

2025



*"A City for All Ages"*

City of PSL

PSL US, PW, TE, IT

# CITY OF PORT ST LUCIE

# FIBER OPTIC NETWORK

Minimum Design Standards and Details

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**DESIGN**

The Engineer of Record shall submit, through the City’s Project Manager, the design plans for review to the City at the 60% and 90% plan review.

The plans should include the fiber optic conduit, pull box, and splice box location. The size of the conduit, fiber size and type and the type of splice/pull box shall also be included on the drawing. The location of the trunk line splice shall be shown for review and approval. A proposed splice diagram shall be included. Midspan splices should be avoided to the trunk line and will need to be approved by the City.

**CONSTRUCTION**

The contractor shall provide complete installation of conduits and pull boxes including materials, equipment, labor and documentation, in accordance with these specifications and recognized industry standards and the system must be fully operational.

**SHOP DRAWINGS**

Contractor may utilize products on the City of Port St Lucie (CPSL) Qualified Product List (QPL 2023) without requirement to provide individual project submittals. For each work order or contract with the City, the Contractor shall submit a QPL cover sheet noting the items to be implemented on the project. In the event the Contractor wishes to utilize a product not on the CPSL QPL, the Contractor must submit complete manufacturer cut sheets, shop drawings or schematics of proposed alternate items.

Contractor to include on product submittal cover sheet, a complete listing of pathway, closure and fiber optic infrastructure intended for use on the project to include the following:

- Conduit
- Pull Boxes, Splices Boxes, Splice Vaults, Splice Enclosures, Splice Cabinets
- Locate Tracer Wire, Wire Ground Units, Side Leg/Liner Terminators or Switch Boxes
- Marking Tape
- Pull Tape
- Cable Route Markers
- Fiber Optic Cable
- Splice Closures – Trays
- Termination Housings - Components
- Fiber Optic Test Procedures
- IP Network Devices
- Communication Devices

QPL cover sheet or shop drawings shall be approved prior to construction. Any work conducted prior to approval may result in Contractor expense for approved replacement items.

**PULL BOX, SPLICE BOX AND SWEEPS**

Conduit plans need to be approved prior to construction. All items identified in the design section shall be shown on the construction plans. Designer and Contractor to follow Building Industry Consulting Service International (BICSI) Outside Plant Design Manual (OSP) which follows and implements standards set forth in the American National Standards Institute/Telecommunications Industry Association/ Electronics Industry Association (ANSI/TIA/EIA-758) for “telecommunication infrastructure designed of for installation exterior to buildings.”

For each CPSL work order, project or contract, Engineer or Contractor shall provide schematics or drawings including proposed locations of pull and splice boxes with provisions for maximum pull box spacing.

Desired spacing for fiber optic backbone route interim pull box (17" x 30"), interim run single drop splice pull boxes (24" x 36") and splice pull boxes (30" x 48") shall be used at every divided boulevard intersection to allow for multidirectional conduit and cable routing as well as additional splice access. Standard depth of each pull box size is 24" unless exiting utilities limit to 18" minimum.

The maximum spacing for backbone routes is 750 linear feet between interim pull boxes and no greater than 2,500 feet between a splice box (24" x 36") or an intersection splice box (30" x 48"). This establishes a pattern of one splice box after every four pull boxes (i.e., intersection box, pull box, pull box, pull box, splice box, pull box, pull box, pull box, intersection box, etc.).

Any pull box designed to be placed in sidewalks, must be a minimum of 24" x 36" x 24". All pull boxes that are not in concrete or asphalt sidewalks, shall have a concrete collar placed for protection that shall be a minimum of 12" length and width outside the pull box dimension with 6" depth of concrete with wire mesh or rebar for strength.

The Project Design Engineer shall review these default distances which need to be modified for more frequent splice box placement to facilitate backbone cable connection for certain parcels or routes with more frequent project connections.

Designs should follow the OSP manual and accommodate ducts entering pull and splice boxes by multiple means of deployment. The contractor shall provide 45-degree conduit sweeps with long radius consistent with site conditions or sweep HDPE ducts in gradual bend attempting to avoid 90 degree bends. Conduit sweeps should be referenced on the construction plans and Contractor must follow must be approved prior to construction.

## **SPLICING REQUIREMENTS**

The Contractor shall follow approved Project Splice Plans or submit splice diagrams for review and approval prior to splicing unless responding to an emergency damage restoration. Once the splice diagram is approved, the CPSL requests the Contractor give three (3) business days' notice to CPSL for circuit preparation. No splicing of the fiber optic cable system will be permitted without appropriately qualified City Information Technology staff approval, by onsite direction or written approval.

All splicing shall be by fusion splice method. Although CPSL staff may not be present for Contractor splice activity, Contractor to follow manufacturers' recommended procedures and provide test reports confirming adherence to ANSI/TIA/EIA and CPSL splice standards where no splice shall exceed .15dB on a bidirectional average of the OTDR traces or .05 as reflected on a core alignment fusion splice machine.

If Contractor experiences mismatched fiber optic core alignment that may causing excessive losses, Contractor to follow ANSI/TIA/EIA requiring re-splicing 3 times before acceptance.

## **AS-BUILT DRAWINGS**

As-built drawings shall be provided by means of a secure file transfer method. If included by specific item inclusion on any CPSL contract, work order or project, all fiber optic pathways and cables are to be as-built in FiberTrak® inclusive of individual fiber allocations in Bentley Communications, GPS recording in ESRI GIS format inclusive of MySQL GIS referenced datasets of CPSL infrastructure attributes. All GPS points shall be sub-meter accuracy. All fiber optic as-builts shall be turned in to the Department who issued the contract and the CPSL Information Technologies Department for update to the CPSL Master Fiber Optic Network records.

**QUALIFIED PRODUCT LIST (QPL)**

All material used shall be per the Approved products noted at the end of each appropriate section and shall be new, unused and of current design and manufacturer. Any materials not found in the Approved products section shall not be used without the City’s approval.

Contractor to submit product cut sheets, technical data, calculations for materials intended for project use that are not found in the CPSL QPL to the Project Engineer 30 days before use to allow for review and approval by the City IT Dept.

All material will be inspected and verified prior to installation. All other applicable specifications will be adhered to as directed by the City.

**DEFINITION of TERMS:**

CITY: The terms “City” and “the City” shall refer to the City of PSL personnel, or their representatives.

CONTRACTOR: “Contractor” shall mean an individual, firm, partnership, or corporation, and his, their or its heirs, executors, administrators, successors and assigns or the lawful agent of any such individual, firm, partnership, covenantor, or corporation, or his, their or its surety under any contract bond, constituting one of the principals to the Contract and undertaking to perform the work specified in the design plans and specifications. Where any pronoun is used as referring to the word “Contractor”, it shall mean the Contractor as defined herein.

CITY ONLINE SPECIFICATIONS ACCESS: “Online Access” is available for City of Port St. Lucie performance specifications and Qualified Products Listing for fiber optics supporting the Public Works, Traffic Engineering/Operations, Utility Systems, Parks & Recreation and Information Technologies Department’s available through online City webpage for review at:

ENGINEER OF RECORD: The terms “Engineer” and “Engineer of Record” shall be a duly licensed and registered engineer in the State of Florida.

BACKBONE Fiber Optic cable: The term used for any fiber optic cable in City of PSL rights of way that traverses the entire City in multiple pathways, routes and network architectures supporting multiple City Departments or other entities for Core Site to Core Site and Core Site to Device Site connections. This shall be no less than 96F and is to be called out in project plans by any Project EOR for proper route capacity.

All Backbone Fiber Optic cables shall be taken into Tier 1 and Tier 2 facilities for full (100%) terminations.

LATERAL (Drop) Fiber Optic Cable: The term used for the fiber optic cable making a single communication node connection where specific, select numbers of fibers are intercepted off the CPSL backbone cable for device/site connectivity into the overall City of PSL Optical Network by specific User Departments.

