

SECTION 16747

TELECOMMUNICATIONS FIBER OPTIC DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for installation and modification of fiber optic distribution systems by Tenants, for use in Tenant facilities and spaces within Ted Stevens Anchorage International Airport, hereinafter referred to as "ANC". Requirements include strict adherence to ANC's established materials and methods, designer and installer qualifications, and telecommunications space and pathway utilization.
- B. ANC has established system manufacturers and strict design requirements for fiber optic systems at all facilities on ANC premises. Tenants are required to maintain compatible systems, including parts, installation methods, extended warranty, etc., for all lease spaces. Tenants are encouraged to employ ANC's designated, pre-qualified telecommunications contractor. However, tenants may utilize a different, ANC-approved, **qualified** specialty contractor, subject to the qualifications of this Section.

1.2 SCOPE OF WORK

- A. Provide complete design and installation of all additions and modifications to facility fiber optic telecommunications systems required to support Tenant's telecommunications systems, including engineering, materials, equipment, labor, testing and documentation, in accordance with ANC's requirements.

1.3 QUALITY ASSURANCE

- A. Provide system engineering and design required to produce drawings and specifications for all Work to be installed in support of Tenant facilities. Submit drawings and specifications to ANC for approval and permits prior to beginning Work. See Referenced Standards and Submittal Requirements below for system design requirements.
- B. Design and layout of the Tenant's fiber optic telecommunications Work shall be performed by a Professional Electrical Engineer, Registered in the State of Alaska, or by a BICSI Registered Communications Distribution Designer (RCDD). Submit the name and qualifications of the system designer as specified in this Section.
- C. Perform Work in accordance with all regulatory rules and regulations as well as references in this specification.
- D. Perform Work in accordance with ANC Terminal Construction Standards, as required by this and all related Sections. ANC Telecom Standard Details are available from ANC and shall be utilized as a basis for the system arrangement.
- E. Perform all testing in accordance with ANSI/EIA/TIA-455-A, ANSI/TIA/EIA-526-7 and ANSI/TIA/EIA-526-14A specifications and submit printed reports to ANC.
- F. Perform all labeling and documentation of the installation in accordance with Section 16748 - Communications Cable Management Documentation and submit all required documentation to ANC.
- G. Qualifications:
 - 1. The work specified in this Section and related telecommunications Sections requires special skills mastered by education, experience, or both. A specialty telecommunications contractor, who may be a division of, or a sub-contractor to, the

Tenant's electrical contractor shall perform fiber optic telecommunications work described in this Section.

2. These systems will become part of an airport wide structured cabling system (Premises Wiring Distribution System – PWDS) based on **Krone** UTP copper cabling and **Corning** fiber cabling systems. **The installer of cabling systems specified herein shall be a certified installer of the respective system, pre-qualified by the Manufacturer for the purpose of offering the extended system Warranty as specified in this Section. Refer to Section 16745 – Tenant Telecommunications Copper Cabling Distribution for requirements for copper telecommunications cabling systems.**
3. Specialty contractors performing telecommunications work shall have a minimum of five years experience in the construction, testing, and servicing of systems of the type specified herein. The contractor shall have direct access to all tools and test equipment required to complete the telecommunications work.
4. Fiber optic cable terminations and testing shall be made by journeymen fiber optic cable installers who have had a minimum of 3 years of individual experience in terminating fiber optic cables.

H. Regulatory Requirements

1. Where a Nationally Recognized Testing Laboratory (NRTL) listing or classification exists for a product and the product is suitable for the purpose specified and indicated, the product shall bear the appropriate marking indicating the listing or classification.
2. Where a UL Standard is in effect, equipment shall:
 - a. Meet that Standard.
 - b. Bear the UL Label.

I. Factory Testing Program:

1. Test all fiber optic cables on the spools at the factory prior to shipping. Submit factory test reports in accordance with submittal requirements.

1.4 REFERENCE CODES AND STANDARDS

- A. The publications listed below form a part of this section to the extent referenced. Publications are referred to in the text by basic designation only, **latest edition** with all addenda. The reference codes and standards are minimum requirements:

REFERENCE	TITLE/REVISION
ANSI/EIA/TIA- 455-A	STANDARD TEST PROCEDURES FOR FIBER OPTIC FIBERS, CABLES AND TRANSDUCERS, SENSORS, CONNECTING AND TERMINATING DEVICES AND OTHER FIBER OPTIC COMPONENTS
ANSI/TIA/EIA-526-7	OPTICAL POWER LOSS MEASUREMENTS OF INSTALLED SINGLE MODE FIBER CABLE PLANT
ANSI/TIA/EIA-526-14A	OPTICAL POWER LOSS MEASUREMENTS OF INSTALLED MULTIMODE FIBER CABLE PLANT
ANSI/TIA-472CAAA	DETAIL SPEC. FOR ALL DIELECTRIC FIBER OPTIC CABLE FOR PLENUM USE

