State of Delaware
Department of Transportation

ITMS FIBER NETWORK
Construction, Installation, and Maintenance Services

Request For Proposals
Contract No. DOT1885-FIBER_NETWORK

APPENDIX C

Special Provision Item Specifications
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Section SP830 - Conduit Junction Wells for Fiber Installations

SP830001 - Furnish and Install Conduit Junction Well, Type 16, 17” x 30” x 18” Precast Concrete/Polymer

SP830.01 Description.
Furnish, construct, install, adjust, relocate and remove conduit junction wells in accordance with the Contract Documents and as directed by the Engineer.

SP830.02 Materials.

A. Conduit Junction Well, Type 16
   1. Nominal dimensions: 17” x 30” x 18” (width x length x depth)
   2. Precast polymer concrete stackable box with no base, straight-walled
   3. Del. Stone No. 57, Standard Specifications Section 1004
   4. Precast Polymer Concrete
      a. Reinforced by heavy-weave fiberglass
         i. Compressive strength of 9,000 – 15,000 pounds per square inch
         ii. Impact energy of 30-72 foot pounds
         iii. Tensile strength of 800 – 1,100 pounds per square inch
         iv. Tested in accordance with ASTM D543, Section 7, Procedure 1 for chemical resistance
   5. Precast Polymer Concrete Cover
      a. Heavy-duty type with a design load of 15,000 pounds over a 10-inch square.
      b. Coefficient of friction greater than 0.5
      c. Provide logo on cover
         i. “DelDOT TRAFFIC FIBER OPTICS”
   6. Junction Well boxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 “Specification For Underground Enclosure Integrity” for Tier 15 applications.

SP830.03 Construction Methods.
The construction methods shall comply with Section 830.03 of the Standard Specifications.

SP830.04 Method of Measurement.
Installation shall be measured according to Section 830.04 of the Standard Specifications.

SP830.05 Basis of Payment.
The quantity of junction wells installed will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for installation, materials, excavation, backfilling, and installing the stone base, grounding and bonding new
junction well, and for all labor, equipment, tools and incidentals required to complete the work as specified and as directed by the Engineering Documents.
Section SP831 - Conduit for Fiber Installations

SP831001 - Furnish and Install 2” Schedule 80 HDPE Conduit (Bore)

SP831002 - Furnish and Install 4” Schedule 80 HDPE Conduit (Bore)

SP831003 - Furnish and Install 2” Schedule 80 PVC Conduit (Open Cut)

SP831004 - Furnish and Install 4” Schedule 80 PVC Conduit (Open Cut)

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SP831007 - Furnish and Install Additional 2” Schedule 80 HDPE Conduit (Bore)

SP831008 - Furnish and Install Additional 4” Schedule 80 HDPE Conduit (Bore)

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SP831012 - Furnish and Install Additional 4” Schedule 80 PVC Conduit (Trench)

SP831013 - Proof Conduit

SP831014 - Furnish and Install Tracer Wire in Conduit

SP831015 - Furnish and Install Pull Tape in Conduit

SP831.01 Description.

This work consists of installing underground communications conduit, proofing conduit, installing tracer wire in conduit, and/or installing pull tape in conduit in accordance with applicable Standard Specifications, the Contract Documents, and as directed by the Engineer.

SP831.02 Materials.

Furnish conduit and related hardware materials for fiber optic installations in accordance with the Contract Documents and as specified herein:

A. HDPE Schedule 80 Conduit

1. High Density Polyethylene (HDPE), 2-inch or 4-inch trade size, schedule 80
2. Smooth wall construction
3. Permanently pre-lubricated lining
4. Conform to ASTM D2447
5. Conform to ASTM D3035  
6. Conform to NEMA TC7

B. PVC Schedule 80 Conduit  
1. Polyvinyl Chloride (PVC), 2-inch or 4-inch trade size, schedule 80  
2. Conform to ASTM D1785  
3. Conform to Commercial Standard CS-272-65 (PVC)  
4. Conform to U.C. Standard 651 Specifications

C. Fittings  
1. End caps, couplers, and other fittings of material matching the adjoining conduit  
2. LONG sweep sections of material matching the adjoining conduit, and shall be manufactured 90-degree, 45-degree, and 22-degree sweeping bends

D. Tracer Wire for Fiber Optic Conduit  
1. 12 AWG, solid Copper Clad Steel (CCS)  
2. HDPE or HDWPE insulation  
3. UL Listed

E. Pull Rope for Fiber Optic Conduit  
1. Woven polyester tape, pre-lubricated  
2. Printed with sequential footage markings  
3. Tensile strength: minimum 1,100 lbs.

SP831.03 Construction.  
When possible, install conduit in a straight line between terminal points. Provide junction well spacing of no greater than 600 feet. Use sweeping bends for any bends that are required during installation of conduit. No conduit segment between Junction Wells shall have more than a 180 degree direction change. Consult the Engineer prior to installing any bends to ensure that the proper arc is provided.

Provide minimum cover, as measured from the finished grade, of 24 inches and a maximum cover, as measured from the finish grade, of 48 inches.

If not already pre-installed by the manufacturer, install a pull tape in each conduit for future use.

For conduit not terminated to a base or junction well, use typical termination methods as required by the Standard Construction Details. Do not extend conduit into a junction well any more than 3 inches.

When conduit is left empty, place sealed end caps/duct plugs on the ends of all conduits after compressed air has been used to clear all foreign matter. All conduits entering a cabinet or building must be sealed using an appropriate waterproof duct plug or putty.
Tracer wire for locating purposes shall be installed in at least one conduit in each segment or conduit bank as part of this item immediately upon placement of the conduit. The tracer wire shall be pulled simultaneously with the installation of fiber optic cable in a continuous length. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench or bore, only one tracer wire is required. Where multiple pulls of fiber-optic cable are required and conduits may separate into individual trenches or bores, install a tracer wire in each conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing is allowed only in junction wells. Tracer wires must be bonded to the electrical ground rod in each junction well.

SP831.03.1 PVC Conduit Placement.
Furnish up to 4-inch nominal diameter PVC conduit meeting the Material requirements of Section SP831.02 and as specified in the Contract Documents. Using conduit tools, cut and prepare the conduit.

Connect all lengths of PVC conduit by inserting the normal end of one length of conduit into the flared end of the adjoining length of conduit. If conduit pieces bond to one another to form a solid waterproof link. If approved by the Engineer, a coupler module may be used where conduit segments do not align properly to allow the flared end of one conduit segment to mate with the normal end of the other segment.

SP831.03.3 HDPE Conduit Directional Bore Installation.
Use the directional bore method when specified in the Plans for installation of conduits with a diameter no less than 1-1/2 inches under existing pavement. Provide a directional bore that does not exceed the outside diameter of the conduit being installed by more than 1.5-times the conduit diameter. In cases where the directional bore exceeds the outside diameter by more than 1.5-times the conduit diameter, and subject to direction by the DelDOT Fiber Representative / Inspector, pump cement grout into the void.

Upon completion of the directional boring operation and installation of the conduit, uncover the forward end of the conduit and use compressed air to clear all foreign matter before inspection. Repair any existing conduit that is disturbed during installation.

SP831.03.4 HDPE and PVC Open Cut Installation.
Use the open cut installation method when specified in the Plans for installation of conduits with a diameter no less than 1-1/2 inches under existing pavement. If not specified in the Plans, the Engineer must approve all open cutting of roadways. The Contractor is responsible for the removal of all cut pavement and the replacement and repair of any damaged pavement once the conduit is installed.

Saw cut pavement in accordance with Standard Specifications Section 762, and remove and dispose of cut pavement in accordance with Standard Specifications Section 402 or Section 503, for bituminous or rigid pavements respectively. Remove pavement to a width no less than 18 inches and no more than 24 inches. Excavate the trench and stockpile Material for use in backfilling the trench. Stockpiled Material will be deemed suitable or unsuitable for re-use by the
Engineer. If deemed unsuitable, discard and furnish and install new backfill Material at no additional cost to the Department. Excavate to a depth in accordance with Section SP831.03 and the Contract Documents.

Install conduit in the trench and terminate into a junction well or base in accordance with the Standard Construction Details. Flexible conduit (i.e. “bore pipe”) must be secured in the trench in straight line. Heat blankets are not permitted to form bends in rigid conduit. Only manufactured bends will be allowed. Approval must be obtained by the DelDOT Fiber Representative/Inspector prior to backfill.

Backfill trench with approved fill Material. Backfill the trench in maximum 8 inch lifts, compacting the Material in accordance with Standard Specifications Section 207 between lifts. Install underground warning tape over the conduit at a depth of approximately 12 inches below the final grade. Use additional lifts of Material as required to install the warning tape at the specified depth and compact the final lift of fill Material to achieve the desired final grade. Patch open trench in accordance with Standard Specifications Section 402 for bituminous pavements or Standard Specifications Section 503 for rigid pavements.

**SP831.03.5 HDPE and PVC Conduit Unpaved Trench Installation.**

Excavate trench where conduit is to be installed. Excavate the trench and stockpile Material for later use in backfilling the trench. Excavate to a depth in accordance with Section SP831.03 and the Contract Documents. Install conduit in trench and terminate into a junction well or base in accordance with the Standard Construction Details.

Backfill trench with approved fill Material. Fill the trench in maximum 8 inch lifts, compacting the Material in accordance with Standard Specifications Section 207 between lifts. Install underground warning tape over the conduit at a depth of approximately 12 inches below the final grade. Use additional lifts of Material as required to install the warning tape at the specified depth. Tamp the final lift of fill Material to achieve the desired final grade. Topsoil and seed disturbed area in accordance with the appropriate sections of the Standard Specification.