The drop cables are to be identified on every plan set by the EOR, but shall be no less than the following size for Department and Connection Type:

Utility Systems:	12F cable for Field Sites (Pump, Repump, Well Site SCADA) 48F cable for Core Facilities (Admin, Water Treatment)
Public Works:	12F cable for CPSL tier 3-4 sites 48F cable for CPSL tier 2 sites 96F or 144F cable for CPSL tier 1 sites
Traffic Engineering:	12F cable for Public Safety site connections (Police, Fire Facilities) 12F cable for Traffic Signals, ITS Device Sites 96F or 144F cable for designated Traffic/ITS Hub Aggregation Sites
Parks & Rec Services:	12F cable for City Parks & Constitutional Offices 48F cable for multiple Department facilities 96F or 144F cable for designated City Core Ring Sites

TIER Site Classifications: Refers to the criticality of services provided to a site.

Tier 4: Low priority field device sites that do not affect the overall functioning of the system if offline. Site response required within 48 hours for any remediation required.

Tier 3: High priority field device sites that are connected into a system that affects the functionality of another site in the system. Site response required within 48 hours for any required remediation.

Tier 2: Critical Network Hub/Aggregation Facility where system applications are initiated, monitored, and managed and are connected to both Tier 3 & 4 for systems operations and Tier 1 sites for network operations. Sites are 24x7x365 operational requiring response within 8 hours and remain engaged until restored.

Tier 1: Critical Network Data Center where Intra & Inter Networking is created, connected, routed and data is stored and exchanged between other servers and applications and broadband internet providers is made. Sites are 24x7x365 operational requiring response within 4 hours and remain engaged until restored. These sites are those with redundant entrance facilities and backup power from external generators.

**1.0 FIBER OPTIC CABLE SYSTEM for OUTSIDE PLANT CITYWIDE DISTRIBUTED NETWORK**

**1.1 FIBER OPTIC CABLE**

Furnish fiber optic cable that shall be 100% compatible with the City of PSL QPL & existing fiber optic cable plant.

**1.1.1 MANUFACTURER:**

The cable manufacturer shall be ISO9001 certified and shall be TL9000 registered.

**1.1.2 CABLE CONSTRUCTION:**

The cable shall be free of hazardous materials in compliance with RoHS 2002/95/EC. The cable shall be of all-dielectric (non-shielded, non-metal) construction. The cable shall be of loose-tube construction. The cable shall be of entirely gel-free construction.

**1.1.3 OUTER JACKET:**

- Carbon Black Medium Density Polyethylene (MDPE)
- 1.3mm Thickness
- UV Resistant
- Fungus Resistant
- 2.5mm White Length Markings in Feet (US)
- Labeled must have labels of "Fiber Optic Cable", Year of Mfg, Cable Count and length marking

**1.1.4 RIPCORDER or FAST ACCESS RIDGE:** The cable may contain a ripcord under the sheath (outer jacket) or have FastAccess™ Ridge for accessing cable jacket.

**1.1.5 WATER BLOCKING COMPOUND:**

The cable shall contain a dry water blocking material under the outer jacket.

**1.1.6 STRANDING/STRUCTURE:**

The cable shall contain standard 12 buffer tubes in a reverse oscillation stranding structure.

**1.1.7 STRENGTH MEMBER:**

The central strength member shall consist of a dielectric central element.

**1.1.8 FILLER:** Filler(s) may be used in the cable core. Fillers shall be 2.5mm in diameter.

**1.1.9 BUFFER TUBES:**

- Polypropylene
- Dry Water-Blocking Material inside (Gel-Free, Foam-Free)
- 2.5mm Outer Diameter
- EIA/TIA-598-B Color Code Compliant
- Standard is 12 fibers per Buffer Tube

1.1.10 OTHER:

Fibers shall not adhere to the inside of the buffer tube. Fibers shall not stick together. The optical fibers shall not require cleaning before placement into a splice tray.

1.1.11 OPTICAL FIBER CONSTRUCTION:

Optical fibers shall be dispersion-unshifted, step-index, single-mode fibers. Each fiber shall consist of a Germania-doped silica core surrounded by a concentric glass cladding. Fibers shall be a matched clad design. All fiber optic glass shall be from the same manufacturer. Fibers shall be coated with a dual layer acrylate protective coating. Fiber coatings shall be colored with ultraviolet (UV) curable inks. Fibers shall be colored in compliance with EIA/TIA-598-B.

1.1.12 OPTICAL FIBER GEOMETRY & OPTIC SPECIFICATIONS:

- Core Diameter: 8.2 μm
- Cladding Diameter: 125 μm +/- 0.7 μm
- Core-to-Cladding Concentricity: ≤ 0.5 μm
- Cladding Non-Circularity: ≤ 0.7%
- Coating Diameter: 245 μm +/- 5 μm
- Attenuation @ 1310 nm: ≤ 0.35 dB/km
- Attenuation @ 1550 nm: ≤ 0.25 dB/km
- Cutoff Wavelength: ≤ 1260 nm

1.1.13 CABLE OPERATING REQUIREMENTS:

- OPERATING TEMPERATURE RANGE: -40°F to 158°F.
- MINIMUM BEND RADIUS: 10 X cable outer diameter (installed), 15 X under tension
- CABLE STRENGTH/MAX PULLING TENSION: 600 lbf during installation, 200 lbf installed.
- CRUSHING RESISTANCE: Withstands a minimum compressive load of 125 lbf/in.

1.1.14 MANUFACTURER TESTING:

All optical fibers shall be 100% attenuation tested at the factory for compliance with performance specifications described herein. The attenuation data for each fiber shall be provided with each cable reel.

The cable shall be subjected to testing by the cable manufacturer in accordance with the following ANSI/EIA/TIA-455-xx testing procedures (FOTP's):

- FOTP-3, FOTP-41, FOTP-104, FOTP-25, FOTP-33 and FOTP-8 (Result = Δ Attenuation ≤ 0.15 dB @ 1550 nm)
- FOTP-37 (Result = Δ Attenuation ≤ 0.3 dB @ 1550 nm)
- FOTP-82 without leakage through the open cable end.  
(1 meter of cable shall withstand 1 meter static head water pressure for 1 hour)
- FOTP-81 exhibiting no flow (drip or leak) of filling or flooding material @ 70° C.
- FOTP-181 without loss of fiber continuity.

(Cable shall withstand a simulated lightning strike w/ 55kA peak current pulse)

1.1.15 MISCELLANEOUS:

The top and bottom ends of the cable shall be accessible for testing. Both ends of the cable shall be sealed.

Cables included in the Corning 2021 Local Area Networks and Data Center Core Products Catalog will be considered when submitted for approval by specific project or work order application from standard outside plant interconnections.

