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DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SUPPLEMENTAL SPECIFICATION

Section 935 - Fiber Optic System

Delete Section 935 and substitute the following:

935.1 General Description

This work includes the installation of fiber optic cable and equipment including but not limited to cable, interconnect, patch cords, FDC interconnect cables/pig tails, any cable related hardware, connectors, splices, closures, temporary systems, testing, training, or any other fiber optic product as specified on the Plans, or noted in any other Section of these Specifications.

Provide all equipment and materials of like kind and function to be of the exact same manufacture, model, revision, firmware, etc.

Provide all equipment, materials, and work in accordance with all manufacturers' recommendations.

935.1.01 Definitions

General Provisions 101 through 150.

935.1.02 Related References

A. Georgia Standard Specifications

Section 150 – Traffic Control

Section 639 – Strain Poles for Overhead Sign and Signal Assemblies

Section 647– Traffic Signal Installation

Section 682 – Electrical Wire, Cable, and Conduit

Section 940 – System Integration

B. Referenced Documents

Ensure fiber optic cable and equipment meet the requirements in the following documents:

Optical Fiber Standards

- EIA/TIA-492AAAA-A, "Detail Specification for 62.5 μm Core Diameter/125 μm Cladding Diameter Class IA Graded Index Multimode Optical Fibers", Current Edition
- EIA/TIA 492CAAB, "Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers with Low Water Peak", Current Edition
- ITU-T G.652D, "Transmission Media Characteristics, Recommendations G.650-G.659", for single-mode fibers
- Telcordia GR-20-CORE, "Generic Requirements for Optical Fiber and Cable, Current Edition

Fiber Optic Cable and Component Standards

- Telcordia GR-20-CORE, "Generic Requirements for Optical Fiber and Cable, Current Edition
- EIA/TIA-598-B.3, "Optical Fiber Cabling Components Standard", Current Edition

- EIA/TIA-598-B, “Optical Fiber Cable Color Coding Standard”, Current Edition
- RUS 7 CFR 1755.900, “United States Department of Agriculture Rural Utilities Service (RUS) Standard 7 CFR 1755.900”, Current Edition
- Telcordia GR-326 Issue 3, “Generic Requirements for Single-mode Optical Fiber Connectors”, Current Edition
- EIA/TIA-604-XX, “Fiber Optic Connector Intermateability Standards (FOCIS)”, where XX specifies the fiber optic connector type (i.e., ST, SC, LC, etc.), Current Edition
- National Electrical Code Section 770

Fiber Optic Installation Standards and Practices

- Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM), Current Edition
- BICSI Customer-owned Outside Plant Methods Manual , Current Edition
- Society of Cable Telecommunications Engineers (SCTE), “Recommended Practices for Optical Fiber Construction and Testing”, Current Edition
- OSHA Regulations (Standards-29 CFR) 1910, “Occupational Safety and Health Administration Standards
- ANSI/IEEE C2 National Electrical Safety Code
- ANSI/NFPA-70 National Electrical Code

Fiber Optic Measurement and Testing Standards

- EIA Standard FOP-II, Test Condition 1
- Telcordia GR-196-CORE (Issue 2), “Generic Requirements for Optical Time Domain Reflectometer (OTDR) – Type Equipment”, Current Edition
- Applicable Flame Tests: UL 1581 and UL 1666 (Non-Plenum Applications)
- Applicable Flame Test UL 910 (NFPA 262-2002) (Plenum Applications)
- EIA/TIA-526-X, “Standard Test Procedures for Fiber Optic Systems”, Current Edition
- EIA/TIA-526-7 (OFSTP-7), “Optical Power Loss Measurements for Installed Single-mode Fiber Cable Plant”
- EIA/TIA-526-14-A (OFSTP-14A), “Optical Power Loss Measurements for Installed Multimode Fiber Cable Plant”

935.1.03 Submittals

Prior to any work, obtain approval from the Engineer for the products and procedures to be used on the Project.

The following chart provides the Contractor with an outline of the submittal requirements for the equipment and components for this pay item. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

Section 935 Submittal Requirements											
Material	Specification Reference	Catalog Cuts	Mfg. Spec.	Factory Test	Materials Cert.	Lab. Test Reports	Install. Proced.	Test Schedule	Test Plan	Test Reports	Submittal Due Date (Cal. Days after NTP)
F.O. Cable (OSP&IP)	935.2.A,B,&C	X	X	X	X	X	X	X	X	X	60 Days
Patch Cords & FDC Interconnect Cables/Pig Tails	935.2.D	X	X	X		X			X		60 Days
Drop Cable	935.2.E	X	X	X		X			X		60 Days
F.O. Connectors	935.2.F	X	X	X		X					60 Days
Splice Closure	935.2.G&H	X	X	X		X	X		X		60 Days
FDC	935.2.J	X	X	X		X	X		X		60 Days
Transceivers	935.2.K	X	X	X		X	X		X		60 Days

Submit submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items within 60 calendar days after the Notice to Proceed and prior to any installation, unless noted otherwise in the Contract Documents.

Submit to the Engineer for approval, two (2) printed and bound copies and one (1) electronic copy of the manufacturer's descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation and all other materials required within these specifications.

Provide submittal data that is neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item. Use the "Materials Certification Package Index and Transmittal Form", contained in Section 105.02 of the Special Provisions, for each pay item to document and list all material and components that are included in the submittal package. Any submittal data submitted without the Index/Transmittal form or that is incomplete will be rejected.

Products appearing on the Qualified Products List (QPL) are exempt from normal submittal requirements. These products have been evaluated by the Office of Traffic Operations and have proven their capability of meeting the appropriate Georgia Department of Transportation Specification. Any of these products may be used without submitting catalogue cuts, sampling or pre-testing. The Contractor shall submit a letter to the Engineer, stating which QPL items they will use. The Engineer and/or department designee must ascertain that the construction item is the same material identified on the appropriate QPL and will acknowledge receipt of these items in the project diary or as required by the Construction Manual.

A. Cable Certification

Prior to installing any fiber optic cable on the Project, obtain approval for the cable type, cable manufacturer, fiber content, design and installation procedure from the Engineer. Request approval by submitting catalog cuts and factory specifications for the fiber optic cable.

B. Aerial and Underground Splice Closures:

Provide certification from an independent testing laboratory that certifies that the splice closures conform to the specifications and test procedures.