**SP831.03.6 Installation of Additional Conduit**

Install one or more additional conduits at the same time as the initial installation of a single conduit when specified by the Plans. Additional conduits may be stacked one on top of the other, side by side, or in a matrix. The orientation shall be at the contractor’s discretion, but conduits shall not twist around one another or be allowed to deviate from straight-line paths, except in the case of bend installations.

Conduits installed at the same time in the same trench or slot shall remain oriented the same in relation to one another throughout the conduit run. When stacked, the top conduit must maintain the required depth of coverage.
SP831.03.7 Proofing Conduit
Verify that installed conduit is clear of obstructions and structural intact using an appropriately-sized mandrel. A pull tape shall be supplied and installed after the mandrel is sent through the conduit. This work will also include any site preparation necessary to complete the conduit validation, such as pumping water from junction wells or manholes and traffic management. Any obstruction or other defect preventing the passage of the mandrel shall constitute a failure. All failures shall be immediately reported to DelDOT project manager.

SP831.03.8 Installation of Tracer Wire in Conduit
The tracer wire shall be pulled simultaneously with the installation of fiber optic cable in a continuous length. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench or bore, only one tracer wire is required. Where multiple pulls of fiber-optic cable are required and conduits may separate into individual trenches or bores, install a tracer wire in each conduit run.

SP831.03.9 Installation of Pull Tape in Conduit
Pull tape shall be installed in conduit by any method proposed by the contractor and approved by the Engineer.

SP831.04 Method of Measurement.
A. Conduits, all types: The quantity of HDPE or PVC conduit will be measured as the number of linear feet of conduit furnished, installed as specified, complete in place and accepted.
   1. Measure length of conduit installed under existing pavement by directional bore along the path of the bore from the point that cannot be trenched to a point that trenching can resume.
   2. Measure length of conduit installed in open cut pavement or unpaved trench

B. Installation of Additional Conduit, all types: The quantity of HDPE or PVC conduit will be measured as the number of linear feet of conduit for each additional conduit installed as specified, complete in place and accepted. This shall consist only of incremental costs associated with the additional conduit(s) beyond that of installing the first conduit. In runs with multiple additional conduits placed, the quantity will be computed by multiplying the length of run by the number of additional conduits in the run.

C. Proofing of Conduit: The quantity of HDPE or PVC conduit proofed will be measured as the number of linear feet of conduit successfully proofed as specified and accepted.

D. Installation of Tracer Wire in Conduit: The quantity of Tracer Wire will be measured as the number of linear feet of tracer wire furnished, installed as specified, complete in place and accepted.
SP831.05 Basis of Payment.

The quantity of conduit, tracer wire, or pull tape furnished and installed will be paid at the Contract Unit Price per linear foot for each of the Pay Items listed above. Price and payment constitutes full compensation for furnishing conduit, installing conduit under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer. Trench backfill and surface restoration materials shall be considered incidental to these items.

The quantity of conduit proofed will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for furnishing pull tape, proofing conduit under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP852 - Innerduct for Fiber Installations

SP852001 - Furnish and Install Quantity 4 - 1” HDPE Innerduct in Conduit

SP852002 - Furnish and Install 2-inch, 2-Cell Fabric Innerduct in Conduit

SP852003 - Furnish and Install 4-inch, 3-Cell Fabric Innerduct in Conduit

SP852004 - Furnish and Install Second 4-inch, 3-Cell Fabric Innerduct in Conduit

SP852005 – Removal of Innerduct from Conduit

SP852.01 Description.

This work consists of installing innerduct in new or existing conduit in accordance with the Special Provision Item Specifications, applicable Standard Specifications, and as directed by the DelDOT-supplied Engineering Documents.

SP852.02 Materials.

Furnish innerduct and related hardware materials for fiber optic installations in accordance with the Contract Documents and as specified herein:

A. HDPE Innerduct
   1. Corrugated construction
   2. 1-inch nominal inner diameter
   3. 0.035-inch minimum wall thickness
   4. Tensile pulling strength: 261 pounds
   5. Color: multi (as requested by DelDOT)
   6. Carlon A5D2S1xNNBxxxx

B. Fabric Innerduct 2-inch, 2-Cell
   1. Polyester and/or Nylon monofilament design
   2. Designed for installation in 2-inch inner diameter conduit (or larger), providing two cells for cable installation
   3. Capacity for cables of up to 0.85-inch diameter in each cell
   4. MaxCell MXC2002xx or equivalent
   5. Supplied with applicable duct sealing accessories (ex. MXCRTBVLxxxx, or equivalent)

C. Fabric Innerduct 4-inch, 3-Cell
   1. Polyester and/or Nylon monofilament design
   2. Designed for installation in 4-inch inner diameter conduit (or larger), each providing three cells for cable installation
3. Capacity for cables of up to 1.50-inch diameter in each cell
4. MaxCell MXC4003xx, or equivalent
5. Supplied with quadplex duct plugs to seal conduit at all conduit termination points within junction wells (Tyco Jackmoon JU-QUA-xxxxxxx, or equivalent).

**SP852.03 Construction.**

If a pull line is not already pre-installed in the conduit, install a pull line into the new conduit prior to pulling innerduct. Rod existing conduit to ensure that it is free of any obstructions before installing a pull line and pulling innerduct.

If a pull line is not already pre-installed in the innerduct, install a pull line in each innerduct after installing the inner duct.

When installing more than one, innerducts shall all be pulled in together and kept parallel with no twisting or tangling. The pulling procedure and lubricant shall be as recommended by the manufacturer.

No splicing of innerduct shall be permitted between junction wells. All runs must be continuous and unbroken. Innerduct must extend a minimum of 12-inches into each junction well.

All innerducts that are left unused upon installation shall be sealed with suitable duct plugs.

**SP852.04 Method of Measurement.**

The quantity of HDPE or fabric innerduct will be measured as the number of linear feet of innerduct furnished, installed as specified, complete in place and accepted.

**SP852.05 Basis of Payment.**

The quantity of innerduct furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for furnishing conduit, installing conduit under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer. Trench backfill and surface restoration materials shall be considered incidental to these items.
Section SP853 – Microtrenching and Microduct Installation

SP853001 - Furnish and Install 12/8mm HDPE Microduct Under Existing Pavement – Micro-Trenching

SP853002 - Furnish and Install 14/10mm HDPE Microduct Under Existing Pavement – Micro-Trenching

SP853003 - Furnish and Install 12/8mm HDPE Microduct in Unpaved Right-of-Way – Micro-Trenching

SP853004 - Furnish and Install 14/10mm HDPE Microduct in Unpaved Right-of-Way – Micro-Trenching

SP853.01 Description.
This work consists of cutting into existing pavement or unpaved right-of-way to create a trench with a maximum width of 1.5-inches and maximum depth of 14-inches, and placing microduct in an open trench.

SP853.02 Materials:
Furnish Materials for microduct installation, and related hardware in accordance with the Contract Documents and as specified herein:

A. 12/8mm microduct

1. Designed for direct bury, microtrench applications.
2. Constructed of HDPE that conforms to ASTM D3350-98a, Type III, Category 5, Class B or C and Grade P-34 per ASTM D1248-84 or equivalent.
3. Nominal outside diameter of 12mm, and a nominal inside diameter of 8mm

B. 14/10mm microduct

1. Designed for direct bury, microtrench applications.
2. Constructed of HDPE that conforms to ASTM D3350-98a, Type III, Category 5, Class B or C and Grade P-34 per ASTM D1248-84 or equivalent.
3. Nominal outside diameter of 12mm, and a nominal inside diameter of 8mm

C. Tracer Wire for Fiber Optic Conduit

1. 12 AWG, solid Copper Clad Steel (CCS)
2. HDPE or HDWPE insulation
3. UL Listed
**SP853.03 Construction Methods.**

Install microduct(s) having a nominal outer diameter ranging from 10 millimeters to 14 millimeters, with all necessary fittings. DelDOT has the right to reject any installation method proposed for a given work site.

Microduct shall be placed at the depth specified by DelDOT-supplied engineering drawings, unless otherwise specified by DelDOT-appointed inspector. Where installed beneath paved roadways, microduct shall be placed in the sub-base below the roadway base layer (generally 8 to 14 inches below the paved surface). Microduct not terminated to a base or in a vault shall be terminated two feet beyond the edge of the finished grade otherwise directed by DelDOT.

Microducts shall be installed per manufacturer recommendations and specifications, including minimum bend radius and pulling tensions.

**SP853.03.01 HDPE Microduct.**

Furnish high-density polyethylene (HDPE) duct meeting the Material requirements of Section SP1087. All supplied microduct shall have a smooth inner wall and smooth outer wall. Splicing or coupling of HDPE microduct is prohibited without prior approval from DelDOT. All microducts shall be sealed in junction wells and other termination locations per manufacturer specifications. Microducts shall be installed per manufacturer recommendations and specifications, including minimum bend radius and pulling tensions.

**SP853.03.02 Open Cut Installation in Pavement.**

Cut into existing pavement to create a trench with a maximum width of 1.5-inches and maximum depth of 14-inches, and place microduct in the open trench. All open cutting of roadways must first be approved by DelDOT. The conduit shall be installed by cutting a slot in the pavement with a masonry saw. The contractor shall be responsible for the removal of all cut pavement and the replacement and correction of any damaged pavement once the microducts(s) are installed. Install HDPE microduct for all micro-trench runs, unless otherwise specified by engineering drawings. If more than one microduct is required between the same points, install microduct in one common micro-trench. Install tracer wire in each trench directly above the microduct, unless microduct solution has a pre-installed tracer wire.

Remove all excavated material from the job site dispose of properly. Place the microduct flat against the base of the trench and anchor with self-compacting pea gravel at intervals of no more than 9-feet. Pea Gravel shall be placed in mounds no more than 3-inches tall. Fill the trench with free-flowing non-shrink grout meeting or exceeding ASTM C 1107 standards. Unless otherwise specified by DelDOT, the trench shall be filled to match the existing finished grade.
SP853.03.02 Open Trench Installation in Unpaved Surfaces.

