1. DESCRIPTION:

1.1 Under this item, the Contractor shall furnish, install, configure, and test a Fiber Optic Pre-Terminated Distribution Cable (FPDC) as per the contract documents and/or as directed by the Engineer.

1.2 Fiber Optic Pre-terminated Distribution Cable (FPDC) – Last mile fiber optic cable, with a factory installed, sealed, and hardened connector housing panel, which interconnects a Fiber Optic Backbone Cable (FBC) to specific field equipment cabinets, facilities, or networking centers as noted in contract documents.

2. MATERIALS:

2.1 Optical Requirements;


2.1.2 Attenuation: The nominal attenuation shall not exceed 0.4 dB/km at a wavelength of 1310 nm and 1383, and 0.19 dB/km at a wavelength of 1550 nm. Fiber attenuation shall be uniform with no discontinuities greater than 0.1 dB. The attenuation measurements shall be in accordance with EIA/TIA Standards FOTP-20, 59, 61 and 78. The average change in attenuation at extreme operational temperatures (-40°C to 70°C) shall not exceed 0.05 dB/km at 1550 nm. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.15 dB/km at 1550 nm. The change in attenuation measurements shall be in accordance with EIA/TIA Standard FOTP-3.

2.1.3 Cutoff Wavelength: Not to exceed 1260 nm.

2.1.4 Mode-Field Diameter: 9.30 ± 0.50 µm at 1310 nm and 10.50 ± 1.00 µm at 1550 nm.

2.1.5 Zero Dispersion Wavelength: 1312 nm ± 10 nm.

2.1.6 Zero Dispersion Slope: Not to exceed 0.092 ps/ (nm²-km).

2.1.7 Polarization Mode Dispersion: Not to exceed 0.5 ps/ (km)¹/².

2.1.8 Dispersion: Less than 3.5 ps/ (nm-km) for 1285 nm through 1330 nm and less than 18 ps/ (nm-km) at 1550 nm as measured in accordance with EIA/ TIA Standard FOTP-169.

2.1.9 The FPDC connectors shall be of type specified in the contract documents.

2.1.10 The connector ferrule shall be ceramic with a glass insert.

2.1.11 The connector shall meet the requirements of TIA/EIA-568-B.3.
2.2 **Mechanical Requirements**;

2.2.1 One end of the FPDC shall be permanently integrated into a hardened panel housing.

2.2.2 The panel housing shall be black in color and built of Polycarbonate Material.

2.2.3 Nominal dimensions of the panel housing shall be from 7.3” to 13.05” long, 1.74” wide and 1.705” deep from coupler tip to the base of the unit.

2.2.4 The panel housing shall have 4, 6, 8, 10, or 12 connectors as specified in the contract documents.

2.2.5 The connectors shall be arranged at a 45 degree angle along the length of the housing in a stair-stepped arrangement to facilitate easy access to each coupler pair.

2.2.6 Each coupler port shall have a label affixed to designate the port number.

2.2.7 The fiber optic connectors on the inside of the housing shall be constructed with all ceramic ferrules.

2.2.8 The fiber shall be secured into the ferrule using a heat cured epoxy and shall be factory terminated and polished.

2.2.9 The inside of the housing shall be filled with an environmentally and temperature stable epoxy to permanently secure the connectors and the cable on the inside of the housing and to protect the fiber optic components from vibration and shock. The Epoxy shall be thermally stable from -40 to + 130 degrees Celsius.

2.2.10 The housing shall incorporate a 2.5-inch strain relief boot around the exiting cable to provide bend radius protection and a short term cable retention of at least 200 lbf.

2.2.11 The housing shall have integrated mounting notches for field mounting.

2.2.12 The FPDC supplied by the contractor shall have the number of strands specified in the contract documents to be installed.

2.2.13 The cable and glass fibers shall be manufactured in the United States of America.

2.2.14 The FPDC shall meet the requirements of the ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-2006 and The United States Department of Agriculture Rural Utility Service (RUS) 7 CFR1755.900.