<https://www.corning.com/catalog/coc/documents/selection-guides/LAN-1273-AEN.pdf>

**GENERAL PROPERTIES**

ISO 9001 Compliant Manufacturer  
 TL 9000 Registered Manufacturer  
 RoHS 2002/95/EG Compliant Materials  
 All-Dielectric (Non-Shielded, Non-Metal)  
 Gel-Free, Foam-Free Construction  
 Loose-Tube Cable  
 600 lbf Max Tensile Strength (Installation)  
 200 lbf Max Tensile Strength (Static)  
 125 lbf/in Crush Resistance  
 Operating Temperature Range of -40°F to 158°F  
 Minimum Bend Radius = 10 x Cable Diameter (Static)  
 Min. Bend Radius = 15 x Cable Diameter (Tension)

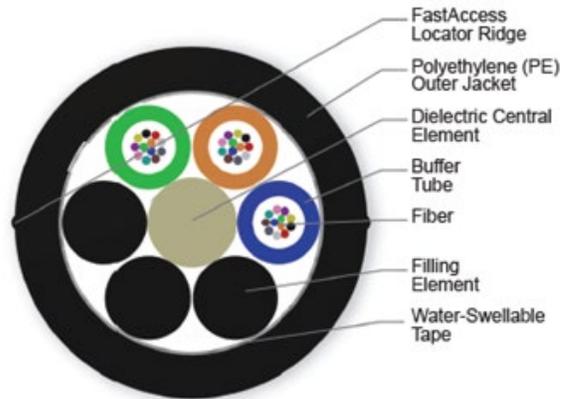
**EXTERNAL PROPERTIES**

1.3mm Medium Density Polyethylene (MDPE)  
 UV Resistant  
 Fungus Resistant  
 Black Color  
 2.5mm Length Markings in Feet (US)  
 Labeled "City of PSL Fiber Optic Cable" every X Feet

**INTERNAL PROPERTIES**

Water-Blocking Tape (Outside of Buffer Tubes)

Up to 12 Buffer Tubes  
 Reverse Oscillation Stranding Structure  
 2.5m Polypropylene Buffer Tubes  
 EIA/TIA-598 Color Code Compliant Buffer Tubes  
 Dry Water-Blocking Material Inside Buffer Tubes  
 12 Fibers per Buffer Tube  
 All Fibers contained in Buffer Tubes



ALTOS All-Dielectric Cable with FastAccess Technology, Gel-Free, 36 Fibers | Photo PIM2326

**FIBER PROPERTIES**

**CONSTRUCTION:**

Dispersion-Unshifted Step-Index Single-Mode Fibers  
 Germanium-Doped Silica Core surrounded by a Concentric Glass Cladding  
 Matched Clad Design  
 Dual Layer Acrylate  
 Coatings Ultraviolet (UV)  
 Curable Inks  
 EIA/TIA -598-B Color Code

**Compliant GEOMETRY & OPTICS:**

<i>Core Diameter:</i>	8.3µm
<i>Cladding Diameter:</i>	125µm +/-0.7µm
<i>Core-to-Cladding Concentricity:</i>	≤ 0.5µm
<i>Cladding Non-Circularity:</i>	≤ 0.7%
<i>Coating Diameter:</i>	245µm +/-5µm
<i>Attenuation @1310nm:</i>	≤ 0.35 dB/km
<i>Attenuation @1550nm:</i>	≤ 0.25 dB/km
<i>Cut-Off Wavelength:</i>	1260nm

**1.2 FIBER OPTIC SPLICE CLOSURES**

**1.2.1 MANUFACTURER:**

The splice closure manufacturer shall be ISO9001 certified and shall be TL9000 registered.

**1.2.2 GENERAL:**

Splice closures shall be “dome type” splice closures. Splice closures shall be designed for all outdoor applications (aerial, duct, buried, etc.). Splice closures shall be free of hazardous substances according to RoHS 2002/95/EC. Splice closures shall be constructed of a black thermoplastic material. Splice closures shall be capable of through, branch and mid-span type splice applications. Splice closures shall be airtight and prevent water intrusion. Splice closures shall permit pressurization. Splice closures shall not contain gel, or any substance which requires cleaning or removal before splicing.

**1.2.3 ENTRY MECHANISM:**

Splice closures shall allow tool-less re-entry via an exterior mechanical base-to-dome seal. The interior shall permit access to splice trays without kinking buffer tubes or macro-bending.

**1.2.4 CABLE ENTRY PORTS:**

Splice closures shall have a total of 4 or 6 cable entry ports. Splice closures shall permit the use of all ports without the use of expansion kits. Cable entry ports shall be sealed with heat shrinkable materials.

**1.2.5 DIMENSIONS:**

Splice closures shall have enough interior space to accommodate 10 feet of slack from each cable that enters the splice without exceeding the minimum bend radius of the cable.

Splice closure shall be used as directed by the City:

**SMALL CLOSURES:** ≤ 22”L x 9”W x 7”D (Accommodates 6 trays/144 splices)

- Through splices of 2 x ≤96 fiber trunk cables
- Drop/Midspan splice sites for 1 x 12 fiber drop cable into ≥96 fiber backbone cable
- 

**LARGE CLOSURES:** ≤ 28”L x 10.5”W x 10.5”D (Accommodates 8 trays/>288 splices)

- Splices of 2 or more 96 to 144 fiber cables with 1 or more 12-48 fiber drop cables
- Complex splices of 3 or more trunk cables
- Upsizing may be required at locations depending on the City’s future plans

**1.2.6 SLACK BASKET:** Splice closures shall include a slack basket for managing loose buffer tubes.

1.2.7 SPLICE TRAYS:

Splice trays shall be specifically designed for use with the selected splice closure and shall fit accordingly into the splice closure. Splice closures shall use hinged splice trays. Splice trays shall be re-enterable. Splice trays shall provide storage and protection for minimum of 12 splices for drop site small closures and minimum 24 splices for large closures. Splice trays shall hold (splice sleeves) rigidly in place. Splice trays shall provide sufficient space to prevent macro-bending of the optical fibers.

**1.3 PATCH PANELS**

Furnish modular interconnect centers (Patch Panels) for installation inside the equipment cabinets.

1.3.1 MANUFACTURER:

The manufacturer shall be ISO 9001 certified and TL9000 registered.

1.3.2 PATCH PANEL CONSTRUCTION:

Patch panel housings shall be constructed of powder-painted baked-epoxy galvanized steel. Patch panels shall be designed for cable entry parallel to the rear of the panel. Cable openings shall be protected by grommets. The front of the panel shall form a shelf providing physical protection of connectors and routing options for the patch cords. The housing shall include strain relief, bend radius protection, and short-term cable retention clamps.

1.3.3 PORTS:

Patch panels shall provide 12 LC SM coupler ports with ceramic inserts on its front-facing panel unless restoring a legacy site with ST or SC splice on pigtail connectors.

- Compatible with pre-assembled coupling plates (6 or 8 ports per plate, 3 plates per row).
- Designed to contain 24 ports per unit of rack space (1U=1.75”H).
- Expandable up to 144 ports (24 ports per unit of rack space, 6U total).
- Dust caps included with all coupler ports.

Couplers shall be configured in an arrangement to facilitate easy access to each coupler pair.

**1.4 PIGTAILS**

1.4.1 MANUFACTURER:

The manufacturer shall be ISO 9001 certified compliant.

1.4.2 PIGTAIL CONSTRUCTION:

Pigtails shall consist of a standard 250µm fiber single-mode fiber enveloped with a 900µm tight buffer. The fiber shall be constructed with a Dual-Acrylate Slip Layer between the 250µm fiber and 900µm tight buffer. Stripping the 900µm tight buffer off the 250µm fiber shall only require the use of standard mechanical strippers and shall not require the use of thermal strippers.

The fiber type shall be single mode and the core characteristics shall be splice compatible with existing fiber, matching the specifications stated in Section 1.1.12 unless campus project specifically calls for multi-mode cable.

Pigtails shall be LC, 12 or 24-fiber capacities Pigtails shall be protected with dust caps on the connector ferrules until connected to a port.

### 1.4.3 SPECIFICATIONS:

Pigtails and their pre-assembled connectors shall also meet or exceed the following specifications:

#### CONNECTOR:

- Connector Type: LC (Non-Keyed/No Security)
- Polish/Contact Type: UPC (Ultra Polish/Physical Contact)
- Boot: Blue, Fungus Resistant material
- Body: Composite
- Ferrule: 2.5mm Zirconia Ceramic
- Max. Typical Loss: 0.15dB
- Reflectance/Back Reflection:  $\leq -58$ dB
- Operating Temperature:  $-40^{\circ}\text{F}$  to  $185^{\circ}\text{F}$
- Intermateability Standard: TIA/EIA-604-2
- Durability Testing:  $\leq 0.2$  dB loss/1000 re-matings, FOTP-21

#### CABLE:

- Type: Simplex (1F) or 12F, Single-Mode
- Jacket: 0.9mm, color coded OFNR rated
- Length: 2 meters
- Minimum Bend Radius: 30mm

#### GENERAL:

- Material Compliance: ITU-T G.652.D and ITU-T G.657.A1
- Substance Restrictions: RoHS Compliant construction

## 1.5 PIGTAIL MODULE

### 1.5.1 MANUFACTURER:

The manufacturer shall be ISO 9001 certified compliant.