C. Fiber Distribution Center (FDC)

With the submittal data for the pre-terminated FDC (subsection 935.2.J), provide two complete samples of each size and type required in the project. Provide a minimum of 20 feet (6 m) of drop cable with each pre-terminated FDC; any type and manufacture of drop cable is permitted in the sample as long as the cable contains at least as many fibers as the pre-terminated FDC size. For each sample, provide factory test documentation as required in 935.3.06.E.

D. Fiber Optic Test Documentation

Provide the date, time and location of any tests required by this specification (see 935.3.06) to the Engineer at least 72 hours before performing the test. Provide two copies of documentation of the test results to the Engineer within 5 working days of completion of the test for review and approval, or else retest the represented fiber optic cable and provide the documentation within 5 working days of the retest. Bind the test documentation and include the following:

1. OTDR Set-Up: Cable & Fiber Identification
    - Cable ID
    - Cable Location - begin and end point
    - End-to-end cable length in kilometers calculated from cable markings
    - Fiber ID, including tube and fiber color
    - Operator Name
    - Date & Time
2. OTDR Test Parameters: Information to be recorded on each trace
    - Wavelength
    - Pulse width
    - Refractory index
    - Range
    - Scale
3. Test Results
    a. OTDR Test
        - Total Fiber Trace distance in kilometers
        - Splice Loss attenuation in dB per km
        - Events > 0.01 dB
        - Trace analysis detailing all events exceeding 0.01 dB

        Provide OTDR traces meeting Telcordia GR-196-CORE (Issue 2) data format requirements. With advance approval by the Engineer, an alternative format may be used, providing a licensed copy of the software is provided to the Department at no additional cost to the Department.

        Provide all traces on a CD to the Engineer.

        At a minimum, ensure the data includes: cable ID, fiber number, buffer tube, FDC port, fiber distance, test wave length, attenuation in dB per km. Obtain data requirements for each project from the Engineer.

    b. Power Meter End – To – End Attenuation Test

        Perform this test on each fiber link using test procedures described in document EIA/TIA 526 sections 7 & 14A.
        - For each test, document length, number and type of splices and connectors
        - For each test, document link attenuation
        - Provide test data to the Engineer in Excel or compatible spreadsheet form and on a CD.

E. As-Built Documentation

The as-built documentation shall meet all requirements in the Section 940 specifications. In addition to those requirements, the as-built documents shall include final splicing and fiber allocation details for every splice location.

935.2 Materials

Furnish and install all fiber optic parts, materials, components, and equipment consistent and compliant with the latest version or edition of the standards and industry practices specified in Section 935.1.02.B. If a conflict of difference exists between the requirements contained in the specified standards and practices and the requirements contained in these Specifications, use the most stringent material requirement for this contract. Notify the Engineer of any such conflicts or differences prior to procurement of materials and components.

A. Fiber Optic Cable

Ensure all fiber optic related products conform to this specification. Install, apply, inspect, and use those products in accordance with the manufacturer's standard operating and installation procedures and this Specification.

Ensure optical fiber used in both outside and inside plant cable conforms to the requirements specified herein as well as the industry standards and practices listed in Section 935.1.02.

Ensure all fiber optic cable on this project comes from a currently ISO9001 certified manufacturer who is regularly engaged in the production of this material using the processes noted within this Specification. All outside plant fiber optic cable used on each individual project shall be from only one manufacturer and manufacturer production batch.

Use only cable that is new (manufactured no more than eight months prior to the project Notice to Proceed) and of current design and manufacture.

Ensure that single mode optical fiber used in cables meets EIA/TIA 492CAAB, “Detail Specification for Class IVa Dispersion-Unshifted Single-mode Optical Fibers with Low Water Peak”, Current Edition, and ITU-T G.652D, “Transmission Media Characteristics, Recommendations G.650-G.659”, for single-mode fibers

Ensure that all optical fibers in the cable are usable fibers.

The fiber optic cable type, configuration, and installation method will be detailed on the Plans, Drawings, Details, Specifications and in the pay items. Ensure cable and cable installation conforms to all requirements within the Plans and Specifications.

B. Outside Plant (OSP) Cable

This section sets forth the general standards for fabrication and design of outside plant fiber optic cable.

1. OSP Cable Construction
    a. General Requirements: Ensure OSP cable is an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) as meeting the requirements of 7 CFR 1755.900.

       Only use optical fibers that are placed inside a loose gel-free buffer tube.

    b. Buffer Tubes: Ensure each buffer tube contains 12 fibers for all fiber optic cables unless specified otherwise. Ensure fibers cannot adhere to the inside of the buffer tube. Ensure the fibers utilize dry water-blocking materials and construction.

    c. Ensure the fiber optic cable includes loose buffer tubes that isolate internal optical fibers from outside forces and provides protection from outside forces and provide protection from physical damage as well as water ingress and migration.Cable Core: Protect the cable core with a water blocking material. Ensure water blocking material is non-nutritive to fungus, electrically non-conductive and homogenous.

    d. Strength Members: Use a central anti-buckling member consisting of a glass reinforced plastic rod to prevent buckling of the cable.

       Use high tensile strength aramid, fiberglass, or a combination of aramid and fiberglass yarns to provide tensile strength.

    e. Ensure color scheme meets EIA/TIA-598-B, "Color Coding of Fiber Optic Cable."

    f. Cable Jacket: Include in the cable at least one ripcord under the sheath for easy sheath removal.

    g. Helically strand the high tensile strength yarns evenly around the cable core.

    h. Sheath all dielectric cables with medium density polyethylene. Ensure the minimum nominal jacket thickness is 0.06 in (1.5 mm). Apply jacketing material directly over the tensile strength members and water-blocking compound. Ensure the polyethylene contains sufficient carbon black to provide ultraviolet light protection and prevent the growth of fungus.

    i. Ensure the jacket or sheath is free of holes, splits, and blisters.

    j. Ensure the cable jacket contains no metal elements and is of a consistent thickness.

    k. Marking: Mark cable jackets using the following template, unless otherwise shown in the Plans:

       Manufacturer’s Name - Optical Cable - Year - Telephone Handset Symbol – GA DOT - Description

       - For Description of Single-Mode Cable use: XXF SM where XX denotes the fiber count

       Mark the cable length every meter, every 2 ft if marking the cable in English units. Ensure the cable length markings are within -0/+1% of the actual cable length.