2.2.15 **Fibers**: All optical fibers shall be Corning glass fibers or approved equivalent. All fibers within a given cable shall be from the same
manufacturer, and shall contain no factory splices. Each fiber shall conform to the following minimum requirements:

1) Typical Core Diameter: 8.3 µm
2) Cladding Diameter: 125.0 ± 1.0 µm
3) Core-to Cladding Offset: Not to exceed 0.5 µm
4) Cladding Non-Circularity: Not to exceed 1.0%

2.2.16 Color Coating: Each fiber shall have a color coating applied to it by the manufacturer. The coating shall not affect the optical characteristics of the fiber. The color configuration shall be in accordance with EIA/TIA-598-A:

1) Blue
2) Orange
3) Green
4) Brown
5) Slate
6) White
7) Red
8) Black
9) Yellow
10) Violet
11) Rose
12) Aqua

2.2.17 Primary Coating: Each fiber shall have a dual layered, UV acrylate coating applied to it by the manufacturer. The coating shall be mechanically strippable without damaging the fiber. The coating diameter shall be 245 ± 10 µm.

2.2.18 Central Strength Member: The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

2.2.19 Buffering: All fibers shall be enclosed in non-conductive dual-layer loose buffer tubes with a nominal outer diameter of 2.5 or 3.0 mm. Each buffer tube shall contain twelve (12) fibers. The fiber shall not adhere to the inside of the buffer tube. Each buffer tube containing fibers shall be color coded in a similar scheme as the fiber color. The basic color configuration shall be as follows, in accordance with EIA/TIA-598-A:

1) Blue
2) Orange
3) Green
4) Brown
5) Slate
6) White
7) Red
8) Black
9) Yellow
10) Violet
11) Rose
12) Aqua

Cables requiring additional buffer tubes (greater than 144 strand) shall follow the same color scheme, except dashed. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or the gel filling material. Colors shall not cause fibers to stick together. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900. The buffer tubes shall be filled with a non-hygroscopic gel to prevent water and moisture penetration. The gel shall contain anti-oxidant additives, and the gel shall be readily removable with conventional solvents. The gel shall be non-toxic and dermatologically safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, and electrically non-conductive.
2.2.20 **Filler Rods:** Fill rods shall be used to fill all unused buffer tubes, or shall be used instead of unused buffer tubes. The filler rod shall be a solid polyethylene material and shall be natural in color. The filler rods shall maintain the concentricity of the cable cross section where required.

2.2.21 **Stranding:** Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Two polyester yarn binders shall be applied contra-helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

2.2.22 **Water Swellable Tape:** Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Two polyester yarn binders shall be applied contra-helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

2.2.23 **Tensile Strength Provisions:** Aramid yarn shall be helically stranded evenly around the cable core to provide tensile strength. The yarn shall enable the cable to withstand a maximum pulling force of 2700 N during installation and 890 N long term installed without changing the characteristics of the optical fibers. Each length of cable shall have sufficient strength to be installed in continuous lengths as specified on the plans.

2.2.24 **Outer Jacket:** A medium density polyethylene (MDPE) outer jacket, which complies with the ASTM D1248, Type II, Class C and Grades J4, E7 and E8 standards, shall be applied over the entire cable assembly. The outer jacket shall have a minimum nominal jacket thickness of 1.4 mm, and be free of metal elements, thickness inconsistencies, holes, splits and blisters. The polyethylene shall contain carbon black and shall not promote the growth of fungus. Jacketing material shall be applied directly over the strength members and the water swellable tape. The outer jacket shall contain no metallic elements and shall be of a consistent thickness.

2.2.25 **Markings:** The outer cable jacket shall have sequential length markings in English Units. The actual length of the cable shall be within ±1% of the length markings. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 0.1". The jacket
shall be marked in contrasting color at three (3) feet intervals with the following information:

2.2.25.1 Name of Cable Manufacturer
2.2.25.2 Manufacturer's Catalog Number that includes information on type of fiber and fiber count
2.2.25.3 BNRCN FIBER OPTIC CABLE - NYSDOT – YYYY, where YYYY shall be the year that the cable was manufactured.

2.2.15 Ripcord: The cable shall contain a single ripcord under the sheath to facilitate cable preparation.

2.2.16 Bend Radius: The cable shall be capable of withstanding a minimum bending radius of ten (10) times its outer diameter during operation and fifteen (15) times its outer diameter during installation without changing the characteristics of the optical fibers.

2.2.17 Fish Line: The fish line installed with the cable shall be nylon or polypropylene material with a minimum strength of 200 N.