### 1.5.2 PIGTAIL MODULE CONSTRUCTION:

Pigtail Modules are allowed for use when terminating backbone cables. Pigtail Modules shall be LC, 12 or 24-fiber capacities. For use in Corning CCH housings.

Each module provides strain-relief for the pigtail and offers the advantage of greater protection to the cables and connectors being installed when the pigtails will be routed and spliced in a separate housing. Available with both ribbon and 900  $\mu\text{m}$  tight-buffer MIC<sup>®</sup> Cable types, each CCH pigtail module is factory terminated and tested.

The fiber type shall be single mode and the core characteristics shall be splice compatible with existing fiber, matching the specifications stated in Section 1.1.12.

Pigtails shall be protected with dust caps on the connector ferrules until connected to a port.

The optical specification of the hardware is a typical module insertion loss, typical 0.15 dB and maximum of 0.40 dB.

## **1.6 PIGTAIL SPLICE CASSETTE**

### **1.6.1 MANUFACTURER:**

The manufacturer shall be ISO 9001 certified compliant.

### **1.6.2 PIGTAIL SPLICE CASSETTE CONSTRUCTION:**

Pigtail Splice Cassette are allowed for use when terminating backbone cables. Pigtail Splice Cassettes shall be LC, 12 or 24-fiber capacities.

Each cassette provides strain-relief for the pigtail and offers the advantage of greater protection to the cables and connectors being installed when the pigtails will be routed and spliced in a separate housing. Available with both ribbon and 900  $\mu\text{m}$  tight-buffer MIC<sup>®</sup> Cable types, each CCH pigtail module is factory terminated and tested.

The fiber type shall be single mode and the core characteristics shall be splice compatible with existing fiber, matching the specifications stated in Section 1.1.12.

Pigtails shall be protected with dust caps on the connector ferrules until connected to a port.

The optical specification of the hardware is a typical module insertion loss, typical 0.15 dB and maximum of 0.40 dB.

For use in Corning CCH housings.

## **1.7 PATCH CORDS/CABLES**

### **1.7.1 MANUFACTURER:**

The manufacturer shall be ISO 9001 certified.

### **1.7.2 PATCH CORD CONSTRUCTION:**

Patch cordage shall be factory pre-assembled, pre-terminated patch cords that are compatible with the existing fiber system, adhering to the fiber specifications found in Section 1.1.12. All inside plant (IP) assemblies shall meet NEC jacketing requirements for the application.

Jumpers shall be of the same fiber core size, performance and connector type as the existing cable system (see Section 1.1 "Fiber Optic Cable").

Patch cords shall be protected with dust caps on the connector ferrules.

1.7.3 SPECIFICATIONS:

Patch cords and their connectors shall also meet or exceed all of the following specifications:

CONNECTOR:

- Connector Type: LC (preferred by the City), ST, SC (Legacy)
- Polish/Contact Type: UPC (Ultra Polish / Physical Contact)
- Connector Body: Composite, Blue (Typical)
- Connector Boot: White (Typical)
- Connector Ferrule: 2.5mm Zirconia Ceramic
- Max. Typical Loss:  $\leq 0.15\text{dB}$  (UPC)
- Reflectance/Back Reflection:  $\leq -59\text{dB}$  (UPC)
- Operating Temperature:  $-40^{\circ}\text{F}$  to  $185^{\circ}\text{F}$
- Intermateability Standard: TIA/EIA-604-2
- Durability Testing:  $\leq 0.2$  dB loss per 1000 re-matings, FOTP-21

CABLE:

- Type: Duplex, Single-Mode
- Jacket: 3mm, Yellow, OFNR rated
- Length: Varies 1 to 3 meters
- Minimum Bend Radius: 30mm
- Crush Resistance: 1000 N/10cm
- Tensile Strength: 200 N

GENERAL:

- Materials/Construction: LSZH, FRNC
- Substance Restrictions: RoHS Compliant construction

**1.8 SPlicing EQUIPMENT**

1.8.1 MANUFACTURER:

The fusion splicer manufacturer shall be ISO9001 certified and TL9000 registered.

1.8.2 FUSION SPLICER FEATURES:

The fusion splicer shall be designed to splice standard single-mode fibers with a cladding diameter of  $125\mu\text{m}$  and coating diameters from  $250\mu\text{m}$  to  $900\mu\text{m}$ . The fusion splicer shall be equipped with a heat shrink oven compatible with 60mm splice sleeves.

The fusion splicer shall be equipped with a light injection detection (LID) splice loss measurement system (not only a splice loss *estimation* system). The fusion splicer shall be equipped with a monitor display that allows inspection of the fiber ends with 120 X magnification.

**1.8.3 SPECIFICATIONS:**

The fusion splice shall also meet or exceed all of the following specifications:

- Typical Splice Loss (Standard Single-Mode): < 0.05 dB (similar fibers)
- Splice loss measurement accuracy: +/- 0.02 dB
- Operating Temperature Range: -15° to +50°C
- Relative Humidity: <95%, non-condensing
- Built-in GPS System
- Splice Data storage capability (including GPS location data)

The fusion splicer shall be new from the factory or serviced and certified by the manufacturer or its authorized representative within 1 year prior to its use for splicing. The Engineer shall be provided with a letter from the manufacturer or its authorized representative certifying compliance. The fusion splicer used shall have yearly calibration and provide the yearly certification certificate prior to splicing procedure.

**1.9 OTDR TEST EQUIPMENT**

The OTDR shall be used for testing purposes shall be compatible with the installed fiber optic cable (single-mode 8/125 fiber) to be tested. Contractor may be required to test at different wavelengths for coarse or dense wave division multiplexed deployments.

**1.9.1 MANUFACTURER:**

The manufacturer shall be ISO9001 certified and TL9000 registered.

**1.9.2 SPECIFICATIONS:**

- Test Wavelengths: 850nm / 1310nm / 1550nm
- Event Dead Zone: 1m / 1m
- Attenuation Dead Zone: 5m / 6m
- Dynamic Range: 39dB / 38dB
- Distance Ranges (km): 5/10/30/100/275/1,000/10,000/20,000
- Loss Resolution: 0.001dB
- Sampling Resolution: 0.004m to 5m
- Sampling Points: Up to 128,000

**1.9.3 FILE FORMAT:**

The OTDR shall be capable of saving all traces and data in analysis mode so electronic file formats for both uni-directional and bi-directional traces may be developed with Manufacturer software for analysis and compliance verification.

The Contractor shall provide at no cost to the CPSL, OTDR viewing software licenses to be able to view each trace provided.

**1.9.4 CALIBRATION:**

The OTDR shall be new from the factory or serviced and certified by the manufacturer or its authorized representative within 1 year prior to its use for splicing. The Engineer shall be provided with a letter from the manufacturer or its authorized representative certifying compliance. The OTDR Test Equipment used shall have yearly calibration and provide the yearly certification certificate prior to testing procedure.

**1.10 INSTALLATION**

**1.10.1 PRECONSTRUCTION:**

Before starting any installation, the City shall be notified 3 business days in advance. Failure to notify the City may result in rejection of the installation and may subject the contractor to be responsible for removal of the installation at no cost to City of PSL. Before installation, the cable to be installed shall be reel tested (Section 1.11.12).

**1.10.2 PERSONNEL:**

Personnel performing the cable installation shall be adequately trained and shall be IMSA MOT Level 1 certified. All Contractor personnel (including subcontractors) shall be thoroughly familiar with and shall comply with all Occupational Safety and Hazard Act (OSHA) regulations.