Cut into unpaved right-of-way to create a trench with a maximum width of 1.5-inches and maximum depth of 14-inches and placing microduct in an open trench.

Install HDPE microduct for all underground runs, unless otherwise specified by engineering drawings. If more than one microduct is required between the same points, install microduct in one common micro-trench. Install tracer wire in each trench directly above the microduct, unless the microduct solution has a pre-installed tracer wire.

Place microduct flat against the base of the trench and anchor with self-compacting pea gravel at intervals no of more than 9-feet. Pea gravel shall be placed in mounds no more than 3-inches tall. For micro-trenches in unpaved right of way, the trench opening shall be filled to 3-inches below the finished grade with free-flowing nonshrink grout meeting or exceeding ASTM C 1107 standards. The remaining 3-inches shall be filled with matching cover material and seeded with grass of the same type matching the surrounding area. Finish unpaved areas flush with surrounding natural ground.

SP853.04 Method of Measurement:

Installation shall be measured in the number of linear feet of microduct installed and accepted.
SP853.05 Basis of Payment:

The quantity of microduct installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Pricing shall not include microduct materials separately priced in the Material Bid Items. Trench backfill and surface restoration materials shall be considered incidental to these items.
Section SP854 - Fiber Optic Cable Installation in Conduit

SP854001 - Furnish and Install 12-Strand, Loose Buffer Tube Cable in Conduit

SP854002 - Furnish and Install 24-Strand, Armored, Plenum Rated, Loose Buffer Tube Cable in Conduit

SP854003 - Furnish and Install 24-Strand, Loose Buffer Tube Cable in Conduit

SP854004 - Furnish and Install 48-Strand, Armored, Plenum Rated, Loose Buffer Tube Cable in Conduit

SP854005 - Furnish and Install 48-Strand, Loose Buffer Tube Cable in Conduit

SP854006 - Furnish and Install 48-Strand, Ribbon Cable in Conduit

SP854007 - Furnish and Install 96-Strand, Loose Buffer Tube Cable in Conduit

SP854008 - Furnish and Install 108-Strand, Armored, Loose Buffer Tube Cable in Conduit

SP854009 - Furnish and Install 144-Strand, Armored, Plenum Rated, Loose Buffer Tube Cable in Conduit

SP854010 - Furnish and Install 144-Strand, Loose Buffer Tube Cable in Conduit

SP854011 - Furnish and Install 144-Strand, Ribbon Cable in Conduit

SP854012 - Furnish and Install 216-Strand, Ribbon Cable in Conduit

SP854013 - Furnish and Install 100-Foot Fiber Optic Tail in Conduit

SP854014 - Furnish and Install 500-Foot Fiber Optic Tail in Conduit

SP854015- Furnish and Install 1000-Foot Fiber Optic Tail in Conduit

SP854016 - Furnish and Install 1500-Foot Fiber Optic Tail in Conduit

SP854017 - Furnish and Install 2000-Foot Fiber Optic Tail in Conduit

SP854018 - Furnish and Install 2400-Foot Fiber Optic Tail in Conduit

SP854019 - Furnish and Install 100-Foot Fiber Optic Trunk in Conduit

SP854020 - Furnish and Install 500-Foot Fiber Optic Trunk in Conduit

SP854021 - Furnish and Install 1000-Foot Fiber Optic Trunk in Conduit

SP854022 - Furnish and Install 1500-Foot Fiber Optic Trunk in Conduit

SP854023 - Furnish and Install 2000-Foot Fiber Optic Trunk in Conduit
SP854024 - Furnish and Install 2400-Foot Fiber Optic Trunk in Conduit

SP854025 - Removal of Fiber Optic Cable from Conduit

SP854027 – Install DelDOT-furnished Fiber Optic Cable in Conduit

SP854.01 Description.

This work consists of furnishing, installing and removing fiber optic cable in conduit in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP854.02 Materials.

Furnish fiber optical cable materials and related hardware in accordance with the Contract Documents and as specified herein:

A. Armored, Plenum Rated, Loose Buffer Tube Singlemode Fiber Optic Cable
   1. Conform to ITU-T G.652.D
   2. Aluminum interlocking armor design
   3. Listed per NEC OFCP, FT-6
   4. Conform to NFPA 262 and CSA FT-6 (for plenum, riser and general building applications)
   5. Conform to ICEA S-83-596
   6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable

B. Loose Buffer Tube Singlemode Fiber Optic Cable
   1. Conform to ITU-T G.652.D
   2. Conform to Telcordia GR-20
   3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
   4. Comprised of All Dielectric (AD) materials
   5. Comprised of a gel-free cable design incorporating dry water-blocking elements
   6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
   7. Max Tensile Strength Short Term: 2700N (600 lbf)
   8. Max Tensile Strength, Long Term: 890 N (200 lbf)
C. Loose Buffer Tube Multimode Fiber Optic Cable
1. 50 µm core diameter, type OM4 per TIA-492-AAAD or 62.5 µm core diameter, type OM1 per TIA-492-
2. Conform to Telcordia GR-20
3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
4. Comprised of All Dielectric (AD) materials
5. Comprised of a gel-free cable design incorporating dry water-blocking elements
6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
7. Max Tensile Strength Short Term – 2700N (600 lbf)
8. Max Tensile Strength, Long Term 890 N (200 lbf)

D. Ribbonized Fiber Optic Cable
1. Conform to ITU-T G.652.D
2. Conform to Telcordia GR-20
3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
4. Comprised of All Dielectric (AD) materials
5. Comprised of a gel-free cable design incorporating dry water-blocking elements
6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
7. Max Tensile Strength Short Term: 2700N (600 lbf)
8. Max Tensile Strength, Long Term: 890 N (200 lbf)

E. Preterminated Fiber Cable Tails
1. Conforms to Telecordia GR-20
2. Conforms to GR-771
3. Conforms to EIA/TIA 568-B.3
4. RDUP listed
5. One preterminated cable end with non-pinned MT style connector
   a. Conforms to Telcordia GR-3152
   b. Conforms to EIA/TIA 568-B.3
6. One fiber stub cable end

F. Preterminated Fiber Cable Trunks
1. Conforms to Telecordia GR-20
2. Conforms to GR-771
3. Conforms to EIA/TIA 568-B.3  
4. RDUP listed  
5. Two pre-terminated cable ends with non-pinned MT style connector  
   a. Conforms to Telcordia GR-3152  
   b. Conforms to EIA/TIA 568-B.3  

G. Fiber Cable Labels  
1. Self-laminating, rigid vinyl  
2. Yellow / black  
3. Dimensions: 3.50" W x 2.00" H  
4. Labels shall read: 'Caution fiber optic cable type ___ count ___'  
5. Panduit PST-FO, or equivalent  

SP854.03 Construction.  
Any and all cable(s) installed in violation of allowed methodology shall be removed and replaced with new cable(s) using correct methods at no cost to DelDOT.  

SP854.03.1 Loose Buffer Tube Fiber Optic Cable Supply.  
Furnish Loose Buffer Tube Fiber Optic cable meeting the Material requirements of Section SP854.02. Loose buffer tube fiber will contain 12-strand buffer tubes, in 12, 24, 48, 96, 108 and 144-count sheaths, delivered on reels holding a contiguous fiber cable length of up to 16,000 feet. Pricing shall include return shipping of steel reels, if used. Coordinate cable orders to ensure cable lengths are provided as needed to support contiguous cable runs without splicing (not including mid-sheath splices) according to DelDOT Contract documents and/or as directed by DelDOT Fiber Representative/Inspector.  

SP854.03.2 Ribbonized Fiber Optic Cable Supply.  
Furnish Ribbonized Fiber Optic cable meeting the Material requirements of Section SP854.02. Ribbonized fiber will contain 12-strand ribbons in 144 and 288-count sheaths, delivered on reels holding a contiguous fiber cable length of up to 16,000 feet. Pricing shall include return shipping of steel reels if used. Coordinate cable orders to ensure cable lengths are provided as needed to support contiguous cable runs without splicing (not including mid-sheath splices) according to DelDOT Contract documents and/or as directed by DelDOT Fiber Representative/Inspector.  

SP854.03.3 Installation in Conduit, RMC, or Innerduct.  
Install fiber optic cable in existing or newly installed conduits, innerduct or RMC. Conduit, RMC, or innerduct may or may not contain an existing communications cable or cable(s). A strain limiter/release element that will part if the strain exceeds 300 pounds for 12-count fiber and 600 pounds for larger cables shall be used for outdoor fiber optic cable between the pulling grip and the pulling medium.
Any and all cable(s) pulled into any conduit without the use of an acceptable pulling grip, kelloms or equivalent, or without the use of a strain limiter/release element, or by using methods which may result in pulling forces in excess of strain release material set forth herein or prescribed by industry standards are unacceptable.

Slack loops shall be installed in each junction well to provide a minimum of 10-percent additional cable material compared to the physical route distance to facilitate maintenance and splicing, or as specified by DelDOT-supplied engineering drawings.

All cables shall be labeled in each junction well on each side of the slack coil and at each termination point using per-printed cables labels to include labels on all termination devices.

**SP854.03.4 Removal of Fiber Optic Cable from Conduit, RMC, or Innerduct**

Remove one or more fiber optic cable(s) from existing conduit, RMC, or innerduct. Per the contract documents; all may be removed, or one or more cable(s) may remain. Hand pulling methods are required. Prior written approval by DelDOT is required for the use of any power assisted method of pulling wire or cable(s) from conduit. A strain limiter/release element that will part if the strain exceeds 600 pounds shall be used between the pulling grip and the pulling medium.

Removed fiber optic cable shall be coiled, OTDR tested according to specifications herein, and returned to DelDOT if directed by the DelDOT Fiber Representative/Inspector.