2.2.18 Fluid Penetration: When a one (1) meter static head of water or equivalent continuous pressure is applied at one end of a one (1) meter length of filled cable for one (1) hour, no water shall leak through the open cable end. The water penetration testing shall be performed in accordance with EIA/TIA Standard FOTP-82.

2.2.19 Filling Compound Flow: When tested in accordance with EIA/TIA Standard FOTP-81, the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 70°C.

2.2.20 Compressive Strength: When tested in accordance with EIA/TIA Standard FOTP-41, the cable shall withstand a minimum compressive load of 22 N/mm applied uniformly over the length of the sample and applied at the rate of 2.5 mm per minute. The load shall be maintained for a period of one (1) minute and then decreased to 110 N/cm. The 110 N/cm load shall be maintained for a period of ten (10) minutes. Attenuation measurements shall be performed before release of the 110 N/cm load. The change in attenuation shall not exceed 0.15 dB at 1550 nm.

2.2.21 Tensile Loading and Bending: When tested in accordance with EIA/TIA Standard FOTP-33, using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670 N and a residual load of 30% of the rated installation load. The axial fiber strain shall be $\leq 20\%$ of the fiber proof level after completion of ten (10) minutes of conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm.

2.2.22 Impact Resistance: When tested in accordance with EIA/TIA Standard FOTP-25, except that the number of cycles shall be two at three locations along a one (1) meter cable length and the impact energy shall be at least
4.4 Nm (in accordance with ICEA S-87640), the change in attenuation shall not exceed 0.15 dB at 1550 nm.

2.2.23 Cable Flex: When tested in accordance with EIA/TIA Standard FOTP-104, the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The fibers shall not experience an attenuation change greater than 0.15 dB at 1550 nm. The cable jacket shall exhibit no cracking or splitting when observed under 5X magnification.

2.2.24 Temperature Cycling: When tested in accordance with EIA/TIA Standard FOTP-3, the change in attenuation at extreme temperatures (-40°C to +70°C) shall not exceed 0.15 dB/km at 1550 nm.

2.2.25 Low or High Temperature Bending: When tested in accordance with EIA/TIA Standard FOTP-37, the cable shall withstand four full turns around a mandrel of ≤ 20 times the cable diameter for four (4) hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. The fibers shall not exhibit a change in attenuation greater than 0.15 dB/km at 1550 nm.

2.2.26 Cable Twist: When tested in accordance with EIA/TIA Standard FOTP-85, a length of cable no longer than 6 feet shall withstand 10 cycles of mechanical twisting without experiencing an attenuation change greater than 0.1 dB at 1550 nm. The cable jacket shall exhibit no cracking or splitting when observed under 5X magnification.

2.2.27 Packaging and Storage: The completed cable shall be packaged for shipment on non-returnable wooden reels. Required cable lengths shall be stated in the purchase order. Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:

- Location to be Installed
- Manufacturer
- Cable Number
- Gross Weight
- Shipped Cable Length in English Units
- Job Order Number
- Product Number
- Customer Order Number
- Date Cable was Tested
- Date Cable was manufactured
- Manufacturer Order Number
- NYSDOT Item Number
- Glass Manufacturer
- Date Glass was manufactured
- Country of origin (USA)
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- An arrow indicating proper direction of roll when handling
- Fork lift-handling illustration
- "DO NOT SHIP REEL ON SIDE" or
- "DO NOT LAY REEL ON ITS SIDE"
- Each reel shall be accompanied by a cable data sheet including all the same information which is on the reel tag.

2.2.28 The Pre-terminated patch panel shall be shipped coiled or on a spool, in either case the free end of the cable shall be on the top end of the coil or spool.

2.3 Material Acceptance Requirements;

2.3.1 The contractor shall submit to the EIC, for review and approval of use, the following products and documentation. All products and documentation listed in this section shall be submitted and approved for each individual cable prior to installation of that cable:

2.3.1.1 A sample length of cable which includes all outer markings required by this specification and tagged with information necessary to trace the sample to the specific cable it was cut from and the manufacturer’s certification documentation.

2.3.1.2 Certification from the fiber strand manufacturer stating the proposed fiber strands meet or exceed the optical requirements stated in this specification.

2.3.1.3 Certification from the cable manufacturer that the optical characteristics of the fiber strands have not been altered by the cable manufacturing process.

2.3.1.4 Certification from the cable manufacturer stating the proposed cable meets or exceeds the mechanical requirements stated in this specification.