**1.10.3 MAINTENANCE of TRAFFIC (MOT) PLAN:**

An approved MOT Plan shall be required any time work is being performed within the City of PSL Right of Way, regardless of permit requirements. MOT Plans shall conform to the latest FDOT Design Standards 600 Series and the latest Manual on Uniform Traffic Control Devices (MUTCD). The Contractor shall be responsible for setup and removal of all MOT devices.

**1.10.4 COMPLIANCE:**

The Contractor shall obtain a Road Closure Permit from the City of PSL or FDOT, where necessary. Cable shall be installed in compliance with NEC requirements where applicable. The Contractor shall receive an Excavation Permit from the City of PSL, where necessary.

**1.10.5 INSTALLATION:**

Conventional fiber optic cable installation techniques shall be used within the conduit in such a manner that the optical and mechanical characteristics of the cables are not degraded in any manner at the time of installation. Contractor to follow Manufacturer recommended cable installation procedures for hand pulling, machine pulling or air assisted jetting or blowing.

**1.10.6 UNREELING:**

Cable shall be rolled off of the spool. Spinning off the side of the spool end shall not be permitted. (It will put a twist in the cable for every turn on the spool.) The figure-eight configuration shall be used for storing cable at intermediate locations to prevent kinking or twisting when the cable must be unreeled and back fed. Pulling and reel locations should be set near the sharpest conduit bend locations (i.e. corner vaults, etc.) where possible.

1.10.7 PULLING:

Fiber optic cable shall be installed by hand or by using a mechanical pulling machine. When a mechanical/automated pulling machine is used it shall be equipped with a monitored tension meter/tension control. Cable pulling tension shall be continuously monitored; the pulling process shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable. A proper wire mesh pulling grip and swivel shall be used in the cable pulling process. Fuse links and breaks shall be used to insure that the cable will not be subjected to stresses exceeding 600 lbf.

The minimum-bending radius of the cable shall not be exceeded. Corner rollers (wheels), if used, shall not have radii less than the minimum installation bend radius of the cable. A series array of smaller wheels may be used for accomplishing the bend if the cable manufacturer specifically approves the array. Entry guide chutes shall be used to guide the cable into the pull-box conduit ports. When simultaneously pulling fiber optic cable with other cables, separate grooved rollers shall be used for each cable.

On runs over 100 feet, lubricating compound shall be used to minimize cable-to-conduit friction. Lubricating compound shall be a water-based compound specifically produced for fiberoptic cable lubrication. Lubricants such as dish soap and other substitutes shall not be permitted.

Every effort shall be made to pull cables from a conduit in as straight an angle as possible. "Offset" pulling shall be avoided whenever possible. (Pulling on an angle can cause damage to the cable.) The number of 90° turns on a pull shall not exceed 4 within 750lf segment.

The cable shall be installed in continuous lengths from splice point to splice point, as indicated in the plans.

1.10.8 Air Assisted Cable Installation

Placing optical fiber cables in duct systems using air-assisted installation techniques presents different installation requirements than traditional pulling. In return, these techniques enable installation of much longer cable lengths to take advantage of long manufactured lengths (up to 12 kilometers or approximately 7.5 miles). Installing long cable lengths often reduces labor and material expenses.

Jetting and blowing are two common air-assisted cable installation techniques. Both methods require pushing the cable with a tractor mechanism while blowing compressed air into a preinstalled duct around the cable being installed. Both rely on air flow to help "float" the cable inside the duct, minimizing sidewall pressures to reduce friction between the cable and the duct.

Jetting and blowing differ, though, in how pulling force is applied to the cable. Jetting uses a reaction head (or parachute) attached to the cable. A differential pressure across the reaction head creates a pulling force on the cable. Blowing does not use a reaction head. Instead, the pulling force on the cable is due to fluid drag of air rushing along the cable. This pulling force is distributed along the cable length.

1.10.9 CABLE SLACK REQUIREMENTS:

Throughout the cable plant, pull and store excess cable slack at each pull box, splice box, hub, and each TMC or TOC. The following lengths of slack cable are minimums:

Fiber Pull Box (17"x30"):	50 ft.
Fiber Splice Box (24"x36" or 30" x48"):	220 ft. (100' each side of any splice closure and allotting 20lf for inside the splice closure)
Bridge Barrier Wall:	5 ft. (Contractor must maintain the minimum bend radius inside bridge box)
Device Cabinet:	20 ft.
Hub Building (Inside):	100 ft.

Cable slack shall be neatly arranged and looped horizontally on the floor of each pull box. Coils of slack from separate cables shall be grouped together and taped individually.

Do not leave slack cable lying free (uncoiled) on the ground, bottom of a pull box, or floor of a Device Cabinet, Hub Building, etc., except during the installation/pulling process.

When coiling and storing cable slack the cable minimum bend radius shall not be exceeded. The cable slack/coils shall not protrude above the pull box/splice vault cover or in any way interfere with the placing or replacing the splice box cover.

1.10.10 LABELING & DOCUMENTATION:

Document the sequential cable length markings at each pull box and splice vault wall that the cable passes through and include this information with the as-built documentation.

Each cable that enters/exits a conduit inside a pull box shall be clearly labeled with a weatherproof colored tape within 3 foot of exiting the conduit. The color of the "tape" placed on each cable shall identify which direction the cable is "headed" from this pullbox. The color standard to be utilized is:

- Yellow – East
- Green – West
- Blue – North
- Red - South

Each cable that enters/exists inside a pullbox shall have a tag/label attached to indicate: the cable type, fiber count, direction, and date. The tag shall provide enough space for all info to be written clearly and legibly on its front in permanent marker.

1.10.11 INSPECTION:

Prior to splicing and/or termination, the City shall be notified when cable installation

(pulling) is complete so that they may inspect the cable prior to any splice or termination activity. The cable may be inspected at all accessible locations (pull boxes, splice vaults, traffic cabinets, etc.) for correctness and for damage to the cable that may have occurred or may have been preexisting.

Once the cable installation has been inspected and/or approved by the City representative, then the contractor may proceed with completion of the installation (splicing, termination, testing, etc.).

#### 1.10.12 DAMAGE:

The City shall be notified immediately of any damage to the cable, including, but not limited to: any nick that penetrates the outer jacket of the cable (even if buffer tubes, gel, fibers, etc., are not exposed); any breaks, kinks, twists, warps, bends, or crushing of the cable that result in a deformation that does not restore to normal on its own, even if the damage appears to be only superficial.

If any damage to the fiber optic cable occurs before, during or after installation, the contractor shall not attempt to repair the damage before the City has been notified and exercised its option to inspect the damage prior to any splicing or termination activity.

The Contractor may present a repair plan, consistent with above specified restoration periods, inclusive of the procedure to be implemented, the beginning or end point of any such repair, the location of any additional proposed splice points.

Once inspected, the City will choose the repair method and direct all repair operations, including but not limited to placing a new fiber segment from two (2) existing original reel end splice points, sealing the cable, required emergency temporary or permanent splicing -or re-splicing of damaged cable at approved vaults, etc.

The City reserves the right to perform any repairs itself wherever to maintain critical operations and/or it deems necessary and seek compensation for damage restoration from any party damaging the City's Fiber Optic Network Infrastructure (cable, conduit or pull boxes).

When making repairs to damaged cable segments, the existing damaged fiber optic cable must be removed from the restored pathways so no damaged or unuseable fiber optic cable is left in any City conduit.

Any Contractor, Owner or Third Party who damages the City of Port St. Lucie fiber optic infrastructure, including conduits, fiber optic cables, tracer wires, handholes and locate system assets, without having previously sought locates from 811 Sunshine One Call, or who damages the infrastructure that is clearly marked within eighteen (18") inches of a locate flag or mark, shall bear the full financial responsibility for the remediation costs

including any emergency or temporary repair activity which may include duct repairs, cable replacement, splicing and termination; and, permanent cable segment replacement with associated cabling, splicing, terminations and testing.

