>
<td>Ripcord</td>
<td>Yellow</td>
</tr>
<tr>
<td>Blue</td>
<td>Orange</td>
<td>Green</td>
<td>Brown</td>
<td>Slate</td>
<td>Ripcord</td>
<td>Violet</td>
</tr>
</tbody>
</table>

Note: All Ripcords are Black Polyester
## FIBER TERMINATION HARDWARE

<table>
<thead>
<tr>
<th>P/N</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT24WFM</td>
<td>24-port wall-mount, indoor fiber termination unit (FTU). Key locked maintenance door and magnetic user access door. Modular design; can be attached to front of small tube distribution unit (TDU) (DE06MDU).  Unit Dimensions: 16&quot;H x 16&quot;W x 4&quot;D.  Weight: 20 lbs.  Capacity: Four EIA standard 6-pack panels/four splice trays (not included).</td>
</tr>
<tr>
<td>FT48WFM</td>
<td>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&quot;H x 16&quot;W x 6&quot;D.  Weight: 22 lbs.  Capacity: Eight EIA standard 6-pack panels/four splice trays (not included).</td>
</tr>
<tr>
<td>FT18RFS</td>
<td>Rack-mount fiber termination unit. Fits both 19&quot; and 23&quot; equipment racks. Low profile. Includes one 24-fiber splice tray.  Unit dimensions: 1.75&quot;H x 17&quot;W x 12&quot;D.  Weight: 10 lbs.  Capacity: 18 fibers.</td>
</tr>
<tr>
<td>FT36RFS</td>
<td>Rack-mount fiber termination unit. Fits both 19&quot; and 23&quot; equipment racks. Includes three 12-fiber splice trays.  Unit dimensions: 3.5&quot;H x 17&quot;W x 12&quot;D.  Weight: 13 lbs.  Capacity: 36 fibers.</td>
</tr>
<tr>
<td>FT48RFS</td>
<td>Rack-mount fiber termination unit. Fits both 19&quot; and 23&quot; equipment racks. Includes four 12-fiber splice trays.  Unit dimensions: 7&quot;H x 17&quot;W x 12&quot;D.  Weight: 20 lbs.  Capacity: 48 fibers.</td>
</tr>
<tr>
<td>FT72RFS</td>
<td>Rack-mount fiber termination unit. Fits both 19&quot; and 23&quot; equipment racks. 72-fiber capacity. Includes six 12-fiber splice trays.  Unit dimensions: 10.5&quot;H x 17&quot;W x 12&quot;D.  Weight: 25 lbs.  Capacity: 72 fibers.</td>
</tr>
</tbody>
</table>
# FIBER TERMINATION HARDWARE (Continued)

<table>
<thead>
<tr>
<th>P/N</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 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. |
| 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. |
| 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.

### Lynx2 CustomFit® Splice-On Connector

**LYNX2 - Part Numbering Guide**

LYNX2-AABBBCCCCD-DDDDDD

<table>
<thead>
<tr>
<th>Part Number Section</th>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>LC</td>
<td>LC Style Connector</td>
</tr>
<tr>
<td>BBB</td>
<td>UPC</td>
<td>Ultra Physical Contact (For Singlemode Fiber Only)</td>
</tr>
<tr>
<td>CCCCCC</td>
<td>SM</td>
<td>Single Mode Fiber</td>
</tr>
<tr>
<td>CCCCCC (will range from 2 to 5 characters)</td>
<td>PC</td>
<td>Physical Contact (For Multimode Fiber Only)</td>
</tr>
<tr>
<td>CCCCCC</td>
<td>M6</td>
<td>Multimode Fiber 62.5µm</td>
</tr>
<tr>
<td>DDDDDDD (will range from 3 to 6 characters)</td>
<td>250900</td>
<td>Accommodates Media of 250µm and 900µm Coated Fiber</td>
</tr>
<tr>
<td>DDDDDDD</td>
<td>250FT8</td>
<td>Accommodates Media of 250µm &amp; Upjackets with 8” Furcation Tubing (for SC only)</td>
</tr>
<tr>
<td>DDDDDDD</td>
<td>900LT</td>
<td>Accommodates Media of 900µm Loose Buffer Coated Fiber</td>
</tr>
<tr>
<td>DDDDDDD</td>
<td>1.6</td>
<td>Accommodates Media of 1.6mm Cabled Fiber</td>
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<tr>
<td>DDDDDDD</td>
<td>2.0</td>
<td>Accommodates Media of 2.0mm Cabled Fiber</td>
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<td>DDDDDDD</td>
<td>2.4</td>
<td>Accommodates Media of 2.4mm Cabled Fiber</td>
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<tr>
<td>DDDDDDD</td>
<td>3.0</td>
<td>Accommodates Media of 3.0mm Cabled Fiber</td>
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<tr>
<td>DDDDDDD</td>
<td>4.8</td>
<td>Accommodates Media of 4.8mm Cabled Fiber</td>
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### BLOWING EQUIPMENT, TOOLS, & MISCELLANEOUS ACCESSORIES

<table>
<thead>
<tr>
<th>P/N</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 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. |
| 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. |
### STANDARD FIBER BUNDLE BLOWING DISTANCES

<table>
<thead>
<tr>
<th>2-, 4- &amp; 6-FIBER BUNDLES (2mm OD)</th>
<th>APPROX. DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSP MSO Aerial tube cable</td>
<td>1200 meters or 4000 feet</td>
</tr>
<tr>
<td>All other OSP &amp; TRX tube cables</td>
<td>1000 meters or 3300 feet</td>
</tr>
<tr>
<td>TGX, TPX, &amp; NA3 tube cables</td>
<td>600 meters or 1950 feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12- &amp; 18-FIBER BUNDLES (3mm OD)</th>
<th>APPROX. DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSP MSO Aerial tube cable</td>
<td>600 meters or 1950 feet</td>
</tr>
<tr>
<td>All other OSP &amp; TRX tube cables</td>
<td>500 meters or 1650 feet</td>
</tr>
<tr>
<td>TGX, TPX &amp; NA3 tube cables</td>
<td>300 meters or 1000 feet</td>
</tr>
</tbody>
</table>

**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

**END OF APPENDIX 1**