       Provide cable marking that is contrasting in color to the cable jacket. Provide cable marking with character heights of approximately 0.10 in (2.5 mm).

2. Additional Requirements for Loose Tube Cable

   Use only cable that is all dielectric, loose tube design. Ensure buffer tubes are stranded around a central member using the reverse oscillation, or "SZ", stranding process.

3. Cable Performance

Ensure all OSP cable meets or exceeds the requirements of the Fiber Optic Test Procedure (FOTP) criteria referenced in 7 CFR 1755.900. Upon the request of the Department, provide certification from an independent testing laboratory certifying the cable conforms to the specifications and test procedures.

a. Pulling Tension: Ensure the cable can withstand a maximum pulling tension of 600 lbf (2.7 kN) during installation (short term) and 200 lbf (890 N) installed (long term).

b. Temperature Range: Provide only OSP cable designed to endure exposure to shipping, storage, and operating temperatures of -30 °F to +158 °F (-34 °C to +70 °C). Provide only OSP cable designed to endure exposure to installation temperatures of -20 °F to +140 °F (-30 °C to +60 °C).

C. Inside Plant (IP) Cable

This section sets forth the general standards for fabrication and design of inside plant fiber optic cable.

1. IP Cable Construction

   a. Strength Members: For the strength member, use a high modulus U.S. manufactured aramid yarn. Ensure non-toxic, non-irritant talc is applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket. For all IP cables used in plenum structures, use only IP cable that meets NEC UL-910 requirements for plenum rated cables.

   b. Cable Jacket: Ensure the jacket to be continuous, free from pinholes, splits, blisters, or other imperfections. Ensure the jacket is smooth, as is consistent with the best commercial practice. Ensure the jacket provides the cable with a tough, flexible, protective coating, able to withstand the stresses expected in installation and service.

      Use yellow cable jackets for single mode.

      Design the cable jacket for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. Ensure that a non-toxic, non-irritant talc is applied to the aramid/fiberglass yarns to allow the yarns to be easily separated from the fibers and the jacket.

      Ensure the nominal thickness of the cable outer jacket is sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.

   c. Color: Use color coded individual fibers for identification. Ensure color coding complies with EIA/TIA-598-B “Optical Fiber Cable Color Coding” as stated in 935.2.B.1.e.

   d. Marking: Mark the outer cable jacket at least every 3 ft (1 m) with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length marking (e.g. "62.5/125 MICRON Type OFNR - UL"). Use print color that contrasts to the color of the jacket and is permanent and legible for the life of the cable.

2. Fabrication by Cable Type

   a. Interconnect Cables: Use interconnect cable to connect the distribution panels of a fiber optic cable plant with the actual electronic devices. Fabricate interconnect cable by surrounding the 900 μm tight buffered fibers with layered U.S. manufactured aramid yarns and a jacket of PVC or Copolymer depending on NEC requirements. Use the aramid yarns as tensile strength members.

   b. FDC Interconnect Cable: Use this cable to splice a factory connectorized multifiber pigtail cable on to an OSP cable end, routing that cable within an FDC and its splice cabinet, and connecting to the termination panels of the FDC. Construct FDC interconnect cable of 900 μm tight buffered fiber (single mode or multi-mode optical fiber) surrounded with U.S. manufactured aramid fibers, and jacketed with flame retardant jacket material. Match the fiber count and buffer tube configuration of the FDC interconnect cable to be exactly equivalent to the OSP cable being terminated in the FDC, unless additional fibers (using other buffer tube colors) are required for an FDC that is larger than the OP cable. Use a yellow exterior jacket for the FDC interconnect cable for single-mode.

3. Temperature Range

   Ensure the cable is designed to endure exposure to a storage temperature range of -30° F to +158° F (-34 °C to +70 ° C) while stored on the original shipping reel. Ensure riser cables are designed to endure an operating temperature range of 0 °F to +158 °F (-18 °C to +70 °C). Ensure plenum cables are designed to endure an operating temperature range of 32° F to +160° F (0 °C to 71 °C).

4. Crush Resistance Requirements

Ensure the cable can withstand a minimum compressive load of 0.061 plf (0.89 N/m) applied uniformly over the length of the compressive plate. Use only cable that has been tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables."

5. Impact Resistance Requirements

   Use only cable that can withstand a minimum of 20 impact cycles. Use only cable that has been tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies."

6. Flammability

   Use only cables that are UL-listed in accordance with NEC, Article 770. Use only Riser cables (OFNR) that pass UL-1666. Use only Plenum cables (OFNP) that pass UL-910.

D. Patch Cords and FDC Interconnect Cables/ Pig Tails

1. Patch Cords

   Use patch cords consisting of a length of fiber optic cable terminated on both ends. For all IP cables used in plenum structures, use only IP cable that meets NEC UL-910 requirements for plenum rated cables.

   a. Fabrication: Ensure all factory preconnectorized assemblies adhere to the applicable cable, cordage, and fiber specifications stated in these Specifications.

      Ensure all inside plant (IP) patch cords meet NEC jacketing requirements.

      Use orange outer jackets for multimode and yellow jackets for single mode.

      Use connector boots of two (2) colors for all duplex patch cords, zip cord or round. Use white or off white for one leg of the duplex cord (non-printed zip leg) and red for the opposite leg (printed zip leg) of the duplex cord.

      For all assemblies for outside plant (OSP) where loose tube is used, include a fan-out kit installed at each connectorized end.

      No splices of any type are allowed within a patch cord assembly.

   b. Factory testing: Fully test each assembly and place those test results on a test tag for each mated pair of connectors. Attach the tag to one end of each pair within the assembly.

      Individually package each assembly within a plastic bag and clearly mark on the outside of that bag the submitted manufacturer's part number.

2. Factory Connectorized FDC Interconnect Cables/Pig Tails

   Use FDC interconnect cables/pig tails consisting of a length of fiber optic cable of one single fiber terminated on one end. Use only FDC interconnect cables/pig tails with factory installed connectors in accordance with Subsection 935.2.F. Provide FDC interconnect cables/pig tails with 900 micron tubing or 3 mm fan out tubing as required for the application. Use FDC interconnect cables/pig tails with 900 micron tubing only when fully enclosed within an FDC. Ensure that the other end of the cable is properly prepared for splicing to another cable. Provide FDC interconnect cable/pig tail in conformity with the same construction and testing requirements as patch cords.