**1.11 FIBER OPTIC SPLICING REQUIREMENTS**

All fibers in the fiber optic cable shall be spliced and/or terminated.

**1.11.1 SPLICE PLAN:**

CPSL is to provide a fiber allocation and/or splice plan showing the location and splices to be performed at any location to ensure maintaining proper allocation within Departments and/or Networks.

Contractor may be asked to provide splice schematic for large fiber cross splice sites or sites where >3 cables are splices between cables, buffers and fibers as a plan to follow for field personnel.

All splicing shall be performed according to the plan. Document each splice location and identify the source and destination of each fiber in each splice tray. Document all fiber colors and buffer jacket colors used during installation. Develop and document a sequential fiber numbering plan as required in the TIA/EIA-598-A standard.

Contractor to asbuild every splice closure and termination housing to ensure compliance with optical allocation, routing and assignment.

**1.11.2 FUSION SPLICING:**

The fusion technique shall be used for all splices and terminations. A fusion splicing machine (Fusion Splicer) shall be used to splice all optical fiber as specified in Section 1.6.

**1.11.3 PERSONNEL:**

All splicing personnel shall be adequately trained for the fusion splicing, and shall possess a fiber optic splicing certification from an industry recognized authority such as Corning, FIS, Light Brigade, ETA or other recognized industry resource.

**1.11.4 SPLICING EQUIPMENT PREPARATION:**

Provide splice closures, organizers and incidentals, and cable end preparation tools and procedures, compatible with the cable type being delivered. Fusion splicing equipment shall be cleaned and calibrated per the manufacturer's specifications, and specifically adjusted to the fiber and environmental conditions at the start of each splicing shift.

**1.11.5 SPLICE CLOSURE PREPARATION:**

Select a splice closure appropriate for the application that complies with section (1.2 Splice Enclosures) and shall allow all of the fibers in each cable to be spliced and stored. All cables shall enter into the splice closure on only one side ("butt" configuration). Only

one cable per entry port shall be allowed (except for mid-span “oval” ports). A minimum of 10 feet of cable from each cable entering the closure (i.e. 20 feet of trunk cable in mid-span splicing) shall be prepared and installed within the enclosure.

#### 1.11.6 SPLICE TRAY PREPARATION:

Splice trays shall be selected that will accommodate the required number of splices and provide sufficient storage space and protection to prevent micro-bending of slack fiber. Accomplish loose tube entry using a mid-access tool or split-entry tool. Only open the buffer(s) that contain(s) the fibers to be spliced, and only cut the fibers that must be spliced. Buffer tubes shall be secured onto the splice tray and held rigidly in place. At least 24” of loose fiber shall be exposed for splicing and the remainder shall be stored as slack, along with any exposed fibers that will not be spliced.

#### 1.11.7 SPLICING:

Perform fusion splicing according to latest version of the cable manufacturer’s and fusion splicer’s procedures, accepted standards, codes, and practices; or as directed by the City. Fibers shall not be fused or re-fused more than a total of 3 times.

#### 1.11.8 SPLICE LOSS:

Individual splice loss shall not exceed 0.05 dB loss as measured by the fusion splicer and 0.15dB on a bi-directional average of an OTDR.

#### 1.11.9 SPLICE PROTECTION:

Each spliced fiber shall be packaged in a 60mm heat shrinkable splice protection sleeve with strength member. The protection sleeve shall cover the splice and any bare fiber stripped of its coating.

#### 1.11.10 STORAGE:

A maintenance loop at each Pull Box or Fiber Splice Box shall be per Section 1.10.

#### 1.11.11 LABELING:

Each cable entering a splice closure shall be clearly labeled with a weatherproof tape/tag within 1 foot of the splice closure, which shall indicate: the cable type, fiber count, length marking, “from” direction, and the cable’s origination and termination points. Splice closures shall be tagged with a weatherproof tag/label.

The tag shall provide enough space for all info to be written clearly and legibly on its front. Labeling shall include date of installation, splicing technician initials, splice diagram/chart reference #, etc. A splice diagram/chart shall be included inside the splice. The diagram will define each fiber from every cable that enters the enclosure.

**1.12 FIBER OPTIC TERMINATION REQUIREMENTS**

All fiber optic cables shall be terminated by means of fusion splicing onto factory pre-terminated assemblies (pigtailed) with LC connectors. Patch Panels, Pigtailed and Splice Trays shall be provided as specified earlier in this document. Patch panels shall accommodate all fibers entering equipment cabinets. Splice Trays shall be selected that fit the patch panel.

**1.12.1 PATCH PANEL PREPARATION:**

The cable shall be clamped to the patch panel by means of a “hose clamp”. The cable central strength member shall be secured (clamped) to the patch panel. Protective spiral wrap shall be placed and secured (taped) over the cable and buffer tubes where the cable enters the panel and passes through the grommet. 10 feet of cable entering the panel shall be prepared and installed within the enclosure.

Pigtailed shall be spliced onto the bare fibers as detailed in section 1.9. The splicing sequence shall follow the order of the fiber # position within the buffer and cable.

Once all bare fibers have been terminated onto pigtailed, the pigtailed shall be connected to the LC or SC coupler ports according to their position within the fiber or cable. Pigtailed shall be arranged neatly within the panel without crushing, exceeding the minimum bend radius, or introducing losses. Dust caps shall be placed on all unused coupler ports.

All fiber terminations shall be visually inspected, and optically tested for attenuation and reflectance, and shall exhibit an optical performance with a maximum insertion loss and a minimum return loss as noted on the qualified product cut sheet.

**1.12.2 LABELING:**

**PATCH PANELS:**

Patch panels shall be labeled to indicate which cable and direction they provide access to. Port plates shall be labeled to indicate which buffer within the cable they provide access to. Coupler ports shall be labeled to identify which fiber # or color that the port provides access to.

**EQUIPMENT PATCH CORDS:**

Patch cords that provide connections to network switches shall be labeled at each end to indicate the source cable & fiber #/color it connects to for transmit and receive, and which port on the switch it connects to.

**JUMPER PATCH CORDS:**

Jumper patch cords, if any, shall be labeled at each end to indicate which cable & fiber #/colors that they are connected to for transmit and receive and shall include labeling which indicates the “To” and “From” connection end points.

## 1.13 ACCEPTANCE TESTING

The Fiber Optic Cable Network shall be tested as follows:

### 1.13.1 MANUFACTURER'S TEST AND CERTIFICATION:

Each reel of fiber optic cable shall be accompanied by the manufacturer's test data (Section 1.1.14). The manufacturer's test data shall identify each fiber in each cable and list its factory- tested attenuation in dB/km. Attenuation shall meet attenuation requirements Section 1.1.12.

### 1.13.2 PRE-INSTALLATION TESTS (REEL TEST):

The Contractor is to reel test the fiber optic cable prior to its installation. Each optical fiber in the cable shall be tested from one end at one wavelength with a compatible OTDR. Test for continuity, length, anomalies, and approximate attenuation. Record each measurement with color, location and fiber type measured, and submit the documentation to the City in electronic format. If the tested loss per Km exceeds the loss from the manufacturer's test data the City will reject the cable.

### 1.13.3 POST INSTALLATION TESTS (FINAL TEST):

1. Contractor to attempt to notify the City 3 business days via email or test in advance of the Final Testing so that the City may elect to be present for the testing.
2. After installation (splicing and termination) is complete, the optical fibers shall be tested for loss characteristics. A full bi-directional test (using bi-directional averaging) shall be performed on all terminated fibers in each cable using an Optical Time Domain Reflectometer (OTDR) (See Section 1.9).
3. Any fibers in a *"building or device cabinet or other horizontal drop cable"* that remain un-terminated or un-spliced at one end on the project and therefore are "left bare at one end" shall be protected for future use at the "bare end" and shall be tested from the terminated end in a uni-directional OTDR test to prove termination attenuation and fiber continuity.
4. All Singlemode Fibers shall be tested at 1310nm and 1550nm. All Multimode fibers shall be tested at 850nm and 1300nm. There may be instances where Contractor(s) are required to test additional wavelengths for CPSL course or dense wave division multiplexed deployment projects which will be shown in plans for project by the EOR.
5. If the OTDR does not have internal fiber to eliminate any dead zone effects on the test, the Contractor shall use a factory assembled patch cord, or launch cables equal to a length of 150% of the Dead Zone as published by the OTDR Manufacturer. The launch cable shall have the appropriate connectors to allow for connection to the terminated fiber port without the use of additional couplers.