REFERENCE	TITLE/REVISION
ANSI/TIA-472DAAA	DETAIL SPEC. FOR ALL DIELECTRIC FIBER OPTIC CABLE FOR OUTSIDE PLANT USE
ANSI/TIA-492AAAA-A	DETAIL SPEC. FOR 62.5/125 MULTIMODE, GRADED INDEX OPTICAL FIBERS
ANSI/TIA-492AAAB	DETAIL SPEC. FOR 50/125 MULTIMODE, GRADED INDEX OPTICAL FIBERS
ANSI/TIA-492BAAA	DETAIL SPEC. FOR CLASS 4A DISPERSION-UNSHIFTED SINGLEMODE OPTICAL FIBERS
ANSI/ICEA S-83-596	FIBER OPTIC PREMISES DISTRIBUTION CABLE
ANSI/ICEA S-83-640	FIBER OPTIC OUTSIDE PLANT COMMUNICATION CABLE
ANSI/TIA/EIA-568-B	COMMERCIAL BUILDING TELECOMMUNICATION CABLING STANDARD
ANSI/TIA/EIA-569-A	COMMERCIAL BUILDING STANDARD FOR TELECOMMUNICATIONS PATHWAYS AND SPACES
ANSI/TIA/EIA-598-A	OPTICAL FIBER CABLE COLOR CODING
ANSI/TIA/EIA-606A	ADMINISTRATION STANDARD FOR THE TELECOMMUNICATIONS INFRASTRUCTURE OF COMMERCIAL BUILDINGS
ANSI/TIA/EIA-607	COMMERCIAL BUILDING GROUNDING AND BONDING REQUIREMENTS FOR TELECOMMUNICATIONS
ANSI/TIA/EIA-758	CUSTOMER-OWNED OUTSIDE PLANT TELECOMMUNICATIONS CABLING STANDARD
ANSI/TIA/EIA-758-1	ADDENDUM TO ANSI/TIA/EIA-758
ANSI Z136.2	AMERICAN STANDARD FOR THE SAFE OPERATION OF OPTICAL FIBER COMMUNICATION SYSTEMS UTILIZING LASER DIODE AND LED SOURCES
BICSI	TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL

B. Related Terminal Construction Standards Sections:

1. 16111 – Conduit and Fittings
2. 16115 – Cable Tray
3. 16745 – Tenant Telecommunications Copper Cable Distribution
4. 16748 – Communications Cable Management Documentation

1.5 DEFINITIONS

- A. "Fiber" refers to optical fiber cable.
- B. "Composite" – refers to cable constructed with single-mode and multi-mode fibers within a single hybrid cable jacket.

- C. "Pathways" refers to conduits, sleeves, cable trays, distribution rings, etc., which are employed to route backbone and stations cables between equipment rooms, telecommunications closets, stations, outlets, etc.
- D. "Backbone Cables", "Riser Cables" or "Tie Cables" refers to optical fiber cables 6-strand or more, connecting main cross-connect facilities, intermediate cross-connect facilities and telecommunications Closets. These cables may include outside plant cables between buildings and riser cables between floors.
- E. "Equipment Rooms" (ER) refer to a special-purpose room that provides space and maintains a suitable operating environment for building special systems equipment.
- F. "Telecommunications Rooms (TR)" refer to an area-serving facility for housing cable terminations, cross-connect wiring and telecommunications equipment. This is the point at which all horizontal and backbone cables (copper and fiber) terminate.
- G. "Patch Panel" refers to rack or frame mounted multiple fiber terminations with the type of connectors as specified herein.
- H. "Cable Management" refers to rings, troughs, gutters etc., mounted in conjunction with telecommunications distribution equipment and terminal blocks, for the orderly routing of cables, patch cords, etc.
- I. "FTTD" Fiber to the Desk, refers to two-strand, multi-mode fiber optic cable installed from the TR to the end user equipment for horizontal telecommunications circuits.

1.6 SYSTEM REQUIREMENTS

- A. ANC's telecommunication distribution system is a centrally managed, structured Premises Wiring Distribution System (PWDS) consisting of optical fiber backbone, copper voice backbone, Category 5e horizontal cabling and a system of interconnected cabling pathways and equipment spaces.
- B. Main Distribution Frame rooms (MDF) in the North and South Passenger Terminals serve distributed Telecommunications Rooms (TR) in a star configured backbone cabling system. (Some older documents refer to these rooms as IDFs using the then-current terminology for such spaces. References to TRs and IDFs mean the same type of space.) The South Passenger Terminal MDF is the system's primary MDF, located in close proximity to the serving telecom utilities' Main Point of Presence (MPOP). The primary MDF is accessible from MDF rooms in satellite facilities and the North Passenger Terminal via existing inter-building cable plant owned by ANC.
- C. The system is structured for shared Tenant use of ANC owned backbone cabling. Tenants having a single location presence shall utilize ANC's backbone to access utility service via the MPOP. Tenants having multiple location presence shall utilize ANC's backbone for utility access and for transport between non-adjacent tenant spaces. If Tenant's special circumstances require additional backbone capacity, the Tenant shall submit request in writing to ANC. ANC will have the option of modifying or approving tenant modifications to the backbone structure. Use of backbone transport shall be in accordance with Airport Telecommunications Policy. Contact ANC Facilities' Utility Manager for additional information.
- D. Where Tenants are unable to utilize existing ANC backbone fiber optic cabling, additional cables shall be installed by the Tenant in accordance with the requirements of this Section. ANC's telecommunications backbone raceway system is a managed system. Obtain all required permits and duct assignments before installing backbone cabling.
 - 1. Where required for inter-building fiber optic circuits, provide all trenching and backfill, raceways, innerducts, pull ropes, sleeves, boxes, etc.