2.3.1.5 Third party testing which verifies the manufacturer’s certifications.

2.3.1.6 The fiber count per buffer tube and the buffer tube count configuration.

2.3.1.7 Test procedures and a hard and soft copy of results from an on-site end to end optical power loss power meter test, witnessed by the Engineer, at nominal wavelengths of 1310 nm and 1550 nm, in accordance with the specified testing standards, on all cables after delivery to the site, and prior to installation.

2.3.1.8 Test procedures and a hard and soft copy of results from an on-site OTDR test, witnessed by the Engineer. Testing shall check for continuity, length, anomalies, and approximate attenuation at both 1310 nm and 1550 nm wavelengths, in accordance with the specified testing standards. Each measurement shall be recorded with color, installation location, and the end of the fiber measured. In the event that a meaningful measurement cannot be made from one end, it shall be performed from the opposite end of that fiber.

2.3.2 Proper fiber cladding and fiber tube colors shall be verified by visual inspection. Any difference discovered from the requirements of this specification, fiber optic cable plant layout or approved catalog cut sheets for the cable, shall be grounds for cable rejection.
2.3.3 If the measured attenuation on any fiber does not meet or exceed the specified optical performance criteria of this specification, the entire cable shall be rejected.

2.3.4 The contractor shall provide to the engineer all required experience and certification documentation for the personnel who will be performing installation and configuration activities

2.3.5 Each pre-terminated panel housing shall be provided with factory test results for reflectance and insertion loss. This test report shall reference the serial number of the cable.

2.3.6 Each cable shall be tested from both ends when delivered to the project.

2.3.7 Each terminated end shall be visually inspected with a view safe scope. Any malformations, cracks, or foreign material viewed shall be grounds for rejection of the entire cable.

3. CONSTRUCTION DETAILS:

3.1 Construction Installation;

3.1.1 Prior to the installation of the fiber optic cable, the Contractor shall submit his proposed cable plant design and installation plan to the Engineer for approval. No cable shall be installed until the proposed cable plant design and installation plan submission is approved by the Engineer. The cable plant design and installation plan shall include the following:

3.1.1.1 Catalog cuts and shop drawings for all cable, connectors, splice equipment, Splice Closures, splice trays, Patch Panels, jumper cables, wall mounted cabinets, and cable installation and test equipment.

3.1.1.2 Preliminary locations of all proposed splices.

3.1.1.3 Preliminary fiber assignment diagrams.

3.1.1.4 Proposed pull box locations where hand assists or intermediate assist winches will be required during installation.

3.1.1.5 Cable manufacturer’s recommended cable installation techniques and requirements such that the optical and mechanical properties of the cables are not degraded at the time of installation. The cable manufacturer’s proposed recommendations shall include the following (that apply to this project):

3.1.1.5.1 Cable manufacturer’s approved pulling lubricant for use on the cable and method of application. No other lubricants will be permitted.

3.1.1.5.2 Installation set-up including size and types of rollers, feeder guides, tension gauge make and model number, attachment of pulling jig to jacket and direction of pull.
3.1.1.5.3 Maximum pulling tensions, which shall specify both, pulling from the cable’s conductors and for pulling from the cable’s outer jacket.

3.1.1.5.4 Minimum bend radii, which shall specify a radius both loaded and unloaded.

3.1.1.5.5 Method to install multiple cables.

3.1.2 Splices shall be allowed only at locations designated in the approved cable plant layout or as approved by the Engineer.

3.1.3 The FBC shall be installed in accordance with the approved manufacturer’s recommendations. In addition, the following requirements shall be met:

3.1.3.1 Prior to any installation of cable, the Contractor shall verify that all conduits, manholes and other pathway infrastructure are clean and free of obstructions. If obstructions are found, the contractor shall notify the Engineer and clear the obstructions as ordered by the engineer.

3.1.3.2 Personnel equipped with two (2) way radios shall be stationed at each access point through which the cable is to be pulled to observe and lubricate the cable.

3.1.3.3 Fish line shall be installed in all communications ducts or conduits along with fiber optic communication cables. A 2.0 m length of fish line shall be left coiled, tied and accessible in each cabinet and pull box. The fish line shall be installed according to manufacturer’s specifications and shall be “free” and NOT helicoiled about communications cables.