6. Test result printouts shall include, but not be limited to, the following:
  - a. Cable ID and Fiber ID;
  - b. Distance of trace;
  - c. Total Loss;
  - d. Splice Loss;
  - e. Beginning Testing Location;
  - f. End of Fiber Testing Location;
  - g. Operator/Technician Name or Initials;
  - h. Date and Time test was performed;
  - i. Test Wavelength;
  - j. Test Pulse Width;
  - k. Refractory Index
  
7. All installation test data shall be submitted in electronic format both PDF summary reports as well as native OTDR trace files (.trc file format unidirectional traces & .bdr file format for bidirectional traces) to the City as basis for acceptance. The Contractor shall provide to the City of PSL Department at no charge a “viewer” license of any OTDR software.

**1.14 TRAFFIC & UTILITIES OSP MULTI-PAIR CABLES (COPPER DATA CABLES):**

For department specific device connections, the Contractor shall supply manufacturer specified multi-conductor composite cables to support SCADA, serial or ethernet communications and/or power for such devices.

For ethernet connected devices, the Contractor shall furnish and install multi-pair data cable (CAT6) that will support full-duplex Fast Ethernet operations up to 10GB operations. Furnish all tools, materials, connectors, and required consumables, and perform all installation operations necessary to provide a complete, fully operational multi-pair data cable (CAT6).

**1.14.1 MANUFACTURER:**

The manufacturer shall be ISO9001 certified and TL9000 registered.

**1.14.2 SPECIFICATIONS:**

Multi-pair data cable, CAT6 shall meet the minimum specifications as published on city website in table 27 10 11.01.B.

**1.14.3 CONNECTORS:**

CAT6 cabling shall be terminated with Connectors shall be RJ-45 (8P8C) type connectors and 110 style IDC pair terminations.

**1.14.4 TESTING:**

Category 6A performance testing shall be done according to the requirements of ANSI/TIA-568.2-D-2018 and ANSI/TIA-1152-A-2016.

**2 NETWORK DEVICES**

Provide hardened, Managed Field Ethernet Switches (MFES) for drop termination connections supporting field devices for Traffic Engineering, Utility Systems, Parks and Recreation, Public Works, and Information Technologies. The MFES shall be 100% compatible and interoperable with the existing Ethernet networks.

The Contractor shall follow project plans for determining the number of POE+ connected devices and shall size the power supply to support the required power draw over POE ports.

**2.1 MANUFACTURER:**

The manufacturer shall be ISO9001 compliant.

**2.2 CONSTRUCTION:**

All parts shall be made of corrosion resistant materials such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metals. Every conductive contact surface shall be gold-plated or made of a noncorrosive, non-rusting, conductive metal. The MFESs shall be constructed with no moving parts (Fan-Less Design).

**2.3 PHYSICAL/MECHANICAL:**

Height:	≤ 8”H x ≤ 8”W x ≤ 5.5”D
Mounting:	DIN rail mounted

**2.4 ELECTRICAL:**

All wiring shall meet NEC requirements and standards.

- Power Consumption: ≤ 42W
- Input Voltage: 9.6-60 VDC; 110/220 VAC

**2.5 ENVIRONMENTAL:**

- Operating Temperature Range: -40°C to +75°C
- Humidity: ≤ 95 % non-condensing
- Ingress protection: IP40 rated (1mm objects)
- Compliance: NEMA TS 2 Standard (Traffic Control Equipment)

**2.6 ETHERNET PORTS:**

The Contractor is to review the project plans in order to determine the required number of ports.

“Fast Ethernet” (10/100BaseTX) Copper Ports.

- Copper ports shall be RJ-45 Type.
- Auto-negotiate speed (10/100/1000) and duplex (half/full).
- IEEE 802.3 standard compliant pinouts.

Fiber Optic single-mode “Gigabit Ethernet” (1000BaseX) ports

- Each optical port shall consist of a pair of SC or LC Type connectors only
- Optical power budget ≥ 15 dB

2.7 WARRANTY: 5 years manufacturer warranty from the date of purchase.

2.8 PERFORMANCE:

- Switching Bandwidth:  $\geq 20$  Gbps non-blocking
- VLANS: 1,000
- IGMP Groups: 1,000
- Minimum 32KB MAC address table (16,000 MAC addresses)
- Minimum Mean Time Before Failures (MTBF) of 10 years ( $\geq 519,190$  hours)

2.9 OTHER:

Diagnostic Light Emitting Diodes (LEDs) indicating Link, TX, RX and speed for each port, as well as Alarms and Power on unit. LED indicators shall be on the front panel of the unit.

2.10 MANAGEMENT CAPABILITIES:

The City shall be able to manage each MFES individually or as a group/cluster for switch configuration, performance monitoring, and troubleshooting. The MFES shall support setup/configuration and management and/or monitoring of all user programmable features and functions via the following:

- Fast Boot Express setup
- Web Device Manager, Industrial Network Director (IND)
- MIB, Smartport, SNMP, Syslog, storm control, unicast, multicast, broadcast
- SPAN sessions, RSPAN
- DHCP server, customized DOM (digital optical management)
- Embedded Event Manager (EEM), Plug-n-Play Agent

2.11 CYBER SECURITY FEATURES:

The MFES shall support the following standard and advanced cyber security features:

- SCP, SSH, SNMPv3, TACACS+
- RADIUS Server/Client
- MAC Address Notification, BPDU Guard
- Port-Security, Private VLAN
- DHCP Snooping, Dynamic ARP Inspection, IP Source Guard
- 802.1x, Guest VLAN, MAC, Authentication Bypass
- 802.1x Multi-Domain Authentication, Storm Control, Trust Boundary
- FIPS 140-2, Netflow Lite

2.12 NETWORKING FEATURES:

Standard and advanced (layer 2+) networking features shall include, but are not limited to:

- Layer 2 IPv6 - IPv6 Host support, HTTP over IPv6, SNMP over IPv6
- Layer 3 Routing -
- Internet Group Messaging Protocol (IGMP) IGMPv1, v2, v3 Snooping, IGMP filtering, IGMP Querier
- Quality of Service (QoS) priority classify by port, Ingress Policing, Rate-Limit, Egress Queueing/shaping, AutoQoS, QoS

2.13 NETWORKING STANDARDS / IEEE COMPLIANCE:

The MFES shall comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.1D MAC Bridges, STP
- IEEE 802.1p Layer2 COS prioritization
- IEEE 802.1q VLAN
- IEEE 802.1s Multiple Spanning-Trees
- IEEE 802.1w Rapid Spanning-Tree
- IEEE 802.1x Port Access Authentication
- IEEE 802.1AB LLDP
- IEEE 802.3ad Link Aggregation (LACP)
- IEEE 802.3af Power over Ethernet provides up to 15.4W DC power to each end device
- IEEE 802.3at Power over Ethernet provides up to 25.5W DC power to each end device
- IEEE 802.3af Power over Ethernet
- IEEE 802.3at Power over Ethernet Plus
- IEEE 802.3ah 100BASE-X SMF/MMF only
- IEEE 802.3x full duplex on 10BASE-T
- IEEE 802.3 10BASE-T specification
- IEEE 802.3u 100BASE-TX specification
- IEEE 802.3ab 1000BASE-T specification
- IEEE 802.3z 1000BASE-X specification
- IEEE 1588v2 PTP Precision Time Protocol
- IEEE 802.1AS PTP
- IEEE 802.1Qbv TSN

