271323-TC
OPTICAL FIBER SPLICING AND TERMINATIONS for Telecommunications Systems

Related Documents
The following related sections of the OT standards shall also be applicable to this section.

OT Engineer shall approve all product cut sheets prior to purchasing and installation by contractor. Reference S9 Approved Products.

S1 Approved Product Request
S1 Change Request
S1 Request for Variance
S1 Resource Allocation Permit
S2 Introduction
S3 SOP and Policy
S4 275116-TC CORE Passenger Communications Paging System
S4 275118-TC Emergency Communications and Evacuation Paging System
S5 270000X Telecommunications Systems (Boiler Plate)
S5 MAA Radio System
S7 270000-TC Common Work
S7 270100-TC Systems Cabling
S7 270101-TC COMCAST Standard
S7 270526-TC Grounding and Bonding
S7 270528-TC Hangers and Support
S7 270553-TC Identification
S7 270555-TC OT Facility Warning Standard
S7 271116-TC Cabinets Racks Frame Enclosures
S7 271119-TC Termination Blocks and Patch Panels
S7 271313-TC Cable Splicing and Termination
S7 271519-TC Horizontal Cabling
S7 271525- TC Tenant and Airlines Extended DEMARC
S7 271543-TC Faceplates and Connectors
S7 271600-TC Telecommunications Station Equipment
S8 E911 PS ALI Standard
S9 Approved Products

Part 1 - General

1.1 Work Included

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

1.2 Scope of Work

A. This document describes the products and execution requirements relating to furnishing and installing Optical fiber backbone cabling (optical fiber splicing and terminations) is covered under this document.

B. This section includes minimum requirements for the following:
- Optical Fiber Backbone Cabling System

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.

1.3 Regulatory References

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

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

NFPA

NFPA-70	National Electric Code (NEC)-1999

ISO/IEC

ISO/IEC 11801	Generic Cabling for Customer Premises

B. The most recent versions of all documents apply to this project. If there is a conflict between applicable documents, the order above shall dictate the order of precedence in resolving the issue unless an enforceable local or national code is in effect.

1.4 Backbone Cabling System

The Backbone Cable Subsystem in a building is the part of the premises distribution system that provides connection between equipment rooms, telecommunication rooms, and telecommunications service entrance facilities. A backbone subsystem provides either intra-building connections between floors in multi-story buildings or inter-building connections in campus-like environments.

All cables shall be run using a star topology (home run) from the Main Cross-Connect (MC) to each Horizontal Cross-Connect (HC) within the telecommunications room. One additional Intermediate Cross-Connect (IC) may be implemented between the MC and HC if so required. The length of each individual run of backbone fiber cable shall not exceed 2000 meters for multimode and 3000 meters for singlemode and the length of each UTP cable run for voice applications is not to exceed 800 meters (90 meters for data) as specified under TIA/EIA-568-B. The length of the media between the IC and HC shall not exceed 300 meters.

The type of backbone fiber cable shall be 62.5/125 μm multimode fiber cable or 8.3/125 μm singlemode fiber cable. The bending radius and maximum pulling tension of the cable shall be adhered to during handling and installation.

1.5 Fiber Data Station Cable

All backbone fiber optic cable shall be 62.5/125 μm tight buffered or 8.3/125 μm jacketed fiber optic cable. Fiber cable shall be riser (OFNR) or plenum (OFNP) listed where applicable.

1.6 Optical fiber Cables

A. Multimode Cable Elements.

1. Multimode cable to be 62.5 micron core.
2. Fiber shall have a maximum Attenuation of 3.5 dB/km @ 850nm and 1.5 dB/km @ 1300nm.
3. Fiber shall have a minimum LED Bandwidth 1500 MHz•km @ 850nm and 500 MHz•km @ 1300nm
4. Fiber shall have a minimum Effective Modal Bandwidth 2000 (MHz•km) @ 850nm
5. Fiber shall have a serial Gigabit Ethernet Distance Guarantee 1000m @ 850nm and 600m @ 1300nm
6. Fiber shall have a serial 10 Gigabit Ethernet Distance 300m @ 850nm.
7. Fiber shall have minimum tensile load strength of 2700 Newtons.
8. Fiber shall conform to RUS 7 CFR 1755.900 and ANSO/ICEA S-87-640
9. Fiber shall have 3.0mm buffer tube size.
10. Fiber shall have SZ-stranded, loose tube design to isolate fibers from installation and environmental elements.
11. Fiber shall have a jacket made of medium density polyethylene.
12. Fiber cable construction shall be of all-dielectric construction.
13. Fiber shall be plenum rated.