E. Drop Cable Assembly – Outside Plant

Drop cable assembly is defined as a connectorized fiber optic cable (drop cable) and appropriate fan out (if required) used for connectivity between a primary fiber trunk or feeder cable and field devices such as signal controllers, closed circuit television cameras, video detection system cameras, changeable message signs, etc.

1. General Requirements

   Provide a loose tube design drop cable in the drop cable assembly meeting the requirements for outside plant cable as specified in Subsection 935.2.B. Provide the drop cable assembly type (multimode, single-mode or hybrid) and fiber count specified in the Plans.

2. Assembly Fabrication

   Provide a drop cable assembly as specified in the Plans and meeting the following requirements. Use only drop cables that are factory pre-terminated, use splice-on factory-connectorized pigtails/FDC interconnect cables, or are included in pre-terminated FDCs. For factory pre-terminated drop cable assemblies, label each individual fiber with its drop cable fiber number ("1," "2," etc.) on a self-laminating clear overwrapping label on the fan-out tubing within 2 in. (50 mm) of the terminating fiber connector.

   a. Pre-terminated Drop Cable Assembly: Install pre-terminated drop cable assemblies with loose tube design fiber optic cable, factory-installed fiber optic connectors in accordance with Subsection 935.2.F on each drop cable fiber, and factory-assembled fan outs with 3 mm fan out tubing.

b. Field-spliced Drop Cable Assembly: Install field-spliced drop cable assemblies with loose tube design fiber optic cable, fusion spliced factory-connectorized pigtails/FDC interconnect cables, in accordance with Subsection 935.2.D and Subsection 935.2.F on each drop cable fiber.

c. Fan Out - Loose Tube Cable Design: Install field-installed fan outs with 3 mm fan out tubing in accordance with Subsection 935.3.05.J. Additionally, secure the fan out tubing to the main cable sheath in a hard epoxy plug transition that extends a minimum of 2.0 in (50 mm) onto the cable and 2.0 in (50 mm) onto the 3 mm tubing.

F. Fiber Optic Connectors

Furnish and install LC compatible connectors unless otherwise specified, Use ceramic ferrule ultra polish connectors (UPC) for single-mode applications for all connector types. Install connectors as per manufacturer application and recommendations, including proper termination to the outer-tubing.

Use UPC connectors rated for an operating temperature of -40 °F to +167 °F (-40 °C to +75 °C).

Use only factory-installed UPC connectors for all applications except where shown in the Plans for specifically permitted applications in accordance with 935.2.E.2. Use factory-installed UPC connectors installed with a thermal-set heat-cured epoxy and machine polished mating face. Do not use field-installed fiber optic connectors.

Where barrel couplers are used in passive termination applications such as FDCs, use only ST compatible ceramic-insert couplers. Use only manufacturer recommended single-mode couplers for single-mode connector applications. Provide dust caps for both sides of couplers at all times until permanent connector installation.

Provide connectors listed below that do not exceed the maximum loss listed for each connector.

Connector Type	Installation	Max. Loss	Typical Loss	Optical Return Loss
Single-mode	Factory	0.50 dB	0.25 dB	>55 dB

G. Splice Closure - Underground

1. Use

   Provide closures designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes. Ensure splice closures meet or exceed minimum physical requirements listed in the following subsection:

2. Physical Requirements

   Use cylindrical closures or rectangular dome type closures with cable entries at one end only and sealed one-piece high-density polyethylene dome bodies.

   Ensure splice closures are suitable for ECB or pull box applications as shown in the Plans.

   Ensure splice closures prevent the intrusion of water without the use of encapsulate.

   Ensure splice closure cable entry ends have flexible thermoplastic rubber end seals with pre-template cable ports.

   The closure size shown in the Plans specifies the number of splices to be accommodated by the closure. With the closure, provide all materials to accommodate the number of splices specified by the closure size, including splice tray, storage, and organizing materials.

   Provide splice closures capable of accommodating splice organizer trays that accept mechanical, fusion, or multi-fiber array splices. Use splice closures having provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or non-spliced fiber. Use splice organizers that are re-enterable and resealable.

   Use only UL rated splice cases. Where high fiber count (144 to 432) splice cases are required, use cases that have an external pressurization port for optional pressurization.

   Provide splice closures that do not require the use of specialized tools, equipment, or additional parts for re-entry and subsequent reassembly.

   Provide splice closures with provisions for controlling fiber bend radii to a minimum of 1.5 in (38 mm).

H. Splice Closure - Aerial

1. Use

   Provide splice closures designed for use in aerial applications and conform to the requirements below:

2. Physical Requirements

Use cylindrical closures or rectangular dome type closures with cable entries at one end only and sealed one-piece high-density polyethylene dome bodies. Provide splice closures designed for free breathing splice protection without the use of encapsulate. Provide splice closures designed as fully assembled weather tight closures. Ensure splice closure cable entry ends have flexible thermoplastic rubber end seals with pre-template cable ports.

Provide splice closures utilizing corrosion resistant aluminum or stainless steel hardware. Provide splice closures designed in such a way as to allow complete splice access after closure placement, without requiring removal of the closure or electrical bonds from the cable. Provide splice closures suitable for straight, butt or branch splices. Provide splice closures that include provisions for strain relief, both around the cable jacket and to internal cable strength members. Provide aerial closures designed in such a manner that shall eliminate the need for drip collars and sealing collars.

The closure size shown in the Plans specifies the number of splices to be accommodated by the closure. With the closure, provide all materials to accommodate the number of splices specified by the closure size, including splice tray, storage, and organizing materials.

Ensure all closures are the appropriate size to accommodate the number and type of fiber cables used and fit within the space available.

3. Optical Fiber Organizer

   The fiber organizer is a system that holds splice or organizer trays in such a way as to protect and support cable splices within an environmentally protected area. Provide organizer trays capable of storing all common splices; fusion and mechanical, in all configurations; butt, inline and branch (with up to four branch cables). Ensure all trays are completely re-enterable. Ensure organizers themselves accept a minimum of four trays, and provide bonding and grounding hardware.