**SP854.04 Method of Measurement**

Installation of Fiber Optic Cables, all types, all methods: the quantity of Loose Buffer Tube, Ribbonized, Preterminated Fiber Cable Trail, or Preterminated Fiber Cable Trunk shall be measured as the number of lineal feet of Fiber Optic material (to include footages of slack loops installed) furnished, installed as specified, complete in place and accepted.

Removal of Fiber Optic Cables, all types, all methods: the quantity of Loose Buffer Tube, Ribbonized, Microfiber, Preterminated Fiber Cable Trail, or Preterminated Fiber Cable Trunk shall be measured as the number of lineal feet of Fiber Optic material (to include footages of slack loops installed) removed as specified, returned and accepted.

**SP854.05 Basis of Payment**

The quantity of fiber optic cable furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for furnishing fiber optic cable, installing fiber optic cable under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.

The quantity of fiber optic cable removed and returned will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for
removing fiber optic cable, testing fiber optic cable under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP855 – Aerial Fiber Optic Cable Installation

SP855001 - Furnish and Install 12-Strand Singlemode, Loose Buffer Tube Cable on Strand

SP855002 - Furnish and Install 12-Strand Multimode, Loose Buffer Tube Cable on Strand

SP855003- Furnish and Install 24-Strand Singlemode, Loose Buffer Tube Cable on Strand

SP855004 - Furnish and Install 48-Strand Singlemode, Loose Buffer Tube Cable on Strand

SP855005 - Furnish and Install 48-Strand Singlemode, Ribbon Cable on Strand

SP855006 - Furnish and Install 96-Strand Singlemode, Loose Buffer Tube Cable on Strand

SP855007 - Furnish and Install 144-Strand Singlemode, Loose Buffer Tube Cable on Strand

SP855008 - Furnish and Install 108-Strand Singlemode, Armored, Loose Buffer Tube Cable on Strand

SP855009 - Furnish and Install 144-Strand Singlemode, Ribbon Cable on Strand

SP855010 - Furnish and Install 216-Strand Singlemode, Ribbon Cable on Strand

SP855011 - Furnish and Install 100-Foot Fiber Optic Tail on Strand

SP855012 - Furnish and Install 250-Foot Fiber Optic Tail on Strand

SP855013 - Furnish and Install 500-Foot Fiber Optic Tail on Strand

SP855014 - Furnish and Install 1000-Foot Fiber Optic Tail on Strand

SP855015 - Furnish and Install 1500-Foot Fiber Optic Tail on Strand

SP855016 - Furnish and Install 2000-Foot Fiber Optic Tail on Strand

SP855017 - Furnish and Install 2400-Foot Fiber Optic Tail on Strand

SP855018 - Furnish and Install 100-Foot Fiber Optic Trunk on Strand

SP855019 - Furnish and Install 500-Foot Fiber Optic Trunk on Strand

SP855020 - Furnish and Install 1000-Foot Fiber Optic Trunk on Strand

SP855021 - Furnish and Install 1500-Foot Fiber Optic Trunk on Strand

SP855022 - Furnish and Install 2000-Foot Fiber Optic Trunk on Strand

SP855023 - Furnish and Install 2400-Foot Fiber Optic Trunk on Strand

SP855024 - Removal of Fiber Optic Cable from Strand (De-lash)
SP855.01 Description.
This work consists of furnishing, installing and removing aerial fiber optic cable in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP855.02 Materials.
Furnish fiber optical cable materials and related hardware in accordance with the Contract Documents and as specified herein:

A. Loose Buffer Tube Singlemode Fiber Optic Cable
   1. Conform to ITU-T G.652.D
   2. Conform to Telcordia GR-20
   3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
   4. Comprised of All Dielectric (AD) materials
   5. Comprised of a gel-free cable design incorporating dry water-blocking elements
   6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
   7. Max Tensile Strength Short Term: 2700N (600 lbf)
   8. Max Tensile Strength, Long Term: 890 N (200 lbf)

B. Loose Buffer Tube Multimode Fiber Optic Cable
   1. 50 µm core diameter, type OM4 per TIA-492-AAAD
   2. Conform to Telcordia GR-20
   3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
   4. Comprised of All Dielectric (AD) materials
   5. Comprised of a gel-free cable design incorporating dry water-blocking elements
   6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
   7. Max Tensile Strength Short Term: 2700N (600 lbf)
   8. Max Tensile Strength, Long Term: 890 N (200 lbf)
C. Ribbonized Fiber Optic Cable

1. Conform to ITU-T G.652.D
2. Conform to Telcordia GR-20
3. Conform to USDA Rural Development, Utilities Program (RDUP) PE-90
4. Comprised of All Dielectric (AD) materials
5. Comprised of a gel-free cable design incorporating dry water-blocking elements
6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable
7. Max Tensile Strength Short Term: 2700N (600 lbf)
8. Max Tensile Strength, Long Term: 890 N (200 lbf)

D. Preterminated Fiber Cable Tails

1. Conforms to Telecordia GR-20
2. Conforms to GR-771
3. Conforms to EIA/TIA 568-B.3
4. RDUP listed
5. One preterminated cable end with non-pinned MT style connector
   a. Conforms to Telcordia GR-3152
   b. Conforms to EIA/TIA 568-B.3
6. One fiber stub cable end

E. Preterminated Fiber Cable Trunks

1. Conforms to Telecordia GR-20
2. Conforms to GR-771
3. Conforms to EIA/TIA 568-B.3
4. RDUP listed
5. Two pre-terminated cable ends with non-pinned MT style connector
   a. Conforms to Telcordia GR-3152
   b. Conforms to EIA/TIA 568-B.3

F. Fiber Cable Labels

1. Self-laminating, rigid vinyl
2. Yellow / black
3. Dimensions: 3.50" W x 2.00" H
4. Labels shall read: ‘Caution fiber optic cable type ___ count ___’
5. Panduit PST-FO, or equivalent
G. Steel Lashing Wire
   1. Type 302 Stainless Steel
   2. 0.045-inch nominal diameter

H. Fiber Optic Snowshoe
   1. Hubbell Opti-Loop FOS-3, or equivalent
   2. Aluminum with polyester powder coat finish
   3. 17.7” Outside Diameter
   4. 31” Length

SP855.03 Construction.
Any and all cable(s) installed in violation of allowed methodology shall be removed and replaced with new cable(s) using correct methods at no cost to DelDOT.

SP855.03.1 Loose Buffer Tube Fiber Optic Cable Supply.
Furnish Loose Buffer Tube Fiber Optic cable meeting the Material requirements of Section SP855.02. Loose buffer tube fiber will contain 12-strand buffer tubes, in 12, 24, 48, 96, 108 and 144-count sheaths, delivered on reels holding a contiguous fiber cable length of up to 16,000 feet. Pricing shall include return shipping of steel reels, if used. Coordinate cable orders to ensure cable lengths are provided as needed to support contiguous cable runs without splicing (not including mid-sheath splices) according to DelDOT Contract documents and/or as directed by DelDOT Fiber Representative/Inspector.

SP855.03.2 Ribbonized Fiber Optic Cable Supply.
Furnish Ribbonized Fiber Optic cable meeting the Material requirements of Section SP855.02. Ribbonized fiber will contain 12-strand ribbons in 144 and 288-count sheaths, delivered on reels holding a contiguous fiber cable length of up to 16,000 feet. Pricing shall include return shipping of steel reels if used. Coordinate cable orders to ensure cable lengths are provided as needed to support contiguous cable runs without splicing (not including mid-sheath splices) according to DelDOT Contract documents and/or as directed by DelDOT Fiber Representative/Inspector.

SP855.03.5 Aerial Installation.
Install fiber optic cable by lashing cable to messenger wire or an existing areal attachment (overlapping). Aerial cable installation shall be performed using methods approved by the cable manufacturer, and in accordance with NEC and pole owner-approved designs. Lashing wire shall be placed to follow the lay of strand wire, wrapped around cable at intervals no greater than 8-inches. The lashing wire shall start and terminate on each span between poles. The end points shall be installed so that the lashing wire remains tensioned. At mid-span splices, the lashing wire shall terminate on each side of the splice.
Slack loops shall be installed in snowshoes and provide a minimum of 10-percent additional cable material compared to the physical route distance to facilitate maintenance and splicing, or as specified by DelDOT-supplied engineering drawings.

All cables shall be labeled at each slack location and at each termination point using pre-printed cable labels.

New installation of aerial attachments shall occur only after the contractor is notified that any utility pole make-ready work required by the pole owner is complete, and that DelDOT has received attachment licenses from the pole owner.

**SP855.03.6 Removal of Fiber Optic Cable from Strand (De-Lashing)**

Remove fiber optic or coaxial cable from strand wire. The location of the fiber optic cable to be removed will be designated by DelDOT. All tape or lashing wire holding cable to strand must be removed and disposed of properly. The fiber optic cable must be completely removed from the strand and shall not be cut in shorter lengths as it is being removed. Removed fiber cable shall be coiled, OTDR-tested, and returned to DelDOT unless otherwise stated.

**SP855.03.7 Aerial Fiber Optic Slack Loop Installation**

Install aerial fiber optic cable slack loops to support strand using suitable “fiber optic snowshoe” hardware at locations prescribed by engineering drawings supplied by DelDOT. Coil fiber optic cable with a bend radius no less than what is specified for storage by the cable manufacturer. Unless otherwise specified, install a minimum of 100 feet of slack cable between the Snowshoe racks or between the snowshoe and splice case. Lash slack cable separately from the initial span lashing. Install fiber optic snowshoe racks with diameters that exceeds the manufacturer’s specification for the minimum bend radius of the cable placed in it.
**SP855.04 Method of Measurement**

Installation of Fiber Optic Cables, all types, all methods: the quantity of Loose Buffer Tube, Ribbonized, Preterminated Fiber Cable Trail, or Preterminated Fiber Cable Trunk shall be measured as the number of lineal feet of Fiber Optic material (to include footages of slack loops installed) furnished, installed as specified, complete in place and accepted.