B. Singlemode Cable Elements.

1. Singlemode cable to be 8.3 micron core.
2. Fiber shall have a maximum Attenuation of 0.4 dB/km @ 1310 nm and 0.3 dB/km @ 1510 nm
3. Fiber shall have a serial Gigabit Ethernet Distance Guarantee of 5000 m @ 1310 nm.
4. Fiber shall have a serial 10 Gigabit Ethernet Distance of 10000 m @ 1310 nm and 40000 m @ 1510 nm.
5. Fiber shall have minimum tensile load strength of 2700 Newtons.
6. Fiber shall conform to RUS 7 CFR 1755.900 and ANSO/ICEA S-87-640
7. Fiber shall have 3.0mm buffer tube size.
8. Fiber shall have SZ-stranded, loose tube design to isolate fibers from installation and environmental elements.
9. Fiber shall have a jacket made of medium density polyethylene.
10. Fiber cable construction shall be of all-dielectric construction.
11. Fiber shall be plenum rated.
12. Cable shall be capable of supporting 1470, 1490, 1510, 1530, 1550, 1570, 1590 and 1610 nm wavelengths.

C. Backbone Cable (the following fiber counts are subject to job specific needs)

1. Provide internal use riser rated optical fiber cable with 144 strands of single mode optical fiber cable and 72 strands of multimode optical fiber cable .The cable shall be riser rated (CMR) for use as an internal cable in a non-plenum / plenum environment.
2. Provide printed length markings on the cable jacket every two feet.
3. All fiber will be installed in a 1.5 inch inner duct within the conduit.

D. External Cable (the following fiber counts are subject to job specific needs)

1. Provide external optical fiber cable with 144 strands of single mode optical fiber and 72 strands of multimode optical fiber cable.
2. The cable shall be recommended by the manufacturer for use as an external cable suitable for installation in an underground duct or conduit system.
3. Provide printed length markings on the cable jacket every two feet.
4. Optical fibers will be contained within loose buffer tubes utilizing water blocking tapes or compounds surrounding these tubes. The cable will be an all-dielectric construction, with a central strength member.

1.7 Rack Mounted Optical Fiber Patch Panel.

A. Conforming to the following specification:

1. Each panel shall be suitable for installation in EIA 19" mounting frame.
2. Patch panels shall be capable of holding 6 coupler (bulk head) adapters.
3. Each panel shall provide either compression glands or internal clips and entrapment of yarn based impact resistance to provide strain relief.
4. Each panel shall provide fiber handling for fiber strands, including 20" fiber reserve (service loop) inside the patch panel with no bends sharper than 2" bend radius.
5. Each patch panel shall be fitted with bulkhead simplex adapters (with ceramic alignment sleeves for 6 ST or SC Connectors. Provide sufficient quantity of adapters to support all terminated fibers. Provide adapter plates to house bulkhead adapters and provide blanking adapter plates to cover all unused spaces as necessary.
6. Each patch panel shall allow any individual element to be terminated or otherwise handled without disturbing or damaging other strands.

1.8 Optical Fiber connectors

NOTE: Horizontal cables shall be manually polishing connectors for station fiber.
Backbone cables shall be fusion spliced using OT approved splice modules

A. Multimode Optical Fiber Connectors. Provide multimode optical fiber connectors ST conforming to the following specification.

1. Maximum insertion loss, of mated pair, less than 0.75 dB at acceptance
2. Optimally keyed, allowing reproducible mating conditions each time a connection is made between connector and coupler.
3. Fitted with color coded strain relief boots to ensure durable and robust connections
4. Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
5. Fitted with a tight polymer cap, until the connector is fitted to a bulkhead adapter, over the connector to prevent ingress of dirt and dust, until the connector is fitted to a coupler.
6. Having (6/12) ST connectors per mounting panel (bulk head adapter).

B. Singlemode Optical Fiber Connectors. Provide single mode optical fiber connectors SC , conforming to the following specification.

1. Insertion loss of mated pair at 1310 nm to be less than 0.5 dB at acceptance for every duplex connector.
2. Minimum return loss of 36dB at 1310 nm
3. Optimally keyed, allowing reproducible mating conditions each time a connection is made between connector and coupler.
4. Fitted with strain relief boots to ensure durable and robust connections
5. Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
6. Fitted with a tight polymer cap over the connector to prevent ingress of dirt and dust, until the connector is fitted to a coupler.
7. Having (6/12) SC connectors per mounting panel (bulk head adapter).