3.1.3.4 The length of cable slack provided in pull boxes containing splices shall be as designated in the Contract Documents or as directed by the Engineer. If no length is specified in the Contract Documents a minimum slack length of 30 feet shall be provided. Additional slack, as indicated on the approved cable installation plan, may be provided for closure preparation and splicing.

3.1.3.5 The Contractor shall be responsible for ensuring the cable length is sufficient to allow for connection between the communication equipment and the Splice Closures including provision for slack, vertical runs, cable necessary for splicing, waste and cable to allow for the removal of the Splice Closure for future splicing.

3.1.3.6 No fiber optic cable shall be pulled through more than one (1) 90 degree bend unless so indicated on the approved Contract Documents or specifically approved by the Engineer.

3.1.3.7 The cable shall not be pulled over edges or corners, over or around obstructions, or through unnecessary curves or bends.

3.1.3.8 The cable shall be looped in and out of cabinets and pull boxes to provide adequate slack and the least amount of stress on the
fibers. The Contractor shall ensure that the cable is not damaged during storage or installation.

3.1.3.9 Fiber optic cable ends shall be kept sealed at all times during installation, using a method recommended by the cable manufacturer and approved by the Engineer. The cable end shall remain sealed until the Contractor terminates the fiber cables. Cables that are not immediately terminated shall have a minimum of six (6) feet of slack.

3.1.3.10 When using lubricants, the Contractor shall adhere to the cable manufacturer’s requirements for the proper amount, application tools and method, and removal of the lubricant from the exposed cable.

3.1.3.11 Optical fiber cable shall be installed in continuous lengths, without intermediate splices, throughout the project except where splices are indicated on the Contract Documents or approved by the Engineer. Splices shall only be in re-enterable Splice Closures mounted in pull boxes, junction boxes and underground vaults.

3.1.3.12 The maximum pulling tensions and minimum bending radii shall not be violated at any time during installation. The Contractor shall consult with the Engineer concerning existing conduit, pull boxes, and risers, which could force the violation of the minimum bending radius for the fiber optic cable. The Contractor shall obtain approval from the Engineer if modifications to these existing facilities are required. Violation of these parameters shall be cause for rejection of the installed cable.

3.1.3.13 Following installation of the cable in the ducts, all duct entrances at Splice 3.1.3.14 Closures and cabinets shall be sealed with an innerduct termination plug (provided under separate pay item) or a duct sealing compound (if plugs are not provided under separate pay item) to prevent the ingress of moisture, foreign materials, and rodents.

3.1.3.15 Where Trunk Cable terminations are left “dead ended” with no splice closure or splice box, a minimum of 25 m of cable shall be left coiled. The end of the fiber cable shall be sealed in accordance with the manufacturer’s recommendations to prevent contamination of the fiber strands.

3.1.3.16 With exception of dead-ended fiber, each unterminated (neither spliced nor terminated) trunk cable fiber shall be neatly stored in a splice tray within the Closure or splice box for future use.

3.1.3.17 Slack cable, where pulled through a pull box, shall be coiled and secured to the pull box wall as per the contract documents.

3.1.3.18 All fiber optic cables shall be identified by circuit numbers in all cabinets, pull boxes, wire ways, and other Closures and access locations and at all terminal points. Cable designations shall be as shown on the Contractor’s approved shop drawings. The tag ties
shall be wrapped around all cables comprising the circuit to be identified.

3.1.3.19 Cable tags shall be suitable for wet locations and shall be stainless steel tags, No. 28 gauge and 190 mm wide, embossed with letters and numbers approximately 8 mm high, fastened to the cable or wire with nylon cable ties.

3.1.3.20 Tags shall indicate which subsystem and trunk or Drop Cable it is connected to and the cabinet number for the other end of the link as indicated in the Contract Drawings.

3.1.3.21 The Contractor shall label the fiber connectors at the Patch Panel. The labeling scheme selected shall clearly identify the fiber number and connecting device. The labeling scheme is to be approved by the Engineer.

3.1.4 The Contractor shall proof all the conduit prior to installation of the fiber optic pre-terminated distribution cable.

3.2 Construction Acceptance Requirements;

3.2.1 After each cable is completely installed according to the contract documents, the following tests shall be conducted in accordance with approved test procedures. The Contractor shall submit test procedures and forms in paper and electronic formats for approval to the Engineer.