2. Where required for intra-building fiber optic circuits, provide all cable trays, raceways, innerducts, pull ropes, sleeves, boxes, firestopping etc.
 3. Where existing facilities are insufficient, provide all racks, shelves, enclosures, shelf and enclosure supports, fiber optic cables, connectors, patch panels, splice trays, patch cords, Fiber Distribution Units (FDUs), splices, connections, cable management, labeling, testing, etc., and all other material, equipment, and labor required to make the systems fully operational.
 4. Provide patch panel capacity for the full termination of all installed fiber.
 5. Provide termination and systematic identification of all cables, including all spare and unused fibers, on both ends.
 6. Perform testing of all fiber strands, including all spare and unused fibers, in accordance with the requirements herein.
 7. Provide factory assembled fiber patch cords of the proper configuration and termination type for the patching of circuits and connection of equipment.
- E. The Tenant may install FTTD cabling in lieu of horizontal copper cabling or in the case of special equipment needs. FTTD cabling shall be in accordance with the requirements of this Section.

1.7 COORDINATION

- A. The necessity to plan, schedule and coordinate this work with ANC is emphasized. ANC is not responsible for any omissions, delays and additional cost due to inadequate planning, scheduling, coordination or applications for approval.
- B. Coordinate design and installation of Tenant's telecommunications Work with ANC. Submit design documentation, work schedules, etc., and obtain Airport permits prior to beginning Work.
- C. Coordinate work with other contractors and trades. The layout and installation of the systems specified herein shall be coordinated such that special requirements for telecommunications systems are provided and incorporated into the project. The systems to be coordinated include (but are not limited to) mechanical piping, ductwork and equipment, baggage handling systems, electrical raceway, grounding, fire rated assembly, lighting, power distribution, control and instrumentation.
- D. Downtime for existing systems shall be avoided. Plan, coordinate, and execute installation activities so that facilities are not interrupted. Periods of unavoidable interruption shall be scheduled well in advance and approved in writing by ANC.

1.8 SUBMITTALS AND SHOP DRAWINGS

- A. Submit designer and installer qualifications in accordance with this Section:
 1. Submit the name, qualifications and experience of the system designer.
 - a. Submit experience of designer(s) to be assigned to this project on other Telecommunications projects of similar size and magnitude.
 - b. Designer shall have five years experience on projects of like magnitude and complexity.
 - c. Refer to designer qualification requirements in the Quality Assurance paragraph of this Section.
- B. Submit contractor qualifications in accordance with this Section:

1. If ANC's designated, pre-qualified Telecommunications Contractor is utilized, identification of this fact will satisfy the qualification requirements.
- C. If other than ANC's designated, pre-qualified Telecommunications Contractor is utilized, provide proof of qualifications and obtain ANC's prior approval of the Contractor.
1. Submit proof that the Contractor is a certified installer of the Corning LANscape® system, and approved by Corning to provide a fully warranted system.
 2. Submit the names of the Contractor's personnel to be assigned to this project and the specific responsibility of each. Submit experience of those to be assigned to this project on other Telecommunications projects of similar size and complexity.
 3. The Telecommunications contractor's project superintendent (in office) and foreman (field) shall have five years experience at the superintendent and foreman levels, respectively, on completed Telecommunications projects of like magnitude and complexity.
 4. Demonstrate and document to the extent necessary that sufficient physical and personnel resources are available to accomplish the communications work of this project without endangering timely and proper completion of the work.
 5. Provide a signed statement indicating that the telecommunications systems contractor has the ability to provide the service required by this Section, using factory trained and qualified technicians for each major system type and shall continue to maintain that capability until the end of the guarantee period.
- D. Submit complete product information on the following items to ANC for review prior to beginning Work:
1. Fiber Optic Cable
 2. Fiber Optic Terminations
 3. Pre-connected Fiber Optic Pigtails
 4. Splice Cases
 5. Splice Organizers (Splice Trays)
 6. Pre-Connected Cable Assembly (Fiber Patch Cords)
 7. Fiber Optic Patch Panels
 8. Fiber Distribution Units
- E. Submit complete product information on related items such as conduit, boxes, cable trays, etc., as required by those related Sections.
- F. Labeling System: Coordinate with ANC and satisfy all requirements of Section 16748 - Communications Cable Management Documentation for labeling conventions and Cable Management System (CMS) work. Submit completed labeling schedules to ANC for approval and entering into the existing CMS database by ANC before applying any labels.
- G. Submit Manufacturers Certificate of Warranty as specified in this Section, including all warranty provisions and procedures for ANC to follow to obtain warranty service.
- H. Provide detailed shop drawings for all installations.
1. Detailed designs of equipment in racks shall be in accordance with the ANC Telecom Standard Details.