I. Mechanical Lab Splice

Insertion Loss:

Single Mode < 0.30 dB

Operating Temperature:

-23 °F to 77 °F (-31 °C to 25 °C)

J. Fiber Distribution Center (FDC)

Use rack-mount, wall-mount, or pre-terminated FDCs as specified in the Plans. Use rack-mount, wall-mount, or pre-terminated FDCs in all field cabinets, including all types of ITS and traffic signal cabinets, unless specifically excepted in the Plans.

Use rack-mount and wall-mount FDCs and FDC splice cabinets with enclosures and mounting components of metallic construction. Use FDC interconnect cable for all OP cable terminations in rack-mount and wall-mount FDCs unless otherwise specified in the Plans.

Use FDCs that fit standard 19 inch EIA equipment racks or cabinets.

Use rack-mount FDCs of specified sizes 6-fiber through 24-fiber having front-opening swing-out drawers for access to fiber splicing trays and fiber termination couplers. When closed, ensure swing-out drawers provide dust-tight seals completely enclosing fiber splicing trays, fiber termination couplers, and connecting ends of fiber patch cords connected to couplers.

Use rack-mount FDCs of specified sizes 36-fiber through 60-fiber having fixed-mounted front-facing fiber termination couplers accessible behind a removable transparent plastic dust cover.

Use FDC’s that are sized to fit within the available space of the cabinet.

Use rack-mount FDCs of specified sizes 60-fiber through 144-fiber that include a separate FDC splice cabinet installed adjacent to the FDC. Alternately, rack-mount FDCs with splice cabinets integral to the overall FDC enclosure but contained in a separated compartment either above or below the FDC termination couplers.

Provide rack-mount or wall-mount FDCs with appropriate quantities of couplers, panels, splice trays, organizers, factory-connectorized pigtails/FDC interconnect cables, and ancillary materials to terminate the number of fibers as specified by the FDC size, regardless of the cable size to be terminated as shown in the plans. Use only FDC interconnect cables for FDCs 30-fiber and larger. Where factory pre-terminated drop cable assemblies are permitted and to be used, do not provide splice trays.

Use pre-terminated FDCs that are factory manufactured assemblies of fiber optic drop cable with factory-installed fiber connectors and integral ruggedized fiber connector enclosures. Use pre-terminated FDCs of the sizes specified in the Plans. Use ruggedized fiber connector enclosures of thermally stable rigid plastic housings fully potted with a thermally stable epoxy filling that encapsulates the drop cable fan out, fibers and connector bodies. Use permanent labels on the enclosure with contrasting color to identify each connector body by its associated fiber number.

For FDCs of all types, provide couplers with dust caps in accordance 935.2.F. Use only LC compatible couplers unless otherwise specified.

K. Fiber Optic Snowshoes

Use industry standard fiber optic snowshoes that are factory-manufactured fiber optic cable storage brackets designed for aerial installation on messenger wire cable support spans.

935.2.01 Delivery, Storage, and Handling

Package the cable for shipment on reels. Each package shall contain only one continuous length of cable. Construct the packaging so as to prevent damage to the cable during shipping and handling.

Seal both ends of the cable to prevent the ingress of moisture.

Attach to each reel, a weatherproof reel tag identifying the reel and cable in such a manner to ensure the manufacturing history of the cable and the fiber can be traced by the manufacturer.

Include with each cable a cable data sheet containing the following information:

- Manufacturer name
- Cable part number
- Factory order number
- Cable length
- Factory measured attenuation of each fiber
- Bandwidth specification (where applicable)
- Index of refraction

935.3 Construction Requirements

Ensure all fiber optic parts, materials, components and equipment installed on this contract are consistent and compliant with the latest version or edition of the standards and industry practices specified in Section 935.1.02.B. If a conflict of difference exists between the requirements contained in the specified standards and practices and the requirements contained in these Specifications, use the most stringent material requirement for this contract. Notify the Engineer of any such conflicts or differences prior to procurement of materials and components.

935.3.01 Personnel

General Provisions 101 through 150.

935.3.02 Equipment

Furnish a portable fiber optic light source and power meter test set for testing the fiber optic cable. Provide a test set matched, calibrated and referenced to work as a synchronized test system. Retain ownership of this equipment.

935.3.03 Preparation

General Provisions 101 through 150.

935.3.04 Fabrication

General Provisions 101 through 150.

935.3.05 Construction

A. OSP and IP Cable Installation

Secure from the cable manufacturer the construction and installation procedures to be used on the project. Produce a detailed construction and installation procedure (SOP) covering all aspects of the construction and installation process for each and all specific cable to be used on this project. Submit the SOP to the Engineer for review and approval.

B. Cable Installation Procedures and Standards

1. Safety Precautions

   Follow all appropriate OSHA and industry standards related to safety when working in manholes or underground vaults and when handling optical fibers.

2. Cable Handling

   Install all fiber optic cable according to the manufacturer's recommended procedures and these specifications.

3. Pulling Tension

   Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer.

4. Allowable Bend Radius

   Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:

20 X Cable Diameter	Short Term - During Installation
10 X Cable Diameter	Long Term - Installed

5. Cable Installation Guidelines

   Before the installation begins, carefully inspect the cable reels for imperfections such as nails that might cause damage to the cable as it is unreeled.

   Take all necessary precautions to protect reeled cable from vandals or other sources of possible damage while unattended. Any damage to the cable sections may require replacement of the entire section.

   Whenever unreeled cable is placed on the pavement or surface above a manhole, provide means of preventing vehicular or pedestrian traffic through the area in accordance with Section 150 of the Specifications.

   Use the "figure-eight" cable lay configuration to prevent kinking or twisting when the cable is unreeled or backfed. Do not coil fiber optic cable in a continuous direction except for lengths of 100 ft (30 m) or less. When "figure-eighting" cable, exercise care to relieve pressure on the cable at the crossover of the eight. This may be done by placing cardboard shims at the crossover or by forming a second "figure-eight".

   Keep the cable continuous throughout the pull. Cable breaks are allowed only at designated splice points.

   Where messenger cable is required, as shown in the Plans, lash aerial fiber optic cable to a steel strand wire messenger cable of the size specified in the plans that conforms to Georgia Department of Transportation Specification 915.02.