Removal of Fiber Optic Cables, all types, all methods: the quantity of Loose Buffer Tube, Ribbonized, Preterminated Fiber Cable Trail, or Preterminated Fiber Cable Trunk shall be...
measured as the number of lineal feet of Fiber Optic material (to include footages of slack loops installed) removed as specified, returned and accepted.

Installation of Aerial Fiber Optic Slack Loops: the quantity of aerial fiber optic slack loops installed shall be measured as the number of slack loops furnished, installed as specified, complete in place and accepted. This Item only includes installation of the fiber optic storage loop, Measurement will not be made for installation fiber optic cable which is accounted for in other Items.

**SP853.05 Basis of Payment**

The quantity of fiber optic cable furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed below. Price and payment constitutes full compensation for furnishing fiber optic cable, installing fiber optic cable under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.

The quantity of fiber optic cable removed and returned will be paid at the Contract Unit Price per linear foot for the Pay Items listed below. Price and payment constitutes full compensation for removing fiber optic cable, testing fiber optic cable under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.

The quantity of aerial fiber optic slack loops furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed below. Price and payment constitutes full compensation for furnishing fiber optic snowshoes, installing aerial fiber optic slack loops under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP856 – Microfiber Optic Cable Installation

SP856001 Furnish and Install 48-strand Microfiber Cable in Microduct

SP856002 Furnish and Install 144-strand Microfiber Cable in Microduct

SP856.01 Description.
This work consists of furnishing, installing and removing fiber optic cable in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP856.02 Materials.
Furnish fiber optical cable materials and related hardware in accordance with the Contract Documents and as specified herein:

A. Microfiber Optic Cable
   1. Conform to ITU-T G.652.D
   2. Conform to ANSI S-87-640
   3. Conform to TIA/EIA-455
   4. Comprised of All Dielectric (AD) materials
   5. Comprised of a gel-free cable design incorporating dry water-blocking elements
   6. Marked with white letters indicating; Manufacturer name, month and year of manufacture, number of optical fibers, and sequential length markings in feet at a minimum of every two feet along the cable

G. Fiber Cable Labels
   1. Self-laminating, rigid vinyl
   2. Yellow / black
   3. Dimensions: 3.50" W x 2.00" H
   4. Labels shall read: 'Caution fiber optic cable type ___ count ___',
   5. Panduit PST-FO, or equivalent

SP856.03 Construction.
Any and all cable(s) installed in violation of allowed methodology shall be removed and replaced with new cable(s) using correct methods at no cost to DelDOT.
SP856.03.1 Microfiber Optic Cable Supply.
Furnish Microfiber Optic cable meeting the Material requirements of Section SP1061. Microfiber will contain 12-strand buffer tubes in 48 and 144-count sheaths, delivered on reels holding a contiguous fiber cable length of up to 16,000 feet. Pricing shall include return shipping of steel reels if used. Coordinate cable orders to ensure cable lengths are provided as needed to support contiguous cable runs without splicing (not including mid-sheath splices) according to DelDOT Contract documents and/or as directed by DelDOT Fiber Representative/Inspector.

SP856.03.2 Installation of Microfiber Optic Cable in Microduct
Install microfiber in microduct using air-assisted installation. Either the “Jetting” or “Blowing” method of air-assisted installation may be used depending on what is recommended by the cable manufacturer’s specification. Use an air compressor with a PSIG and CFM output equal to or below the optimal output recommended by the cable manufacturer’s specification. The compressor should have a shut off or clutch feature that limits the push force on the cable. At no time during the installation process shall the cable’s maximum short-term tensile strength be exceeded. Use lubricant if required by the microduct manufacturer.

Slack loops shall be installed in each junction well to provide a minimum of 10-percent additional cable material compared to the physical route distance to facilitate maintenance and splicing, or as specified by DelDOT-supplied engineering drawings.

SP856.04 Method of Measurement
Installation of microfiber cable shall be measured as the number of lineal feet of Fiber Optic material (to include footages of slack loops installed) furnished, installed as specified, complete in place and accepted.

SP856.05 Basis of Payment
The quantity of microfiber cable furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for furnishing fiber optic cable, installing fiber optic cable under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP857 – Fiber Optic Splice Enclosures

SP857001 - Furnish and Install of New Splice Enclosure

SP857002 - Re-entry of an Existing Splice Enclosure

SP857003- Furnish and Install of New Mid-sheath Splice Enclosure (Ring Cut)

SP857.01 Description.
This work consists of furnishing and installing fiber optic cable splice enclosures in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP857.02 Materials.
Provide fiber optic splice enclosures in accordance with the Contract Documents and as specified herein:

A. Fiber Optic Splice Enclosure
   1. 3M Type 2178-LS, or equivalent
   2. 21.9” x 8.5” x 8.0” (L x W x H)
   3. 6 Cable Entry Ports

B. Splice Enclosure Cable Addition Kit
   1. 3M Type 2181-LS, or equivalent
   2. 21.9" x 8.5" x 1.5" (L x W x H)

C. Aerial Hanger Bracket Kit
   1. 3M Type 2197, or equivalent

D. Replacement Gasket Kit
   1. 3M Type 2187-LS/GSKT, or equivalent

SP857.03 Construction.

SP857.03.1 Installation of New Splice Enclosure
Setup equipment, prepare cable ends for splicing, and install the splice enclosure in an underground junction well or on aerial strand for one or more cables containing up to 288 fiber strands.
Cable preparation shall include marking or labeling cables according to the general direction of the cable path upon egress from the splice enclosure. Current standards consist of marking using color-coded, waterproof tape (blue tape for north/east and orange tape for south/west).

Splice enclosure installation shall be in accordance with applicable standards and manufacturer instructions.

**SP857.03.2 Re-entry of an Existing Splice Enclosure**

Reenter an existing non-encapsulated, gasket-sealed splice enclosure to make additional splices, install a new gasket, and reseal the enclosure after the splice work has been completed. Splice enclosure installation shall be in accordance with applicable standards and manufacturer instructions.

**SP857.03.3 Installation of New Mid-Sheath Splice Enclosure**

Install mid-sheath splice enclosure, allowing access to one or more fibers for splicing without cutting the entire cable. Cut away a section of cable jacketing to expose the buffer tubes, cut or split open a buffer tube (depending on whether or not there are active fibers in that tube), prepare the designated fibers for splicing, and install a splice enclosure to house the exposed section of cable. It typically will be performed on DelDOT’s backbone fiber to facilitate splicing to a new or existing lateral fiber cable.

Cable preparation shall include marking or labeling cables according to the general direction of the cable path upon egress from the splice enclosure. Current standards consist of marking using color-coded, waterproof tape (blue tape for north/east and orange tape for south/west).

Care shall be taken not to cut any fibers that are in active use, and may require use of an active fiber identifier to verify strands not in-use before cutting strands. The work may include pulling fiber cable slack from adjacent junction wells, and includes installing the splice enclosure in an underground pull box or vault for one or more cables containing up to 288 fiber strands. Splice enclosure installation shall be in accordance with applicable standards and manufacturer instructions.

**SP857.04 Method of Measurement**

The quantity of Fiber Optic Splice Enclosures furnished and shall be measured as the actual number of splice enclosures installed as specified, complete in place and accepted.

The quantity of Fiber Optic Splice Enclosures re-entered shall be measured as the actual number of splice enclosures installed as specified, complete in place and accepted.

**SP857.05 Basis of Payment**

The quantity of fiber optic splice enclosures furnished and/or installed will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for furnishing fiber optic cable splice enclosure, installing fiber optic cable.
splice enclosure under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP858 – Fiber Optic Termination Panels

SP858001 - Furnish and Install Rack Mounted CCH-Style Termination Panel Housing, 1RU

SP858002 - Furnish and Install Rack Mounted CCH-Style Termination Panel Housing, 2RU

SP858003 - Furnish and Install Rack Mounted CCH-Style Termination Panel Housing, 4RU

SP858004 - Furnish and Install Rack Mounted CLSSC-Style Termination Panel Housing, 4RU

SP858005 - Furnish and Install Wall Mounted SPH-Style Termination Panel Housing, 1 Connector Panel Capacity

SP858006 - Furnish and Install Wall Mounted WCH-Style Termination Panel Housing, 2 Connector Panel Capacity

SP858007 - Furnish and Install Wall Mounted WCH-Style Termination Panel Housing, 4 Connector Panel Capacity

SP858008 - Furnish and Install Wall Mounted WCH-Style Termination Panel Housing, 12 Connector Panel Capacity

SP858009 - Furnish and Install Termination Coupler Panel in Housing, SC Multimode, 12-Port

SP858010 - Furnish and Install Termination Coupler Panel in Housing, SC/UPC Singlemode, 12-Port

SP858011 - Furnish and Install Termination Coupler Panel in Housing, SC/APC Singlemode, 12-Port

SP858012 - Furnish and Install Termination Coupler Panel in Housing, LC/UPC Singlemode, 12-Port

SP858013 - Furnish and Install Termination Coupler Panel in Housing, LC/UPC Singlemode, 24-Port

SP858014 - Furnish and Install Indoor/Outdoor Preterminated Termination Panel, SC/UPC Singlemode Connector Type, 12 Strand Capacity

SP858.01 Description.

This work consists of furnishing and installing fiber optic termination panels in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), ANSI/TIA/EIA 659 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).
SP858.02 Materials.