- I. Submit factory test reports for all fiber optic cable shipped. Refer to Section on Quality Assurance for testing requirements.
- J. Shop Drawings: Submit Shop Drawings for approval by ANC as follows:
 1. Dimensioned routing of conduits and innerducts for fiber optic cables as provided under this specification and indicated on the Drawings. Dimensioned layouts for existing conduit systems are not required.
 2. Dimensioned rack plan layouts for all fiber optic termination equipment in all telecommunication rooms.
 3. Dimensioned rack elevation layouts for all fiber optic termination equipment in all telecommunication rooms.
 4. Labeling System: Coordinate with ANC and satisfy all requirements of Section 16748 - Communications Cable Management Documentation for labeling conventions and Cable Management System (CMS) work. Submit completed labeling schedules to ANC for approval and entering into the existing CMS database by ANC before applying any labels.
 5. Submit Manufacturers Certificate of Warranty as specified in this Section, including all warranty provisions and procedures for ANC to follow to obtain warranty service.

1.9 WARRANTY

- A. The Corning **LANscape** Warranty shall extend **twenty (20)** years from the date of final completion and shall be the standard warranty offered by Corning.
- B. The warranty shall be provided to ANC by the manufacturer through a single point of contact (local warranty service agency or contractor) and shall be fully backed by the manufacturer.
- C. The Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided consisting of the following:
 1. Extended Product Warranty - The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568-B and ISO/IEC IS 11801-B, exceed the attenuation requirements of ISO/IEC IS 11801-B for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of ISO/IEC IS 11801-B for links/channels. The warranty shall apply to all passive components.
 2. System Assurance - The System Assurance shall cover the failure of the wiring system to support any existing application, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568-B or ISO/IEC IS 11801-B component and link/channel specifications for cabling.
 - 1) FDDI
 - 2) IEEE 802.3z 1000Base-SX, 1000Base-LX
 - 3) Future application certified under the applicable standards as noted above.
 3. Extended Product Warranty - The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).
 4. System Certification - Upon successful completion of the installation and subsequent inspection, ANC shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

5. Warranty work on the certificated system shall be authorized by the manufacturer and performed by any factory certified installer of LANscape® system components.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where available the Tenant may utilize existing ANC owned and managed fiber optic cable, equipment racks patch panels, etc., on a first come, first served, space available basis, subject to approval
- B. Where required, provide Corning LANscape® optical fiber cabling, connecting hardware, and related hardware manufactured by Corning Cable Systems.

2.2 MULTIMODE FIBER

- A. Multimode (MM) fiber: Provide 50 µm dual window graded index optical glass with nominal 125 µm cladding diameter. The optical fiber shall comply with ANSI/TIA/EIA-492AAAB.
- B. Each multimode optical fiber shall meet the following graded performance specifications.
 1. Maximum Attenuation: 3.5 dB/Km @ 850 nm, 1.5 dB/Km @ 1300 nm
 2. Minimum LED Bandwidth: 500 MHz-km @ 850 nm, 500 MHz-km @ 1300 nm
 3. Gigabit Ethernet Distance Guarantee: 600 meters @ 850 nm, 600 meters @ 1300 nm
 4. Numeric Aperture: 0.20 ± 0.015
 5. Core Diameter: 50.0 ± 3.0 µm
 6. Cladding Diameter: 125.0 ± 2.0 µm
 7. Core/Cladding Concentricity Error: ≤ 3.0 µm
 8. Cladding non-circularity: ≤ 2.0 %
 9. Core Non-circularity: ≤ 6.0 %
 10. Minimum Tensile Strength: 100,000 psi
 11. Colored Fiber Diameter: 250 µm ± 15 µm
- C. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have either AFC2 OR CPC6 coating or approved equivalent to ensure color retention, minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.