1.9 Fiber Optic Equipment Trays/Drawers/Enclosures

The Fiber Optic Trays shall be used to provide rack mounted fiber optic trays that manage and protect optical fiber terminations and splices. The trays shall be used with 24 or 48 port modular patch panels or fiber adapter patch panels. The trays shall include a removable cover. They shall mount to EIA standard 19” and 23" (with extender bracket) racks or cabinets, include multiple cable entry points and include a fiber optic cable routing accessory kit.

Wall mounted fiber optic enclosures (when approved) shall be constructed of steel material. Enclosures shall provide patch cable protection without the installation of an additional attachment. Enclosures shall maintain discrete locking capability between installer and end user segments.
Rack mounted fiber optic enclosures shall be designed to manage and organize fiber optic cable to and from the equipment or cabling plant. Enclosures shall protect fiber optic connections for patching or splicing requirements. Enclosures shall accommodate up to 36 fibers (with Fiber Jack, SC, or SC) per rack space and shall be constructed of steel material. Enclosures shall have removable front and rear covers and top and bottom pass through holes.

Part Number	Rack Spaces	Number of Fibers
	1	36 with Fiber Jack
	2	72 with Fiber Jack
	3	96 with Fiber Jack
	4	144 with Fiber Jack

Part 2 - Execution

2.1 Optical Fiber Termination Hardware

Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

A maximum of 12 strands of fiber shall be spliced in each tray

All spare strands shall be installed into spare splice trays.

2.2 Testing and Acceptance

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B, TSB-67 and TSB-155. All strands of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

2. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Optical Fiber Cable & Connectors

1. Test each optical fiber cable element and its associated connectors. Carry out the following test on every element of every optical fiber cable:
2. Visually check optical connectors using microscope (minimal magnification x200) to ensure that no physical damage has occurred during the installation process. There are to be no scratches on the core of the fiber or pits on the core or cladding. If any defect cannot be rectified with polishing, the connector is to be replaced.
3. Carry out OTDR tests on all strands at 850/1300nm wavelength for multimode cable runs and at 1310/1550 nm for single mode. These tests shall be carried out from both ends using a near end launch lead and a far end drop lead.
4. The number of samples (averages) for each OTDR test shall be such that the noise amplitude is significantly less than the smallest loss of any component under test. This may vary for different cable runs, for shorter runs and fusion splices etc.; it may be necessary to run many samples.
5. Verify the labeling of the cable and connectors is correct.
6. If any strand has an excessive attenuation coefficient, a sudden step in attenuation coefficient (greater than 0.2 dB) or back scatter, losses due to micro bending or macro bending or has any other fault then the fault on that element shall be rectified.
7. The following table lists the pass/fail criteria for all connectors and fusion splices under test. Any component that does not pass these figures shall be re-worked or replaced.

Fiber Type	Maximum attenuation across mated connector pair (dB) – outward test	Maximum Attenuation across fusion splice – averaged over both directions(dB)
MM	**0.75**	**0.1**
SM	**0.5**	**0.1**

8. The attenuation of each mode connector shall be measured in both directions.
9. Each fusion splice shall be tested in both directions for both multimode and single mode strands. The measurements for each direction shall be averaged for the final attenuation figure for each fusion splice.

10. The return loss must be measured in both directions for single mode connectors. The return loss shall be greater or equal to the value shown in the table above.
11. Any failures shall be recorded and the results obtained after rectification of the fault shall be recorded.
12. Graphical printouts shall be taken of OTDR tests for each element. These printouts shall be printed 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 diskette copies of the OTDR traces to the Owner on completion of the testing. Provide a copy of the emulation software and the appropriate license to the client.
13. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined in an RFP. Testing shall consist of an end-to-end power meter test performed per TIA/EIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.

14. Test set-up and performance shall be conducted in accordance with ANSI/TIA/EIA-526-14 Standard, Method B.

15. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. ONLY BASIC LINK TEST IS REQUIRED. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.

16. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

2.3 System Documentation

A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.

B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor shall provide copies of the original test results.

C. MAA/OT may test 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

D. **Test Results** documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

E. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-B including applicable TSB’s and amendments. The appropriate level IV tester shall be used to

verify Category 6 cabling systems. The appropriate level III tester shall be used to verify Category 6 cabling systems.

F. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the telecommunications contractor may furnish this information in electronic form (compact disc). These discs shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable from Microsoft Word or Microsoft Excel.

G. 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 documented.

H. The **As-Built** drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner. Numbering, icons, pathways and other drawing conventions are to be assigned their own individual AutoCAD layer.

I. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD rel. 14 or as agreed to by MAA/OT) form.