

SECTION 27 1000 - STRUCTURED CABLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Communications system design requirements.
- B. Fiber optic cable and interconnecting devices.

1.02 RELATED REQUIREMENTS

- A. Section 26 0533.13 - Conduit for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment Revision E, 2005.
- B. ICEA S-83-596 - Indoor Optical Fiber Cables 2016.
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices 1988a (Reaffirmed 2012).
- E. TIA-492AAAD - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers 2009.
- F. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant 2015a.
- G. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant 2015c.
- H. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set 2019.
- I. TIA-568.3 - Optical Fiber Cabling and Components Standard 2016d.
- J. TIA-569 - Telecommunications Pathways and Spaces 2019e.
- K. TIA-598 - Optical Fiber Cable Color Coding 2014d.
- L. TIA-606 - Administration Standard for Telecommunications Infrastructure 2017c.

- M. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises 2019d.
- N. UL 444 - Communications Cables Current Edition, Including All Revisions.
- O. UL 1651 - Fiber Optic Cable Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

- G. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- H. Field Test Reports.
- I. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on drawings.

1.06 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, terminations and testing.

1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
2. Comply with Communications Service Provider requirements.
3. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

2.02 PATHWAYS

- A. Conduit: As specified in Section 26 0533.13; provide pull cords in all conduit.

2.03 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Single-mode Cable:
 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 2. Cable Type: Single-mode, 8.3/125 um (OS2) complying with TIA-492CAAB.
 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
 5. Cable Jacket Color:
 - a. Single-Mode Fiber (OS1/OS2): Yellow.
- B. Fiber Optic Multimode Cable:
 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.

2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAAD.
 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 4. Cable Applications: Use listed NFPA 70 Type OFNP plenum cable unless otherwise indicated.
 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.
- C. Fiber Optic Interconnecting Devices:
1. Connector Type: Type LC.
 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
- D. Fiber Optic Patch Cords:
1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.

2.04 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Fiber Optic Cross-Connection Equipment:
1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adapters per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.

- d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.
 - f. Provide removable lide type, NOT sliding tray cassette type panels
- B. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
- 1. Size: As indicated on drawings.
 - 2. Do not paint over UL label.
- C. Equipment Frames, Racks and Cabinets:
- 1. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
 - a. Cover inside of cabinet back with plywood backboard as specified.
 - 2. Cabinets: Steel construction with corrosion resistant finish.
 - 3. Locks: Keyed alike.

2.05 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Wiring Methods:
 - 1. Install cables in new and existing raceways.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.02 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.

2. 12 inches from power conduits and cables and panelboards.
 3. 5 inches from fluorescent and high frequency lighting fixtures.
 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit, in Addition to Requirements of Section 26 0533.13:
1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
 2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

A.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. In the communications equipment room, provide a 20-foot- (6-m-) long service loop on each end of cable dressed neatly on backboard or ladder rack.
 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- C. Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 2. Do not over-cinch or crush cables.
 3. Do not exceed manufacturer's recommended cable pull tension.
 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- D. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 240 inches dressed neatly on backboard or ladder rack.
 2. At Outlets - Optical Fiber: 39 inches.
- E. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 2. Support vertical cable at intervals as recommended by manufacturer.
- F. Wall-Mounted Racks and Enclosures:
1. Install to plywood backboards only, unless otherwise indicated.
 2. Mount so height of topmost panel does not exceed 78 inches above floor.
- G. Identification:
1. Use wire and cable markers to identify cables at each end.

2. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.
3. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
4. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, horizontal pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
5. Cable and Wire Identification:
 - a. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
6. Label each unit and field within distribution racks and frames.
7. Label each FDU and fiber patch panel with name, and source or destination.
8. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
9. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
10. Flexible vinyl or polyester that flexes as cables are bent.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- D. Testing - Fiber Optic Cabling:
 - 1. After completing cable installation, splicing, and termination, test all fibers for continuity, events losses, and total attenuation of the cable as follows:
 - a. Test each individual fiber for event losses using an OTDR. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
 - b. Connect the OTDR and the cable with a factory patch cord of a length equal to the dead zone of the OTDR. Optionally, the technician can use a factory fiber box of 325 feet minimum with no splices within the box.
 - c. Test each individual fiber for total segment attenuation loss using an optical source/power meter. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
 - d. Conduct both tests, OTDR and optical source/power meter, at 1310 nm and 1550 nm for each fiber in the cable.
 - e. Conduct both tests bi-directionally for each fiber in the cable.
 - 2. After completing the tests, submit 1 hard copy and 1 electronic copy of the test results to the engineer documenting the following test parameters:
 - a. Operator name
 - b. Setup parameters
 - c. Pulse width OTDR

- d. Range OTDR Date and time
 - e. Wavelength
 - f. Refractory index OTDR
 - g. Scale OTDR
3. Summarize the results of both the OTDR and optical source/power meter tests in spreadsheet/tabular format adhering to the following requirements:
- a. List fiber optic segment name including route, start point, and end point.
 - b. List all fibers by number.
 - c. List direction of test as NB, SB, EB, or WB.
 - d. List total fiber optic cable length for each fiber as documented in the OTDR test.
 - e. List attenuation in dB of gain or loss for each fiber optic event in the OTDR test.
 - f. List fiber optic loss event descriptions and locations including splices, miscellaneous events, and terminations.
 - g. List the attenuation across the cable in dB/mile for each fiber tested.
 - h. List the total segment loss for each fiber as determined by the optical source/power meter test.
 - i. Provide bi-directional data including event distances, event descriptions, and attenuation losses for each fiber corresponding to a common start point
 - j. Provide bi-directional data on separate lines, side-by-side within the same sheet.
 - k. Provide 1310 nm and 1550 nm test results on separate sheets in identical formats.
4. Provide copies of the fiber cable traces taken during the OTDR test to the department on diskette for review. Provide electronic files in a universal file format, or with software to view the files.

5. Ensure that test results demonstrate that the dB/mile loss does not exceed plus 3 percent of the factory test or plus one percent of the cable's published production loss. The department will consider the error rate for the test equipment in evaluating results.
6. Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
7. Multimode Backbone: Perform tests in accordance with TIA-526-14.
8. Single Mode Backbone: Perform tests in accordance with TIA-526-7.
9. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
10. Link End-to-End Attenuation Tests:
 - a. Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
 - b. Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.
- E. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- F. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

A. END OF SECTION