2.3 SINGLEMODE FIBER

- A. Singlemode (SM) fiber: Provide 8.3 µm step-index optical glass with nominal 125 µm core/cladding diameter. The optical fiber shall comply with ANSI/TIA/EIA-492CAAA.
- B. Each singlemode optical fiber shall meet the following graded performance specifications.
 1. Maximum Attenuation:
 - a. Indoor Applications (1-4 fiber): 0.4 dB/Km @ 1310 nm, 0.3 dB/Km @ 1550 nm
 - b. Indoor Applications (5-144 fibers): 0.4 dB/Km @ 1310 nm, 0.3 dB/Km @ 1550 nm
 - c. Outdoor Applications and Indoor/Outdoor Applications:): 0.4 dB/Km @ 1310 nm, 0.3 dB/Km @ 1550 nm

2. Gigabit Ethernet Distance Guarantee: 5000 meters
 3. Numeric Aperture: 0.12 ± 0.015
 4. Core Diameter: $8.8 \mu\text{m}$
 5. Cladding Diameter: $125.0 \pm 1.0 \mu\text{m}$
 6. Core/Cladding Concentricity Error: $\leq 0.8 \mu\text{m}$
 7. Cladding non-circularity: $\leq 1.0 \%$
 8. Core Non-circularity: $\leq 6.0 \%$
 9. Minimum Tensile Strength: 100,000 psi
 10. Colored Fiber Diameter: $250 \mu\text{m} \pm 15 \mu\text{m}$
- C. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have either AFC2 OR CPC6 coating or approved equivalent to ensure color retention, minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.

2.4 FIBER CABLE

- A. Provide fiber cables of loose-tube or tight-buffered construction, comprised of all multi-mode, all single-mode or composite single-mode/multi-mode fibers.
- B. Interior: Provide optical fiber cable of all dielectric, tight buffered design for interior applications.
1. Provide cables OFNR labeled and FT-4 Listed, which meet the requirements of NEC Article 770.
 2. Riser rated:
 - a. Multimode, $2 \leq 24$ count: Refer to Appendix C
 - b. Multimode, $24 \leq 72$ count: Refer to Appendix C
 - c. Multimode, $72 \leq 144$ count: Refer to Appendix C
 3. Plenum rated:
 - a. Multimode, $2 \leq 24$ count: Refer to Appendix C
 - b. Multimode, $24 \leq 72$ count: Refer to Appendix C
 - c. Multimode, $72 \leq 144$ count: Refer to Appendix C
- C. Exterior: Provide optical fiber cable of all dielectric, stranded loose tube design for exterior applications.
1. Loose-tube, non-stranded designs are acceptable for fiber counts of 12 or less in exterior applications.
 2. Provide UL-1666 OFNR compliant cables for interior/exterior applications to allow entry into the building beyond 50 feet without a splice.
 - a. The indoor/outdoor rated cable shall meet the flame retardant characteristics required for Riser rated cable while maintaining mechanical and environmental performance required for outside plant applications.

- b. The cable shall consist of a dry block core design meeting all Bellcore outside plant water penetration requirements.
- c. Environmental Specifications:
 - 1) Operating Temperature Range: -40° F to 167° F (-40° C to 75° C)
 - 2) UV protected jacket
- d. Approved Equipment: Refer to Appendix C
 - 3. The mechanical and environmental specifications for all-dielectric outside optical fiber cable shall be in accordance with ANSI/ICEA S-83-596. All other constructions of outside optical fiber cable shall be in accordance with ANSI/ICEA S-83-640.

2.5 FIBER DISTRIBUTION EQUIPMENT RACK

- A. Provide fiber distribution equipment racks in TR spaces designated by ANC, as follows:
 - 1. 19-inch free standing 7-foot high racks with 44 rack units, pre-installed jumper trough at the top and standard 1.75 inch TIA/EIA hole spacing, Hubbell NextFrame, or as approved.
 - 2. On each side of the equipment rack provide inter-bay vertical cable management attachments with moveable front mounted flanged spools and moveable radiused cable guides. Adjacent racks require only one inter-bay unit between them.
 - 3. Below and adjacent to each installed patch panel provide one two-unit (3.5 inch) horizontal cable management panel.
 - 4. Provide a two unit (3.5 inch) horizontal cable management trough at the lowest useable position of each rack, or just below the bottom of the lowest mounted equipment, which ever is highest. Troughs on adjacent racks shall be at the same elevation to facilitate cross-connecting cables between racks.

2.6 FIBER PATCH PANELS

- A. Provide low-density termination and administration point for fiber cables in the telecommunications equipment rooms with 24 or fewer fiber terminations:
 - 1. 19-inch rack mountable frame with six adapter panel positions per two-unit (3.5 inch) frame.
 - 2. Pre-punched and pre-loaded adapter panels with fiber adapters of the types specified herein, recessed a minimum of 2.5" from the front of the shelf for patch cable management. Provide full compliment of fiber adapters and adapter panels for each frame and label unused adapters "spare".
 - 3. Fiber management provisions to protect connectorized fibers from mechanical stress, macro-bending loss at the connection point and prevent tampering with the circuits.
 - 4. Provisions for individual fiber identification on the panel faceplate.
 - 5. Full front and rear accessibility.
 - 6. Factory installed lock kit for hinged front panel, with two keys furnished for each panel. All panels provided for this project shall be keyed to match existing ANC panels.
 - 7. Hinged translucent polycarbonate-tinted door in front of the connector panels.
 - 8. Approved Equipment: Refer to Appendix C.