3.2.2 As required for the Fiber Optic Environmentally Hardened Splice Enclosure (Backbone), the Contractor shall measure and record the splice quality of each fusion splice performed. This information shall be submitted to the Engineer as part of the final testing documentation.

3.2.3 An OTDR shall be used for backscattered light measurements. The OTDR shall operate at a nominal wavelength of 1310 nm and 1550 nm and shall include all necessary hardware required to couple it with non-terminated single mode fiber.

3.2.3.1 Proof of Performance Test:
3.2.3.1.1 After the fiber cable has been installed, but prior to any splicing, the Contractor shall conduct a proof of performance test.
3.2.3.1.2 The Contractor shall measure the attenuation of a minimum of 10% of the total fibers selected at random. The Contractor shall sequence the fibers which are to be measured after each pull, such that the same fibers are not measured on consecutive lengths.
3.2.3.1.3 The Contractor shall record the reel number from which the cable came, the identification of the fibers measured and the attenuation in dB/km of the fibers measured.
3.2.3.1.4 If the measured attenuation does not meet or exceed the specified performance criteria of these
3.2.4 After all splice and connector installations, all optical fiber spans (including all dark/spare fibers and non-terminated fibers) shall undergo the following tests. A span is defined as a continuous length of fiber including all splices and connectors:

3.2.4.1 Using an OTDR test each span at 1310 nm and 1550 for fiber attenuation, continuity, length, and anomalies. Each optical fiber shall meet the following acceptance criteria:

   3.2.4.1.1 **Attenuation:** Not to exceed 0.4 dB/km + 0.1 dB/splice + 0.5 dB/connector. The number of splices and cable attenuation shall be based upon the approved cable plant layout.

   3.2.4.1.2 **Anomalies:** No event shall exceed 0.3 dB. If any event is detected at that value, the Contractor shall repair or replace that section of cable.

3.2.4.2 Using an optical source and a power meter, measure the attenuation from both ends. The measured attenuation shall meet the criteria defined for the attenuation using the OTDR.

3.2.4.3 All cable that fails to meet the aforementioned requirements shall be replaced.

3.2.4.4 The Contractor shall maintain a test result record of each span and each fiber. Optical fiber spans shall be identified in the test results by identifying the fiber under test and by identifying the field cabinet at which the OTDR and power meter was connected. The test results shall include the following measurement:

   3.2.4.4.1 Total length of the single mode link

   3.2.4.4.2 Total attenuation of the single mode link

   3.2.4.4.3 Attenuation of each splice in the link under test

   3.2.4.4.4 Attenuation per kilometer of each interconnected fiber in the link under test.

   3.2.4.4.5 Attenuation shall be measured in decibels referencing optical power.

   3.2.4.4.6 Each single mode fiber and splice tested shall be tested to meet the performance requirements in accordance with the contract.

   3.2.4.4.7 The Contractor shall submit to the Engineer a tabulated list of fibers and the actual end-to-end measured values from the above tests and all traces and loss length printouts and in electronic format. This test data shall be the basis of acceptance for the fiber.

   3.2.4.4.8 For optical fibers spliced to existing fibers, this test shall be repeated between the control center and the field termination after the new and existing fibers have been spliced together. If a fiber fails to meet the loss characteristics for the spliced section fiber, the specifications, additional testing may be necessary or the cable shall be rejected.
Contractor shall determine whether the excessive loss is the result of an anomaly in the new section of fiber, splice(s) or existing section of fiber. The Contractor shall, however, be responsible for the new section of fiber and the splice(s) between the two sections.

4. METHOD OF MEASUREMENT:

4.1 The unit price bid per feet shall include procurement, storage, installation, fish line, mounting materials, labeling, documentation, and all testing required to complete the work as per the contract documents. The cable length shall be measured by the physical length of cable installed off the reel. All cables shall be measured as feet of the same item, regardless of the strand count installed.

5. BASIS OF PAYMENT:

5.1 The unit price bid per linear foot for fiber optic pre-terminated distribution cable shall include the cost of furnishing all labor, material, documentation, tools and equipment and testing of the fiber optic pre-terminated distribution cable necessary to complete the work.

5.2 Payment for each item will be made on a partial payment staged basis as follows:

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<th>Description</th>
<th>Payment Percentage</th>
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