6. Cable End Sealing

   Where a cable ends without termination in a fiber optic closure, seal the end of the cable by re-using a cable end cap shipped with a cable reel, or use a cap that is size-matched to the cable to be sealed. Clean the end of the cable. Partly fill the cap with a waterproof silicone adhesive sealant and press the cap fully onto the cable end, rotating the cap to fully encapsulate the cable end with the sealant in the cap. Apply a full sealant bead between the end of the cap and the cable jacket.

C. Cable Storage

At designated intervals throughout the cable plant, pull and store excess cable for slack for future terminations or splicing.

Properly store all cable to minimize susceptibility to damage. Maintain proper bend radius, both short and long term, during cable storage.

Communication and Pull Boxes: Store the excess or slack cable in the pull box or communication box in accordance with the Plans details.

Hub/TMC/TCC: Properly store the cable in cable troughs and plenum applications which meet NEC requirements.

Aerial Installations: Store the excess or slack cable at storage loops in a "bow tie" configuration on the messenger strand using two fiber optic snowshoes (aerial fiber cable storage brackets) that maintain the proper bend radius in the fiber cable. Install one fiber optic snowshoe for drop cable and trunk cable storage at aerial splice closures to maintain the proper bend radius in the fiber optic cable.

In addition, ensure the following requirements are met:

1. Cable Storage Requirements - Underground (OSP) & IP

   Unless otherwise noted on the plans, the following are the requirements for cable storage for underground and IP applications:

   a. Pull Box – (Types 4, 4S, 5, 5S, 6, and 7) Apply the following storage requirements for the indicated cable/closure situations.

      - Drop cable with no closure – 10 ft. (3 m)
      - One or more trunk cables with no closure – 110 ft. (34 m) of each cable
      - Two or more trunk cables with one closure – store 55 ft. (17 m) of each trunk cable so that the closure can be removed from the pull box approximately 55 ft. (17 m). If a drop cable is spliced to the trunk cable at this point, store 55 ft. (17 m) of each drop cable.
      - One trunk cable with one closure – 110 ft. (34 m) Install closure in the center of the 110 ft. (34 m) cable loop, so that the closure can be removed from the ECB approximately 55 ft. (17 m). If a drop cable is spliced to the trunk cable at this point, store 55 ft. (17 m) of each drop cable.
      - One trunk cable with one closure and trunk cable ends – 95 ft (30 m). Install closure on the trunk cable at 55 ft (17 m) from the pull box. If a drop cable is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
      - Trunk cable ends with no closure – 95 ft. (30 m)

   b. Hub Building *(interior)* – Do not store slack cable inside the hub building.

   c. Hub Building (exterior adjacent ECBs) – 180 ft (55 m)

   d. Traffic Control Center & Transportation Management Center (OSP splice vault) – 180 ft (55m).

   e. Traffic Control Center & Transportation Management Center (IP at equipment room) – cable entrance to distribution panel bay plus 20 ft (6 m)

   f. Electrical Communication Box (ECB) - (Types 3, 4, 5, and 6) Apply the following storage requirements for the indicated cable/closure situations. More than one situation may occur in a single electrical communication box, in which case apply each appropriate requirement.

      - Trunk cable with no closure – 110 ft (34 m)
      - Trunk cable with one closure – 110 ft (34 m). Measure the storage amount from the top of the ECB manhole opening. Install closure in the center of the 110 ft (34 m) cable loop, so that the closure can be removed from the ECB approximately 55 ft (17 m). If a drop cable(s) is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
      - Trunk cable with one closure and trunk cable ends – 95 ft (30 m). Install closure at 55 ft (17 m) from the ECB on the trunk cable. If a drop cable(s) is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
      - Trunk cable ends with no closure – 95 ft (30 m)

2. Minimum Cable Storage Requirements - Aerial Applications

   Unless otherwise noted on the plans, the following are the minimum requirements for cable storage for aerial applications:

      - Install a minimum 150 ft (45 m) storage loop approximately one half the distance between every equipment drop or as shown in the Plans. Where equipment drops are greater than 1000 ft (300 m) apart, install a minimum 150 ft (45 m) storage loop for every 1000 ft (300 m)of uninterrupted cable length.
      - At aerial splice closures, install 75 ft. (23 m) of drop cable storage and 150 ft. (45 m) of trunk cable storage, unless otherwise noted in the Plans, to allow the fully assembled closure, including the trunk cable and drop cable, to be lowered to ground level for maintenance purposes.

D. Cable Splicing

Splice together each individual reel of fiber optic cable to provide the continuous length of installed cable called for on this Project. Splice cable only at splice points designated on the plans or at locations approved by the Engineer. Make no splices within a patch cord assembly or drop cable.

E. Mid Span/Drop Access

At points where mid span/drop access is required, keep all fibers intact except those being accessed for the equipment drop. Use a suitable tool for removing fibers from the buffer tube to prevent damage to the fibers remaining intact.

F. Connector Termination Procedures

Only use procedures for the termination of the connectors meeting the process set out in that connector manufacturer's standard operating procedure (SOP) for the field installation.

G. Cable Marking

1. Materials

   Use 2-1/2" (63.5 mm) wide, 4" (100 mm) long, wrap-around type cable markers suitable for underground and aerial use. Use UV stabilized marker material and printing inks to provide an aerial durability of at least five years.

   Print text in bold black type on orange or yellow PVC markers, as specified in Section 935.3.05.G.2. Fabricate markers from PVC base material with a minimum thickness of 0.015" (0.38 mm). Pre-print the following text, or alternate text shown in the Plans, legibly on markers used for all cables:

   Cable ID: XXXXXXX
   GA DOT
   Optical Cable

   Where XXXXXXX is the appropriate cable ID as defined in the Plans. Print the text specified above twice on every cable marker with the text of the second image reversed and abutting the first image. in such a manner to ensure the text "reads right" when either short edge of the cable marker is held horizontally upright.

2. Installation

   Clean the installed cable of all dirt and grease before applying any marker. Follow the marker manufacturer's recommended procedure for applying cable markers. Mark all cables in or at every communications hub, electrical communications box, pull box, handhole, equipment cabinet, aerial or underground splice closure, pole attachment, aerial storage bracket, and pole conduit riser entrance. At every trunk cable termination, reel end-to-reel end splice, electrical communications box, pull box, handhole, equipment cabinet, aerial splice closure, and aerial storage bracket, record the cable distance markings from the printline for the cable entry and exit, along with the exact location by Station Number or location name. Record the cable distance markings in a tabular format approved by the Engineer or on a documentation form provided by the Department.