- B. Patching Equipment:
 - 1. Multimode Adapter Panel:
 - a. Type ST compatible with ceramic inserts and composite housing.
 - b. Approved Equipment: Refer to Appendix C.
 - 2. Singlemode Adapter Panel:
 - a. "SC" simplex/UPC style with ceramic inserts, factory pre-pigtailed with single-mode MIC cable.
 - b. Approved Equipment: Refer to Appendix C.
- C. Fiber Splicing Equipment:
 - a. Provide rack mounted splice cabinets with capacity as required to connect all single-mode fibers to pre-terminated pigtailed for connection to fiber patch panels:
 - 1) 19-inch rack mountable three-unit housing with 4.5 inch projection containing individual splice trays for transition splicing to pigtailed.
 - 2) Fiber management provisions to protect fibers from mechanical stress.
 - 3) Full front and rear accessibility.
 - 4) Sliding shelf to provide access to individual splice trays and routing guides.
 - 5) Factory installed lock kit for hinged front and rear panels, with two keys furnished for each panel. All panels provided shall be keyed to match existing ANC panels.
 - 6) Hinged translucent polycarbonate-tinted door in front of the connector panels.
 - 7) Approved Equipment: Refer to Appendix C.
 - b. Provide adequate number of splice trays to fully transition all installed single-mode fibers to pre-terminated single-mode pigtailed at each telecommunications room.

2.7 FIBER OPTIC CABLE CONNECTORS

- A. Fiber Optic Connectors – Multi-mode:
 - 1. Provide type ST field installable connectors to terminate multi-mode fiber optic cables from cable-to-cable, cable-to-equipment or equipment-to-equipment, and to make jumpers:
 - a. Insertion Loss: 0.2 dB
 - b. Fiber OD: 125 μ m
 - c. Cable OD: 3.0 / 0.9 mm
 - d. Axial Load, min: 20 lb with less than 0.2 dB change
 - e. Temp. Stability: -40°C to 80°C
 - f. Ceramic Ferrule
 - g. Meet EIA and IEC standards for repeatability and have a locking feature to the coupler and assure non-optical disconnect.
 - h. Approved Equipment: Refer to Appendix C.

B. Fiber Optic Connectors – Single-mode:

1. Provide type SC simplex factory pigtailed connectors to terminate single-mode fiber. Refer to pigtailed connector panels specified above.
 - a. UPC polish with ≤ 55 dB reflectance

2.8 PATCH CORDS AND JUMPERS

A. Multimode Patch Cord Specifications:

1. Provide fiber patch cord consisting of buffered, graded-index fiber with a 50 micron core and a 125 micron cladding for multimode. The 900 micron fiber coating shall be covered by aramid yarn and a jacket of flame retardant PVC. Ceramic ferrules.
2. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connection applications. Provide single strand cords for single equipment connections.
3. Provide the quantity and length of patch cords required, to make an orderly, manageable connection between all patch panels and equipment being cross-connected.
4. Provide patch cords factory terminated with ST compatible connectors for multi-mode circuits.
5. Mated Connector Loss 0.2 dB typical, guaranteed maximum 0.5 dB, 500 insertions
6. Operating temperature: -40°C to 80°C, <0.3 dB change
7. Cable Retention: 20 lb. minimum, <0.2 dB change

B. Single mode Patch Cord Specifications:

1. The fiber patch cord shall consist of Corning SMFC/28 fiber with a 8 micron core and a 125 micron cladding for single mode. The 900 micron fiber coating shall be covered by aramid yarn and a jacket of flame retardant PVC. Provide connectors with ceramic ferrules and UPC polish.
2. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connection applications. Provide single strand cords for single equipment connections.
3. Provide the quantities and length of patch cords required, to make an orderly, manageable connection between all patch panels and equipment being cross-connected.
4. Provide patch cords factory terminated with SC connectors for single-mode circuits.
5. Mated Connector Loss 0.2 dB typical, guaranteed maximum 0.5 dB, 500 insertions
6. Operating temperature: -40°C to 80°C, <0.3 dB change
7. Cable Retention: 20 lb. minimum, <0.2 dB change

2.9 FIBER SPLICES

- A. Fiber optic splices are not allowed except where pre-terminated pigtails are used for single-mode fiber terminations. If field conditions are discovered that require additional splices, submit a request in writing to ANC and obtain approval prior to performing splice
- B. Fiber optic splices shall be fusion splices performed in the field by a qualified splicer. Mechanical splices are not allowed.