Provide fiber optic termination panels in accordance with the Contract Documents and as specified herein:

A. Rack Mounted CCH-Style Termination Panel, 1 RU
   1. Provide one (1) Corning CCH-01U, or equivalent
      a. UL Listed
      b. Conforms to ANSI/TIA/EIA-568A and 606
      c. 1 RU Height
   2. Provide all required accessories and mounting hardware

B. Rack Mounted CCH-Style Termination Panel, 2 RU
   1. Provide one (1) Corning CCH-02U, or equivalent
      a. UL Listed
      b. Conforms to ANSI/TIA/EIA-568A and 606
      c. 2 RU Height
   2. Provide one (1) Corning CJP-01U-P, or equivalent
      a. 1 RU Height
   3. Provide all required accessories and mounting hardware

C. Rack Mounted CCH-Style Termination Panel, 4 RU
   1. Provide one (1) Corning CCH-04U, or equivalent
      a. UL Listed
      b. Conforms to ANSI/TIA/EIA-568A and 606
      c. 4 RU Height
   2. Provide all required accessories and mounting hardware

D. Rack Mounted CLSSC-Style Termination Panel, 4RU
   1. Provide one (1) Corning CLSSC-04U, or equivalent
      a. Conforms to ANSI/TIA/EIA-568A and 606
      b. 4 RU Height
   2. Provide all required accessories and mounting hardware

E. Wall Mounted SPH-Style Termination Panel, 1 Panel Capacity
   1. Provide one (1) SPH-01P, or equivalent
      a. 7.4” x 5.5” x 4.2” (H x W x D)
   2. Provide all required accessories and mounting hardware

F. Wall Mounted WCH-Style Termination Panel, 2 Panel Capacity
   1. Provide one (1) Corning WCH-02P, or equivalent
      a. 6.3” x 16.1” x 2.0” (H x W x D)
2. Provide all required accessories and mounting hardware

G. Wall Mounted WCH-Style Termination Panel, 4 Panel Capacity
   1. Provide one (1) Corning WCH-04P, or equivalent
      a. 14.1” x 16.1” x 2.0” (H x W x D)
   2. Provide all required accessories and mounting hardware

H. Wall-Mounted WCH-Style Termination Panel, 12 Panel Capacity
   1. Provide one (1) Corning WCH-CLSSC-12P, or equivalent
      a. 13.5” x 22.5” x 5.125” (H x W x D)
   2. Provide all required accessories and mounting hardware

I. Termination Coupler Panels
   1. 12 Port SC Multimode Panel – Corning CCH-CP12-91, or equivalent
      a. 12 Strand Capacity
      b. 6 Dual SC Adapters
   2. 12 Port SC/UPC Singlemode Panel – Corning CCH-CP12-59, or equivalent
      a. 12 Strand Capacity
      b. 6 Dual SC/UPC Adapters
   3. 12 Port SC/APC Singlemode Panel – Corning CCH-CP12-D9, or equivalent
      a. 12 Strand Capacity
      b. 6 Dual SC/APC Adapters
   4. 12 Port LC/UPC Singlemode Panel – Corning CCH-CP12-A9, or equivalent
      a. 24 Strand Capacity
      b. 6 Dual LC/UPC Adapters
   5. 24 Port LC/UPC Singlemode Panel – Corning CCH-CP24-A9, or equivalent
      a. 24 Strand Capacity
      b. 12 Dual LC/UPC Adapters

J. Splice Cassettes
   1. Splice Cassette – Corning CCH-CS, or equivalent
      a. 6.4” x 1.4” x 7.9” (L x W x D)
      b. Conforms to ANSI/TIA/EIA-568A and 606
   2. Slack Cassette – Corning CCH-CF, or equivalent
      a. 6.4” x 1.4” x 7.9” (L x W x D)
      b. Conforms to ANSI/TIA/EIA-568A and 606

K. Preterminated Termination Panel
   1. Provide one (1) Corning Zeux Panel ZPM25812EB4D1E030F, or equivalent
      a. 13.05” x 1.74” x 1.71” (L x H x W)
      b. SC/UPC Connector Type
      c. 12 Strand Capacity
d. Conforms to Telecordia GR-3152  
e. Conforms to Telecordia GR-77  
f. Supplied standard with MT Connector

L. 6-Strand Loose Buffer Tube Fan-Out Kit
   1. Corning BT-FAN47-06, or equivalent  
   2. 47” Fiber Tubing Length  
   3. 12 Strand Capacity

M. 12-Strand Loose Buffer Tube Fan-Out Kit
   1. Corning BT-FAN47-12, or equivalent  
   2. 47” Fiber Tubing Length  
   3. 12 Strand Capacity

N. Multimode SC Anaerobic Connector
   1. Corning 95-101-41-SP, or equivalent  
   2. Conforms to TIA/EIA 604-3  
   3. 0.75 dB maximum insertion loss (mated pair)

O. Singlemode SC/UPC Anaerobic Connector
   1. Corning 95-201-41-SP, or equivalent  
   2. Conforms to TIA/EIA 604-3  
   3. 0.75 dB maximum insertion loss (mated pair)

P. Singlemode SC/APC Anaerobic Connector
   1. Corning 95-200-44, or equivalent  
   2. Meet or exceed EIA/TIA 568-B.3  
   3. FOCIS compliant with TIA/EIA 604-10A and IEC61754-20  
   4. 0.75 dB maximum insertion loss (mated pair)

Q. Singlemode LC Anaerobic Connector
   1. Corning 95-201-98-SP, or equivalent  
   2. Conforms to TIA/EIA 604-10  
   3. 0.75 dB Max Insertion Loss (mated pair)

R. Singlemode SC/UPC Fusion Connector
   1. Corning SOC-900-SCU-SM, or equivalent  
   2. Conforms to TIA/EIA 604-3  
   3. Conforms to Telcordia GR-326-CORE  
   4. Conforms to GR-1081-CORE  
   5. 0.30 dB Max Insertion Loss
S. Singlemode LC Fusion Connector

1. Corning SOC-900-LCU-SM, or equivalent
2. Conforms to TIA/EIA 604-10A
3. Conforms to Telcordia GR-326-CORE
4. Conforms to GR-1081-CORE
5. .30 dB Max Insertion Loss

SP858.03 Construction.

SP858.03.1 Installation of Termination Panel Housing and Connector Panels.

Install termination panel housings and connector panels in accordance with the manufacturer’s installation specifications and perform any required assembly of the termination housing/frame, mounting the housing/frame (including mounting a plywood backboard where required), installation of splice trays/cassettes, installation of connector modules and coupler panels, installation of cable management hardware, and proper labeling of fiber ports. This work does not include fiber splicing.

SP858.03.2 Termination of a Fiber Strand using Fusion Splicing

Fusion splice a fiber end to a fusion splice compatible fiber connector, mounting the connector into a connector housing panel and/or splice cassette, and install the panel and/or splice cassette into a wall-mounted housing, or rack-mounted housing. Loose buffer tube fan-out kit shall be installed where applicable. Splices shall have an optical attenuation of no more than 0.3 dB at 1550 nm and 1310 nm.

SP858.03.3 Termination of a Fiber Strand using Anaerobic Cure Adhesive

Mechanically terminate a fiber end to an anaerobic cure compatible fiber connector, mounting the connector into a connector housing panel and/or splice cassette, and install the panel and/or splice cassette into a wall-mounted housing, or rack-mounted housing. Loose buffer tube fan-out kit shall be installed where applicable. Splices shall have an optical attenuation of no more than 0.3 dB at 1550 nm and 1310 nm.

SP858.04 Method of Measurement.

Fiber Optic Termination Panel Housings, all types: The quantity of installed termination panel housings shall be measured as the actual number of termination panels by type, which are installed, complete, in place and accepted, including installation of cable management hardware and related accessories.

Fiber Optic Termination Coupler Panels, all types: The quantity of installed termination coupler panels shall be measured as the actual number of termination panels by type, which are installed, complete, in place and accepted, including installation of splice trays, connector modules and coupler panels, and proper labeling of fiber ports.
SP854.05 Basis of Payment

The quantity of fiber optic termination panel housings and termination coupler panels furnished and installed will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for furnishing fiber optic termination housings and fiber optic termination coupler panels under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP859 – Fiber Optic Cable Splicing

SP859001 - Individual Fiber Strand Fusion Splice (per strand)

SP859002 - Fiber Ribbon Mass-Fusion Splice (per ribbon)

SP859003 - Individual Fiber Strand Termination, Fusion (per strand)

SP859004 - Individual Fiber Strand Termination, Anaerobic (per strand)

SP859.01 Description.

This work consists of performing fiber splicing in accordance with the Contract Documents and as directed by the Engineer. Splice enclosures and/or termination panels associated with the splicing performed is specified separately. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP859.02 Materials.

Provide fiber optic splicing termination in accordance with the Contract Documents and as specified herein:

A. Fiber Optic Splice Sleeves
   1. Tyco SMOUV-1120-01, or equivalent
   2. 61 mm sleeve length

B. Mass Fusion Splice Tray
   1. 3M Type 2527, or equivalent
   2. Stackable Trays
   3. 24 Fiber Single Fusion Splice Capacity
   4. 144 Fiber Mass Fusion Splice Capacity

E. Single Fusion Splice Tray
   1. 3M Type 2524-FT, or equivalent
   2. Stackable Trays
   3. 24 Fiber Single Fusion Splice Capacity

SP859.03 Construction.

SP859.03.1 Fusion Splicing of Individual Strands

Splice individual ends of singlemode fiber strands, placing the fused fiber in a splice tray, and placing the tray in a splice enclosure, wall-mounted housings, or rack-mounted housings. All
fiber shall be fusion-spliced. Splices shall have an optical attenuation of no more than 0.3 dB at 1550 nm and 1310 nm.

**SP859.03.2 Mass Fusion Splicing of Fiber Ribbon**
Splice two ends of ribbon fiber, consisting of 12 to 24 strands, placing the fused fiber in a splice tray, and placing the tray in a splice enclosure, wall-mounted housings, or rack-mounted housings. All fiber shall be fusion-spliced. Splices shall have an optical attenuation of no more than 0.3 dB at 1550 nm and 1310 nm.