   Place cable markers in the following locations:

   - within 18 in (460 mm) of every cable entry to a pull box, handhole, ECB and hub building
   - within 6 in (150 mm) of every cable entry or termination in an equipment cabinet
   - within 18 in (460 mm) of every splice closure at cable entry points
   - within 6 in (150 mm) of every FDC or splice cabinet in a hub building in which a cable terminates or enters
   - every 20 ft (6 m) for the length of a cable in maintenance coils in electrical communications boxes or pull boxes
   - within 12 in (0.30 m) of every pole attachment, aerial storage bracket, and pole conduit riser entrance

   Use orange markers at all locations, except as noted below:

   - Where a trunk cable enters and leaves a closure (mid-span cable entry or end-to-end splice), use orange markers for one leg of the trunk cable and yellow for the other leg, placing corresponding color labels at the closure end of a leg and at the conduit entrance (underground installation) or span attachment (aerial installation).
   - Where two drop cables terminate in a closure, use orange markers for one drop cable and yellow markers for the other drop cable, throughout the entire drop cable's length to its other termination.

H. Fusion Splicing

1. Use

   Unless otherwise noted, fusion splice all fiber optic splices in accordance with industry codes and the latest version of the manufacturer's recommended guidelines.

2. Procedure

   Perform all fusion splicing and install all splice enclosures according to the manufacturer's recommended guidelines.

3. Splice Protection

   Adequately protect all fusion splices in splice trays or organizers in an enclosure. When splicing inside a building; use a splice center where rack or wall space is available.

   Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the splice tray or organizer manufacturer. Use splice types compatible with the tray design.

   Protect fusion splices with a heat shrink tubing that protects the splice and extends over the fiber coating. Do not leave bare fiber exposed.

I. Mechanical Splicing

1. Use

   Do not use mechanical splices for any purpose other than a temporary connection to fiber optic test equipment. Obtain the Engineer's prior approval for any other use of a mechanical splice.

2. Procedure

   Make all mechanical splices as strain relief/locking types requiring no adhesive or polishing of the fiber ends. Ensure the fibers are self-aligning upon the closing of the mechanical splice. Ensure the splice consists of one piece construction. Ensure there is no stress on the fiber in the alignment area.

   Install all splice closures according to the manufacturer's recommended guidelines.

3. Lab Splice

   Use a mechanical fiber optic lab splice when a temporary joining of two fibers is required, such as in the testing of non-terminated fiber. Ensure the lab splice is re-usable for up to 50 matings. Ensure the lab splice accommodates optical fibers with cladding diameters between 120 and 145 μm.

J. Splice Closures

Install splice closures according to all manufacturers' recommendations. Install splice closures where shown in the Plans and in the approximate center of fiber cable storage coils. Securely mount all splice closures in ECBs or pull boxes to cable rack hooks or mounting brackets.

K. Fiber Optic Cable Fan Out

1. Inside Plant

   Provide all inside plant cable with a fan out in accordance with the manufacturer's recommended guidelines.

L. Temporary Fiber Optic Cable

Furnish and install temporary fiber optic cable systems as shown in the Plans. Furnish temporary fiber optic cable as continuous length cable; do not splice remnant cables together. Terminate cables and patch cords as required in the Plans. Splice the cable along cable route at the points indicated in the Plans.

M. External Transceivers

Shelf mount external transceivers in a manner that does not restrict the replacement of other components in the cabinet housing. In Type 170 traffic cabinets, mount the transceiver on an aluminum shelf permanently attached to the EIA 19" cabinet rack in the rear of the cabinet.

N. Fiber Distribution Center (FDC)

Do not install mechanical splices or field installed connectors. Equip unused panel slots with blank panels. Provide inter-cabinet and inter-bay bend radius and jumper management on each side of the FDC. Install all hardware according to the manufacturer's recommended procedures and Department standards. Determine specific hardware sizing from the project documents.

For rack-mount and wall-mount FDCs, array connectors in a vertical pattern with number one being at the top left position.

Prior to manufacture of pre-terminated FDCs, verify the final installed location of all portions of each drop cable route from the splice closure to the equipment cabinet (including but not limited to the cabinet location, all conduit and pullboxes, and the splice closure location) to determine the required length of drop cable, including all splice closure and storage coils, to be factory manufactured with each FDC. Mount the pre-terminated FDCs with the connectors horizontal

or facing downward, and route the drop cable up or down as necessary. Route and secure the drop cable beside or behind the cabinet side panel such that it is fully strain-relieved, does not violate the manufacturer's recommended bending radius, and does not interfere with the operation of or access to any cabinet equipment or electrical components.

935.3.06 Quality Acceptance

A. Fiber Optic Cable

1. Installation Test

   Test the fiber optic cabling installed on this project according to the fiber's assigned use as shown in the plans and as specified below:

   Upon completion of the cable installation, splicing, and termination, and a minimum of fourteen days before equipment hookup, test all terminated fibers and spare fibers for continuity, events above 0.10 dB, and total attenuation of the cable. In the event that fiber optic cable installed on the project is connected to existing fiber optic cable, perform installation testing on both terminated fibers and spare fibers of the new cable and existing fibers to which the new fibers are spliced or connected. Submit both printed and electronic optical time domain reflectometer (OTDR) traces as specified in Subsection 935.1.03.

2. Test Requirements

   a. OTDR Test: For all fiber links, test and document the installation using OTDR testing.

      Conduct installation testing with a certified technician using an optical time domain reflectometer (OTDR) and optical source/power meter. The technician is directed to conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment. Use an OTDR capable of performing standard OTDR functions, including the ability to display individual loss/gain in dB per km, as well as display all 2-point dB loss cursors to allow isolating and viewing any and all points along a given fiber distance.

      Use a factory patch cord of a length equal to the "dead zone" of the OTDR to connect the OTDR and the cable. Optionally, the Technician can use a factory "fiber box" of 325 ft (100 m) minimum with no splices within the box.

      Conduct the tests at 1310/1550 nm for single mode cable.

   b. Attenuation Test: For all single mode and multi-mode fiber links, test and document attenuation by a standard power-meter test.