- C. Splicing equipment shall provide 3-axis alignment for fiber coatings of 250 micrometers to 900 micrometers and a splice loss of less than 0.05 dB for single-mode fibers.
- D. Provide heat shrink splice protection for all fiber optic splices.
- E. Fiber Optic splices, including single-mode termination pigtailed, shall be performed within Splicing Cabinets:
 - a. Provide rack mounted splice cabinets with capacity as required to connect all single-mode fibers shown on the Drawings to pre-terminated pigtailed for connection to fiber patch panels:
 - 1) 19-inch rack mountable three-unit housing with 4.5 inch projection containing individual splice trays for transition splicing to pigtailed.
 - 2) Fiber management provisions to protect fibers from mechanical stress.
 - 3) Full front and rear accessibility.
 - 4) Sliding shelf to provide access to individual splice trays and routing guides.
 - 5) Factory installed lock kit for hinged front and rear panels, with two keys furnished for each panel. All panels provided for this project shall be keyed alike.
 - 6) Hinged translucent polycarbonate-tinted door in front of the connector panels.
 - 7) Approved Equipment: Refer to Appendix C.
 - b. Provide adequate number of splice trays to fully transition all installed single-mode fibers to pre-terminated single-mode pigtailed at each telecommunications room.

2.10 FIBER OPTIC FLEXIBLE DUCT

- a. Provide conduit innerducts for use with fiber optic cabling in accordance with Section 16111.
- b. Fiber optic innerducts shall extend to the racks or equipment cabinet unbroken via conduit or cable tray, and terminate at the top of the rack.

PART 3 - EXECUTION

3.1 FIBER SPLICES

- A. All fiber optic cable splices shall be fusion splice type.
- B. No FACTORY or OTHER splices are allowed except where pre-terminated pigtailed are used for single-mode fiber terminations.
- C. Completed splices shall be covered with a protective sleeve, heat shrink type, to restore the protective properties of the fiber coating and buffering. Deviations to the splice, location and pulling plan will be permitted, upon approval by ANC. All fiber colors shall be continuous from end to end. No switching or staggering of color scheme within the cable at splice points shall be allowed. Fibers shall be spliced in order.
- D. Cables shall be brought out of the splice enclosure in a controlled environment to perform the fiber fusion splice operation. Splice shall be completed by returning the cable to the splice enclosure such that the excess cable does not impede future entrance and utilization. Cable shall be secured at regular intervals.

3.2 OPTICAL FIBER PATCH PANELS

- A. All cable terminations shall be made on optical fiber patch panels. All installed fibers shall be terminated.
- B. Optical fiber cables shall be enclosed in flexible duct over their entire length up to the fiber distribution equipment rack

3.3 CABLE INSTALLATION FOR ALL CABLES

- A. Test each reel of received fiber optic cable using an Optical Time Domain Reflectometer (OTDR) prior to installation. Cables with detected flaws shall not be installed.
- B. Follow cable manufacturer's specifications regarding handling methods, bend radius and maximum pulling tension limitations.
- C. No copper cables shall be installed in same raceway as optical fiber cables.

3.4 UNDERGROUND CABLE INSTALLATION

- A. All underground optical fiber cable shall be run in flexible ducts. Either three 1-1/4 inch flexible ducts or four 1 inch flexible ducts are to be installed in each 4 inch conduit.
- B. Flexible duct shall enclose all optical fiber cable in conduit and ladder rack. Flexible duct shall be securely fastened to ladder rack and shall end directly above the rack in which the fiber is terminated.
- C. Inner duct assignment of individual cables shall be as Approved by ANC. Cables shall not be placed in ducts other than those Approved.
- D. Fiber optic cables transitioning through handholes and manholes shall be enclosed in flexible duct and positioned to avoid damage by personnel or equipment.

3.5 SECURING CABLE

- A. Immediately after cable placement, a permanent identification tag shall be attached to visible cable sections. Cables shall be checked to ensure that the markings are intact.
- B. Cables and equipment shall be supported and secured. Supports and fasteners shall be used to secure cables and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. All cables shall be routed along the interior sides of manholes. Maintain manufacturer's specified minimum bend radius. Cables shall not be kinked during installation.
- C. Corrosion resistant clamps and straps shall be used as necessary to properly secure the cable.

3.6 BENDING

- A. Caution shall be used when bending cable to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 20 times cable diameter. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cables shall not rest against any sharp edges.

3.7 CABLE PULLING LUBRICANT

- A. Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Lubricant shall be applied to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.

- B. Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Soap and grease type lubricants are not allowed.

3.8 CABLE PULLING

- A. Pulling lines shall be attached to both cable ends when cable is destined for bi-directional pull, and fitted with factory-installed pulling eyes where possible. Cables not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Core hitches shall not be used.
- B. Cable reels shall be located and aligned so that the cable is paid out from the top of the reel by rotating the reel in the feed direction at the rate of pull into the duct or conduit in a long, smooth bend without twisting. Cable shall not be paid out from the bottom of the reel or by pulling. A cable feeder guide of proper dimensions shall be used at the mouth to guide the cable into the duct or conduit.
- C. Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.
- D. All equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cable shall be paid out without stopping until the required amount of the cable has been placed. If the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be overcome by increasing the tension in small steps a few seconds apart until the cable is in motion.
- E. Pulling tension shall not exceed 500 lbs or cable manufacturer's recommendation, whichever is less.