**SP859.04 Method of Measurement**
The quantity of individual splices shall be measured as the actual number of fiber strands spliced as specified, complete in place and accepted.

The quantity of mass fusion splices shall be measured as the actual number of fiber ribbons spliced as specified, complete in place and accepted.

**SP859.05 Basis of Payment**
The quantity of fiber optic splices installed will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for installing fiber splices under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP860 – Fiber Optic Cable Testing

SP860.01 Description.

This work consists of acceptance testing of fiber optic cable in accordance with the Contract Documents and as directed by the Engineer. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP860.02 Materials.

N/A

SP854.03 Construction.

Perform optical performance tests for all new and/or repaired cables to validate the optical performance of the entire link, as well as to verify that fiber splicing has occurred according to supplied splice matrices. This testing will consist of bi-directional OTDR testing, as well as direct optical attenuation and continuity testing using a calibrated optical source and power meter. Perform this test only after fibers are terminated on both ends of a link, and all intermediate construction and/or splicing involving the re-entry of installed splice cases or handling of the fiber optic cable is completed for a particular segment under test.

Provide DelDOT with electronic documentation of all test results.

Testing shall be deemed successfully completed if: (1) maximum fiber losses meet manufacturer specifications, with an allowance for splices and connectors; (2) individual splice losses do not exceed 0.3 dB; and (3) maximum mated connector losses do not exceed manufacturer specifications. Testing will be performed by Contractor personnel, and may be observed by designated representatives of DelDOT. DelDOT may request and/or perform additional testing to verify results prior to accepting test data.

An OTDR shall be used to measure and document splice losses and connector losses. To correctly identify abnormalities at a short range, a 100-meter or longer launch cable shall be used between the OTDR and the fiber under test. Bi-directional traces shall be acquired for each fiber. If the connection of the launch cable to the patch panel requires optimization by the operator, sampling acquisition will commence upon completion of the optimization.

Each fiber will be identified, and the results of the test for each fiber will be recorded as indicated below. The test will be repeated for each of the fibers linking a particular site. All tests will be made at 1310 nm and 1550 nm.

A uniform file-naming scheme for recorded data shall be used complying with conventions as defined by DelDOT.
Installed optical fiber OTDR test documentation shall include:
A. Total fiber length;
B. Individual fiber traces for complete fiber length;
C. Losses of individual splices and connectors;
D. Losses of other anomalies;
E. Wavelength tested and measurement directions;
F. Manufacturer, model and serial number of the test equipment; and
G. Name and company of the technician performing the tests.

All data collected at each location during the tests shall be recorded at the time of the tests using electronic means.

Optical power meter measurements shall be made at the same time as the OTDR tests to determine overall fiber loss and to ensure that fibers have appropriate end-to-end continuity (i.e. fibers are not crossed at splice points or within termination panels). Power meter testing shall be performed at both 1310 nm and 1550 nm and shall report the relative loss of each fiber strand.

**SP860.04 Method of Measurement**

The number of fiber optic strands tested shall be measured as the actual number of fiber strands where bi-directional OTDR and optical power meter test results are submitted to DelDOT as specified, complete, and accepted.

**SP860.05 Basis of Payment**

The quantity of fiber optic strands tested will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for installing fiber splices under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP861 – Fiber Optic Cable Building Entry

SP861001 - Furnish and Install 2” Rigid Metal Conduit (RMC)

SP861002 - Furnish and Install Indoor Non-Metallic Junction Box, 18”x18”x8”

SP861003 - Furnish and Install Indoor Non-Metallic Junction Box, 24”x24”x10”

SP861004 - Furnish and Install External Building Penetration with Metallic Pull Box, 24”x20”x8”

SP861005 - Furnish and Install External Building Penetration with Metallic Pull Box, 30”x24”x12”

SP861006 - Furnish and Install External Building Penetration with Metallic Pull Box, 36”x30”x12”

SP861007 - Furnish and Install External Building Penetration with Non-Metallic Pull Box, 24”x20”x8”

SP861008 - Furnish and Install External Building Penetration with Non-Metallic Pull Box, 30”x24”x12”

SP861009 - Furnish and Install External Building Penetration with Non-Metallic Pull Box, 36”x30”x12”

SP861010 - Install Core Drill Interior Wall or Floor

SP861.01 Description.

This work consists of constructing a fiber optic cable building entry, including the supply and installation of associated materials and accessories. All work shall be performed in accordance with ANSI TIA/EIA 758 (latest reference), ANSI/TIA/EIA 659 (latest reference), BICSI Customer-Owned Outside Plant Design Manual (latest edition), and the BICSI Telecommunication Distribution Methods Manual (latest edition).

SP861.02 Materials.

Provide building penetration and fiber optic cable pathway materials in accordance with the Contract Documents and as specified herein:

A. Indoor Metallic Junction Box
   1. 16-gauge (minimum) galvanized steel (without knockouts)
   2. Dimensions:
      a. 18” x 18” x 8” (L x W x D)
      b. 24” x 24” x 10” (L x W x D)
   3. Supplied with lift-off screw cover and all required fasteners
   4. ANSI 61 power coat grey finish
B. Schedule 80 PVC Sweep (90-degree, 45-degree, and 22-degree)
   1. Conform to ASTM D2665
   2. Conform to National Electric Code 2011, Article 352
   3. Conform to ASTM D 1785
   4. Conform to U.L. Standard 651 Specifications
   5. UL Listed

C. Non-Metallic Weather Resistant Pull Box
   1. Fiberglass reinforced construction
   2. UL 508a listed
   3. Meet or exceed NEMA 3RX
   4. Include hinged door with 3-point latch
      a. Type 316L stainless steel padlocking handle
   5. External dimensions (H x W x D):
      a. 24.25” x 20.25” x 8.00” (Hoffman A24H2008GQRLP3PT, or equivalent)
      b. 30.25” x 24.25” x 12.00” (Hoffman A30H2412GQRLP3PT, or equivalent)
      c. 36.25” x 30.25” x 12.00” (Hoffman, A36H3012GQRLP3PT or equivalent)

D. Metallic Weather Resistant Pull Box
   1. 16 or 14 gauge steel construction
   2. UL 50 and UL 50E listed
   3. Meet or exceed NEMA Type 1 requirements
   4. ANSI 61 gray polyester powder paint inside and out
   5. Include hinged door with recessed T-handle latch
   6. External dimensions (H x W x D):
      a. 24.00” x 20.00” x 8.62” (16 gauge steel)
         i. Hoffman A24N208LP, or equivalent
      b. 30.00” x 24.00” x 12.62” (14 gauge steel)
         i. Hoffman A30N2412LP, or equivalent
      c. 36.00” x 30.00” x 12.62” (14 gauge steel)
         i. Hoffman A36N3012LP or equivalent

E. Schedule 80 PVC Conduit Sleeve
   1. Conform to ASTM D2665
   2. Conform to National Electric Code 2011, Article 352
   3. Conform to ASTM D 1785
   4. Conform to U.L. Standard 651 Specifications
   5. UL Listed
F. Galvanized Two-hole Conduit Strap

1. Grade 304 Stainless Steel
2. 2 mounting holes
3. Designed for 2 inch, 3-inch, and 4-inch conduit sizes

SP861.03 Construction.

SP861.03.1 External Building Penetration

Perform building penetrations for entry of fiber optic and/or electrical wiring. Install using up to 4-inch PVC conduit as specified in the Contract Documents. New wall penetrations shall be created according to the following specifications:

1. Underground HDPE conduit shall be joined below grade to a Schedule 80 PVC, 90-degree elbow using a watertight HDPE/PVC transition coupler (ex. Carlon E-Loc). Note: a standard PVC coupler may be used with a suitable HDPE epoxy adhesive.

2. At the height of the building penetration, a weather resistant pull box or conduit outlet body (e.g. LB-style) with removable cover shall be placed for ease of pulling fiber and to maintain the minimum bend radius specified by the cable manufacturer.

3. Core drills must be at 90-degrees (plumb and square) to the wall.

4. A Schedule 80 PVC conduit sleeve shall be placed from the pull-box through the core drill, and must be sealed and waterproofed using hydraulic water-stop cement both on the inside and outside of the bore (Note: silicone caulk/sealant may be used to create a water tight seal between the pull-box / conduit outlet body and the wall when placed against vinyl or metal siding). The conduit sleeve shall extend beyond the interior wall surface by 1" to 2".

5. Fire rated sealant is required for penetrations through all exterior and interior fire resistance-rated walls. All conduits shall be sealed per NEC 300.7. A modular seal product (i.e. GPT Link Seal) is suitable for sealing between the wall penetration and the conduit exterior. The conduit must be internally sealed around the cable using a suitable fire-rated foam sealant or duct plug.

6. Riser conduit shall be fastened to the exterior wall using galvanized steel, two-hole straps. At a minimum, one strap shall be placed within 12" above grade, and another within 12" below the pull-box. Strap spacing shall not exceed 5-feet.
SP854.03.2 Installation of Rigid Metal Conduit (RMC) for Indoor Cable Pathways

Furnish and install up to 2- inch nominal diameter Rigid Metal Conduit (RMC), to include galvanized steel conduit and related junction boxes, couplers, and fasteners meeting the Material requirements of Section SP861.02, Standard Specifications Section 1062, and as specified in the Contract Documents when required to provide an indoor cable path from the building entry point to the fiber termination locations.

RMC shall be hung either from building support steel (not from drop ceiling support material) or mounted and supported to any permanent structure of the building. A minimum bend radius of
36-inches shall be observed for all bends. No more than 180-degrees (e.g. two 90-degree bends) shall be placed in any RMC segment between endpoints or junction boxes. When required, indoor metallic junction boxes shall be used within the RMC pathway.