      For every fiber installed or connected to, perform end-to-end attenuation test. For the test, use a calibrated optical source and power meter using the standard three-stage procedure. Determine acceptable link attenuation by the cumulative value of standard losses based on length, number and type of splices and connectors.

3. Fiber Optic Cable Acceptance

   Use the following criteria for acceptance of the cable:

   Provide test results demonstrating the dB/km loss does not exceed +3% of the factory test or 1% of the cable's published production loss. Consider the error rate for the test equipment in the test.

   No event can exceed 0.10 dB. If any event is detected above 0.10 dB, replace or repair that event point.

   The total dB loss of the cable, less events, cannot exceed the manufacturer's production specifications as follows:

Cable Type	Max. Attenuation dB/km	Test Wavelength
Singlemode	0.30	1550 nm
	0.40	1310 nm

   If the total loss exceeds these specifications, replace or repair that cable run and assume all expenses, both labor and materials. Elevated attenuation due to exceeding the pulling tension during installation will require the replacement of the cable run at no expense to the Department for either labor or materials.

   NOTE: The Department may allow the "bi-directional/averaging" process of OTDR testing, particularly when splice losses are being unfavorably affected by "mode field diameter misalignment," "core off-set" or "core misalignment."

B. Fusion Splicing

Ensure that the maximum splice loss for any fusion splice does not exceed 0.10 dB.

C. Mechanical Splicing

Ensure the maximum splice loss for mechanical splices does not exceed 0.70 dB. As noted in this specification, mechanical splicing is only allowed when approved by the Engineer for temporary applications.

D. Fiber Distribution Center (FDC)

Test all completed and assembled pre-terminated FDCs at the point of manufacture and provide two copies of the manufacturer test documentation. Test each connecterized fiber in the pre-terminated FDC to demonstrate compliance with all requirements for cables and connectors as detailed in other subsections of these specifications. Include in the test documentation the location station number where the FDC is to be installed, the serial number of the pre-terminated FDC, the drop cable footage markings at each end of the drop cable, and the total drop cable distance. Place one copy of the manufacturer test documentation in the equipment cabinet drawer where the pre-terminated FDC is installed, and submit the other copy to the Engineer.

935.3.07 Contractor Warranty and Maintenance

Provide a one year manufacturer support (usual and customary warranties) period for all fiber optic cable materials furnished and installed as part of the fiber cable system. Include in warranty and support all contractor or manufacturer activities related to maintenance, removal and replacement of cabling, closures and other fiber optic system materials during the period of support. Begin the Manufacturer warranty support period upon successful completion of the Fiber Optic Quality Acceptance testing as outlined in Subsection of 935.3.06. Ensure all Manufacturer warranties are continuous throughout the period and state that they are subject to transfer to the Department.

935.4 Measurement

Fiber optic system, temporary fiber optic system, testing and training complete, in place, accepted and of the kind, size, and type specified is measured as follows.

A. Outside Plant Fiber Optic Cable

Outside Plant fiber optic cable is measured for payment by the actual number of linear feet installed, complete, functional, and accepted. Fiber optic cable shall include but is not limited to all required fiber optic connectors, fiber optic snowshoes, , marking and labeling, patch cords and other ancillary items as required for a complete fiber optic installation.

B. Inside Plant Fiber Optic Cable

Inside Plant fiber optic cable is measured for payment by the actual number of linear feet installed, complete, functional, and accepted. Fiber optic cable shall include but is not limited to all required fiber optic connectors, marking and labeling, patch cords and other ancillary items as required for a complete fiber optic installation.

C. Closures

Underground splice closures, aerial splice closures, and FDCs are measured for payment by the actual number of units installed, complete, functional and accepted. Closures shall include but are not limited to all required mounting and fastening hardware, fiber optic connectors, FDC interconnect cables/pigtails, marking and labeling, patch cords and other ancillary items as required for a complete closure installation.

D. Fiber Optic Splice, Fusion

Fiber optic splices, fusion, are measured for payment by the actual number of splices made, complete, and accepted. Fiber optic splices associated with the use of factory-connectorized FDC interconnect cables/pigtails on drop cables, in accordance with Section 935.2, will not be measured separately for payment. Mechanical splicing for temporary applications shall be included in other work and will not be measured separately for payment

E. Temporary Fiber Optic System

Payment for work on the Temporary Fiber Optic System will be a lump sum project bid price and will be considered full compensation for all installed materials and labor associated with the Temporary Fiber Optic System. Specific items include but are not limited to timber poles, guys, anchors, lashing, messenger cable, conduit directional boring, conduit, fiber optic cable, fusion splicing, hardware attachments, splice enclosures, equipment rentals, and disposal of materials.

F. Transceivers

External drop and repeat transceivers and external star transceivers are measured for payment by the number actually installed, complete, functional, and accepted.

For each unit installed, furnish and install all mounting and interconnection materials, including but not limited to card cages, hardware, fiber and RS-232 jumper cables, RS232/485 converters, and power supply cables at no separate cost to the Department.

935.4.02 Limits

General Provisions 101 through 150.

935.5 Payment

Outside and inside fiber optic cable, FDC interconnect cables/pig tails, splice closures, splices, temporary fiber optic system, transceivers, and testing are paid for at the Contract Unit Price for the various items. All other required items including; FDC interconnect cables/pigtails, fan-out kits, fiber optic connectors, fiber optic snowshoes, and other ancillary items for a completed fiber optic system shall be included as part of the below pay items. No separate payment shall be made for these items. Payment is full compensation for furnishing and installing the items complete and in place according to this Specification.

Payment for all items of this Section is as follows:

Payment will be made under:

Item No. 935	Outside Plant Fiber Optic Cable (type, mode, size)	Linear Feet (Linear Meter)
Item No. 935	Inside Plant Fiber Optic Cable (type, mode, size)	Linear Feet (Linear Meter)
Item No. 935	Fiber Optic Closure (type, size)	Per Each
Item No. 935	Fiber Optic Closure, FDC Pre-Terminated (type, size)	Per Each
Item No. 935	Fiber Optic Splice, Fusion	Per Each
Item No. 935	External Transceiver (mode)	Per Each
Item No. 935	External Star Transceiver (mode)	Per Each
Item No. 935	Temporary Fiber Optic System	Lump Sum

935.5.01 Adjustments

General Provisions 101 through 150.