3.9 DAMAGE AND DEFECTS

- A. Contractor shall use a tension monitoring device to ensure that the maximum pulling tension that may be applied to the cable to be pulled into a conduit section is not exceeded. Contractor shall replace cable if cable manufacturer's maximum pulling tension is exceeded at any time during a pull.
- B. Cable shall be carefully inspected for sheath defects or other irregularities as it is paid out from the reel. When defects are detected, pulling shall stop immediately and the cable section shall be repaired or replaced. A system of communications shall be maintained between pulling and feed locations so that pulling can be stopped instantly, when required.
- C. Cable shall be hand guided through intermediate pull points and into the next duct section when making pull-throughs. Proper rigging shall be used in the intermediate pull points to keep the pulling line and cable aligned with the exit duct to prevent the line or cable from rubbing against the edge of the duct. Cables in intermediate pull points shall be set up and/or racked before the cable ends in adjacent manholes are set up and/or racked.
- D. Cable ends pulled into manholes, vaults, pull boxes, or terminal locations that are not to be racked or otherwise permanently positioned immediately shall be tied in fixed positions to prevent damage to the cables and provide adequate working space.
- E. Adequate care shall be exercised when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

3.10 SEAL

- A. Ducts or inner ducts in which cable is placed shall be sealed with urethane foam duct seal. This material shall be inserted between the cable and the duct or inner ducts of which it is in, between the inner ducts and the duct, and in all unused inner ducts, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

3.11 TESTING

- A. Upon receipt of fiber, verify in factory test reports that all fiber cables tested good prior to shipping.
- B. Perform in-place testing of all installed, terminated fibers in accordance with TIA/EIA OFSTP-7 and OFSTP-14 methods. Document and submit all tests results in accordance with specifications.
- C. Multi-mode Testing:
 - 1. Perform optical power loss measurements in accordance with TIA/EIA Standard OFSTP-14 using method C. In addition, perform OTDR testing on multi-mode fiber in accordance with tester manufacturers procedures and examine traces for events indicating faults or flaws which may effect network performance.
 - a. Method C: Using an Optical Loss Test Set (OLTS) with hard-copy and disk output capability to test each installed multi-mode permanent link fiber from both directions at 850 and 1300 nm.
 - b. Using an Optical Time Division Reflectometer (OTDR) test each installed fiber from both directions at 850 and 1300 nm for multi-mode fiber permanent link, minus patch cords.
 - c. Calculate and document test results in accordance with TIA/EIA Standard OFSTP-14.
- D. Single-mode Testing:
 - 1. Perform optical power loss measurements in accordance with TIA/EIA Standard OFSTP-7 using both methods A.3 and B.
 - a. Method A.3: Using an Optical Loss Test Set (OLTS) with hard-copy and disk output capability to test each installed single-mode permanent link fiber from both directions at 1310 and 1550 nm.
 - b. Method B: Using an Optical Time Division Reflectometer (OTDR) test each installed fiber single-mode permanent link fiber from both directions at 850 and 1300 nm.
- E. Provide a graph which indicates the attenuation and distance of each optical fiber for each test performed. The OTDR and associated software shall be Tektronics TFP2 FiberMaster OTDR with FiberMaster Trace Analysis Package or approved equal. Note on each page of test output:
 - 1. Date and Time
 - 2. Test Location
 - 3. Test Technician's Name
 - 4. Test Equipment Used
 - 5. Cable number

6. Strand number
 7. Strand Color
 8. Direction of Test
 9. Attenuation
 10. Length
- F. Test each strand in both directions and produce a graph for each direction. At completion of the project, provide photocopies of the OTDR and OLTS printouts on 8.5" x 11" pages. Also provide output data on CD and submit to ANC at project closeout.
 - G. Test jumpers shall be of the same fiber core size and connector type as the cable system.
 - H. The power meter and the light source shall be set to the same wavelength.
 - I. The light sources, OTDR or OLTS shall operate within the ranges of operation specified for 850 nm, 1300 nm, 1310 nm and 1550 nm in accordance with TIA/EIA-526-14 and TIA/EIA-536-7, or the manufacturer's recommendation whichever is the more stringent. Power meters shall be calibrated and traceable to the National Bureau of Standards.
 - J. All system connectors, sleeves and jumpers shall be properly cleaned before measurements are taken.
 - K. All testing shall be certified as passing testing standards established by TIA/EIA specification for fiber optic cable.
 - L. Test Reports
 1. Contractor shall submit optical fiber test results for each fiber installed. Optical Time Domain Reflectometer (OTDR) Optical Loss Test Set (OLTS) output test result graphs shall be provided for each fiber installed on 8.5" x 11" pages. Also provide output data on CD. The OTDR CD files shall be for use with the OTDR analysis package software. If equipment or software used is incompatible with ANC's OTDR analysis software, a copy of the OTDR analysis package software, licensed to the Owner, shall be delivered to ANC upon completion of the project.

END OF SECTION