Fire rated sealant is required for penetrations through all exterior and interior fire resistance-rated walls. All conduits shall be sealed per NEC 300.7. A modular seal product (i.e. GPT Link Seal) is suitable for sealing between the wall penetration and the conduit exterior. The conduit must be internally sealed around the cable using a suitable fire-rated foam sealant or duct plug.

RMC shall be placed and fastened in a neat and tidy manner in compliance with NEC Article 770.24 using ANSI/BICSI 568 as guideline. When placed above a drop ceiling, the RMC and all fasteners shall be installed in a manner that does not interfere with the removal of ceiling tiles. RMC must not be attached to drop ceiling support wires or ceiling grid.

**SP8561.03.3 Core Drill Interior Wall or Floor**
Perform core drills, if required for pathway of fiber optic and/or electrical wiring. Core drills must be at 90-degrees (plumb and square) to the wall or floor.

Fire rated sealant is required for penetrations through all fire resistance-rated walls. All conduits shall be sealed per NEC 300.7. A modular seal product (i.e. GPT Link Seal) is suitable for sealing between the wall penetration and the conduit exterior. The conduit must be internally sealed around the cable using a suitable fire-rated foam sealant or duct plug.

This work does not include indoor conduit and/or cable placement.

**SP861.04 Method of Measurement**
The quantity of rigid metal conduit and PVC conduit furnished and installed shall be measured as the number of linear feet of conduit furnished, installed as specified, complete in place and accepted.

The quantity of external building penetrations furnished and installed shall be measured as the number of actual external building entrances installed, completed and accepted.

The quantity of interior core drills shall be measured as the number of actual of interior core drills installed, completed and accepted.

**SP861.05 Basis of Payment**
The quantity of RMC, conduit, and indoor junction boxes will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for furnishing required materials, installing building penetrations under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
The quantity of building penetrations will be paid at the Contract Unit Price per each item for the Pay Items listed above. Price and payment constitutes full compensation for furnishing required materials, installing building penetrations under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.
Section SP862 – Fiber Optic As-Built Data Collection

SP862.01 Description.
Perform data collection of as-built conduit pathway and fiber optic infrastructure in accordance with the Contract Documents and as directed by the Engineer.

SP862.02 Materials.
N/A

SP862.03 Construction Methods.
The Contractor shall provide detailed as-built documentation in the final deliverable package for each assigned task.

The Contractor shall provide markups of the original designs, to include field notes that detail any deviation from the original task/proposal. Field notes and drawings will be digitized/scanned and provided in the deliverable package.

The Contractor shall supply comprehensive GPS data for all tasks to enable DelDOT to maintain accurate GIS records of its fiber plant. This information shall be provided to DelDOT in an .mdb database format, and shall include all location information pertaining to installed conduit, installed fiber, the compass direction, conduit junction wells, and related components. DelDOT will provide the data dictionary for the collection of this information.

DelDOT uses Trimble handhelds for the collection of the data in conjunction with Pathfinder and TerraSync software by Tremble. Both the GPS unit and the software necessary to use it, including the pathfinder licenses and TerraSync licenses, are the responsibility of the Contractor.

When applicable, Contractor shall supply DelDOT with log data from the directional bore guidance system used during construction, indicating depth of the conduit placement. Also, markups shall indicate measured depth of conduit placement for conduit placed using open trenching or open cut methodologies at intervals not to exceed 50 feet.

Construction may not deviate from DelDOT-supplied engineering drawings without prior approval from DelDOT or its appointed designee.

SP862.04 Method of Measurement.
Data collection shall be measured in the number of linear feet of fiber infrastructure recorded into GPS.
**SP862.05 Basis of Payment.**

The quantity of GPS data collection shall be paid at the Contract Unit Price per linear foot for the Pay Items listed above. Price and payment constitutes full compensation for labor, equipment, tools and incidentals required to complete the Work as specified and as directed by the engineering documents.
Section SP863 – Fiber Optic Mini Hub Construction

SP863001 - Furnish and Install Fiber Optic Mini Hub

SP863.01 Description.
Furnish and install fiber optic “Mini Hub” cabinet in accordance with the Contract Documents and as directed by the Engineer.

SP863.02 Materials.
Mini Hub cabinets shall be furnished and installed for the purpose of protecting ITMS equipment and network components, including fiber optic termination panels, from rain, dust, vandalism and other conditions found in an outdoor or otherwise harsh environment.

The cabinet shall be the APX Technologies Quad Door cabinet, model APXQD554426, having exterior dimensions of 55” x 44” x 26” (H x W x D - not including extension base), or equivalent. The cabinet shall provide a total of 100 RU (175 inches) of rack mounting space across four sets of standard 25 RU, 19-inch EIA rack mounting rails (two in front, two in rear).

The manufacturer must be able, upon request, to produce part numbers on all components for repair purposes. Certificates of compliance may be requested on each cabinet or on any component or part thereof. Each mini hub cabinet furnished and installed shall meet the following specifications:

1. Performance:
   a. The enclosure(s) shall meet or exceed the requirements of a NEMA 3R rating, and shall be U.L. listed.

2. Cabinet Construction:
   a. The cabinet and door(s) shall be constructed from 5052-H32 sheet aluminum alloy that has a thickness of 0.125 inches. External welds shall be made by using the Heliarc welding method; whereas, internal welds will be made by the wire welding method. All welds shall be neatly formed and free of cracks, blow holes and other irregularities. NOTE: There shall be 2 doors front and back.
   b. All inside and outside edges of the cabinet shall be free of burrs.
   c. The cabinet shall be designed with a crowned top to prevent the accumulation of water on its top surface.
   d. The door opening shall be double flanged on all (4) sides which increases strength around openings and keeps dirt and liquids from entering the enclosure when door is opened.
   e. A door restraint shall be provided to prevent door movement in windy conditions.
   f. Supplied with 12-inch high extension base, APX type “P,” or equivalent, constructed from 5052-H32 sheet aluminum alloy that has a thickness of 0.125 inches.
3. Door Hardware
   a. The door opening will be a minimum of 80% of the front surface area. Double doors will overlap and utilize a removable center post.
   b. The doors shall be furnished with a gasket that satisfies the physical properties as found in UL508 table 21.1 and shall form a weathertight seal between the cabinet and door.
   c. The closed door(s) be flush with the side(s) of the enclosure.
   d. The door hinges shall be continuous and bolted to the cabinet and door utilizing 1/4-20 stainless steel carriage bolts and nylock nuts.
   e. The hinges shall be made of 0.075-inch-thick stainless steel with a 0.25-inch stainless steel hinge pin.
   f. The hinge pin shall be capped top and bottom by weld to render it tamperproof.
   g. Hinge leaves will not be exposed externally when the door is closed, but hinge knuckles may protrude.
   h. The latching mechanism shall be a 3-point draw roller type using an overlapping door design.
   i. Pushrods will be turned edgewise at the outward supports and shall be 0.250-inch by 0.750-inch aluminum, minimum.
   j. Rollers shall have a minimum diameter of 0.875-inch and will be made of nylon. The center catch shall be fabricated from .187 aluminum, minimum.
   k. An operating handle shall be furnished, constructed from stainless steel with a ¾-inch diameter shank.
   l. The latching handle shall have a provision for padlocking in the closed position.
   m. A light/alarm switch bracket shall be provided.

4. Cabinet Ventilation / Fan Kit
   a. The cabinet shall be provided with louvered vents in the front door with a removable air filter.
   b. Louvers shall satisfy the NEMA rod entry test for 3R ventilated enclosures.
   c. The filter will cover the vents and shall be held firmly in place with bottom and side brackets with a spring-loaded upper clamp.
   d. Exhaust air will be vented out between the top of the cabinet and door through a series of .120 x 1.0-inch rectangular holes.
   e. The ventilation plenum area shall be equipped with a removable plate with provisions for mounting the fan assembly.
   f. The ventilation system will consist of a fan and thermostat assembly.
   g. The ventilation system will be designed to handle a minimum of 100 cubic feet of air per minute.

5. Equipment Mounting
   a. The enclosure shall be equipped mounting rails (front and rear) for standard 19” rack-mount equipment.

6. Cabinet Finish
a. The outside surface of the cabinet shall have a smooth, uniform, natural aluminum finish.

7. Electrical
a. The cabinet shall be supplied with an electrical distribution power board equipped to support up to two 15 Amp breakers
b. Must include two standard NEMA 5-15R, 125 VAC receptacles and two GFI receptacles
c. The power board shall be equipped with all necessary terminal strips and ground bars
d. The cabinet shall be equipped with an externally-mounted manual transfer switch to support a connection to an external portable generator:
   i. Support for generator with maximum running output of 7.5 kW
   ii. Maximum utility input current: 30 A
   iii. Maximum generator input current: 30
   iv. Input voltage: 125 VAC
   v. NEMA 3R-rated enclosure
   vi. Utility-on indicator light
   vii. Must be Reliance Controls model C30A1L, or equivalent (note: may require modification by the Contractor to enable utility-on indicator light to be visible from the front panel of the enclosure)
e. Note: Service Pedestal and Safety Switch are supplied separately through applicable DelDOT Standards Specification items

SP863.03 Construction Methods.
Install fiber Mini Hub cabinets in accordance with the manufacturer’s installation specifications, and perform any required assembly of the cabinet sub-components. Fiber Mini Hub cabinets shall be properly affixed to a Type F cabinet base, constructed in accordance with DelDOT Standard Specifications. This work does not include the cabinet base.

SP8563.04 Method of Measurement.
The quantity of fiber optic Mini Hub cabinets shall be measured as the number of actual cabinets installed, completed and accepted.

SP863.05 Basis of Payment.
The quantity of fiber optic Mini Hubs furnished and installed will be paid at the Contract Unit Price per each item for the Pay Items listed above, not inclusive of required cabinet base construction provided in accordance with DelDOT Standard Specifications. Price and payment constitutes full compensation for furnishing and installing the mini hub cabinet under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.