2.14 IETF RFC COMPLIANCE:

- RFC 768: UDP
- RFC 783: TFTP
- RFC 791: IPv4 protocol
- RFC 792: ICMP
- RFC 793: TCP
- RFC 826: ARP
- RFC 854: Telnet
- RFC 951: BOOTP
- RFC 959: FTP
- RFC 1157: SNMPv1
- RFC 1901,1902-1907 SNMPv2
- RFC 2273-2275: SNMPv3
- RFC 2571: SNMP Mgmt
- RFC 1166: IP Addresses
- RFC 1256: ICMP Router Discovery
- RFC 1305: NTP
- RFC 1492: TACACS+
- RFC 1493: Bridge MIB Objects
- RFC 1534: DHCP and BOOTP interoperation
- RFC 1542: Bootstrap Protocol
- RFC 1643: Ethernet Interface MIB
- RFC 1757: RMON
- RFC 2068: HTTP
- RFC 2131, 2132: DHCP
- RFC 2236: IGMP v2
- RFC 3376: IGMP v3
- RFC 2474: DiffServ Precedence
- RFC 3046: DHCP Relay Agent Information Option
- RFC 3580: 802.1x RADIUS
- RFC 4250-4252 SSH Protocol

2.15 INSTALLATION REQUIREMENTS:

Furnish and identify all equipment and appurtenances by name, model number, serial number, technical support and warranty telephone numbers, and any other pertinent information required to facilitate equipment maintenance.

The MFES shall be mounted securely in a DIN rail mounting bracket, inside a field site cabinet, and shall be fully accessible by field technicians. Do not use self-tapping screws. Ensure that the MFES is protected from rain, dust, corrosive elements, and typical conditions found in a roadside environment. All wiring shall comply with NEC requirements and standards.

Connect devices to the power sources. Connect all remote ITS field devices to the appropriate MFES copper ports as specified in the plans. Connect the MFES to the fiber network trunk/drop cable termination panel as specified in the plans. Fiber optic patch cables shall be arranged and secured neatly in the patch panel and the minimum bend radius shall not be exceeded.

Use MFES units that can be serviced or replaced immediately when defective or damaged units must be removed and replaced. The Department shall return damaged units to the manufacturer for warranty repair or replacement.

All front panel status indicators (LEDs) shall remain unobstructed and visible.

2.16 FIELD TEST / VERIFICATION REQUIREMENTS:

The Contractor shall arrange for and conduct the tests and is responsible for satisfying all inspection requirements prior to submission for the City's inspection and acceptance. The City reserves the right to witness all FATs. Complete the tests within five business days.

Once the MFES has been installed, conduct local Field Acceptance Tests (FATs) at the MFES field site according to the test procedures stated herein.

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Verify all connections, including correct installation of communication and power cables.
5. Verify connectivity by means of link LEDs.
6. Verify configuration of the MFES Internet Protocol (IP) addresses and subnet mask.
7. Verify the network connection to the MFES through ping and telnet sessions from a remote personal computer (PC).
8. Perform testing on multicast routing functionality when applicable.
9. Call the City to verify that all field devices are reachable over the network.

**3 CCTV Cameras**

Furnish and install a closed-circuit television (CCTV) camera at the locations shown in the Plans. The installed equipment must provide unobstructed video images and other current conditions of City roadways, traffic, facilities around a CCTV field site; respond to camera control signals from an operator; and transmit video images to remote locations for observation by department.

Provide a CCTV camera that is compatible with the current software application used by the City for monitoring and control.

**3.1 MANUFACTURER:**

The manufacturer shall be Bosch or Axis, determined by the applicable department.

**3.2 PERFORMANCE:**

- Day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.
- CCTV cameras must provide titling and masking features including, but not limited to, programmable camera title, programmable preset titles for each preset position, and programmable privacy zones. Programmable titles must allow a minimum of 18 characters per line.
- Lenses shall be suited for the application and have minimum 22x motorized optical zoom and varifocal lenses
- All Traffic CCTV cameras must support the National Transportation Communications for ITS Protocol (NTCIP) 1205 v1.08.
- IP cameras must also support the Open Network Video Interface Forum (ONVIF) Core, Streaming, and Media Service specifications.
- CCTV cameras must perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.
- All CCTV cameras, mounting hardware, and any other camera-related material that is exposed to the environment must withstanding 150 mph wind speeds.

**3.3 ELECTRICAL:**

The Contractor should provide appropriate power supply consistent with specified camera per department defined camera, which may require providing a POE Injector.

**3.4 INSTALLATION:**

When installing cameras for CPSL Traffic Dept., the Contractor shall procure and place a neoprene gasket to be placed between any metallic attachment point such as a mast arm and the mast-o-bracket and pole banding or strapping to eliminate inductance potential.

When installing cameras all CPSL Departments, the Contractor must review with Project Manager desired field of view and any masking of that view that is required by project.

3.5 VERIFICATION REQUIREMENTS:

Post installation the Contractor shall schedule an inspection with the City for final installation approval and acceptance.

**4 GUARANTY PROVISIONS:**

The manufacturers' warranties for the MFES and Cameras shall be fully transferrable from the Contractor to the City. These warranties shall require the manufacturer to furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the City within 10 calendar days.

REFERENCES:

Corning 2021 Local Area Networks and Data Center Core Products Catalog

<https://www.corning.com/catalog/coc/documents/selection-guides/LAN-1273-AEN.pdf>

Corning Cable Systems - SRP-005-011 "Duct Installation of Fiber Optic Cable"

[005-011.pdf \(corning.com\)](#)

[SRP-005-011.iss8 \(wordpress.com\)](#)

Corning Cable Systems - SRP-005-044 "Installing a Wire Mesh Pulling Grip On ... ALTOS Cables"

Corning Cable Systems - Whitepaper "Air Blown Fiber Systems – A Technical Discussion"

5 CONDUIT

5.1 MATERIAL SPECIFICATIONS FOR UNDERGROUND INSTALLATION

The City of PSL standard for backbone fiber optic communication pathways along City roadway rights of way are for a minimum of two (2), two (2") inch conduits to be placed in every project for City communications. The City of PSL standard connections to the backbone fiber optic communications pathways from City Buildings will be a minimum of two (2), two (2") inch conduits but may be more depending on project plans.

The City of PSL standard for horizontal/drop fiber optic communication pathways from the backbone splice vault to an "field endpoint cabinet" (ex: traffic signal, water pump/meter site, Park interface cabinet, ...) shall be one (1), two (2") inch conduits for placement of a smaller distribution cable.

Contractor(s) shall not be allowed to place directional bores diagonally across a roadway or intersection unless previously approved by the CPSL Information Technology Dept. and will only be allowed after field inspection of existing conditions identifies limited right of way for perpendicular deployment.

Engineer(s) and/or Contractor(s) must relocate any existing CPSL infrastructure (conduit, pathways, pullboxes and/or fiber optic cables) where expansion, extension or other modification to roadways (turn lanes, round-a-bouts) encroach over existing CPSL infrastructure. The Engineer(s) or Contractor(s) shall relocate CPSL infrastructure out from proposed hard scape cover within the project limits.

5.1.1 TYPE APPLICATION

HDPE SDR 11 conduit shall be used for all directional bores greater than 600lf.

HDPE SDR 11 or 13.5 is allowed for directional bores of 600LF or less.

HDPE SDR 11, SDR 13.5 or PVC Schedule 40 (communications only), Schedule 80 (electrical) may be used for open trench.

5.1.1.1 OUTER DUCT

Conduit shall be manufactured from virgin high-density polyethylene with PE 3408 resin. Conduit shall be extruded with uniform full-thickness orange coloring unless approved by CPSL Information Technology Department. Printed or embossed striping is not permitted.

Conduit shall be labeled with durable identification giving the name of the manufacturer, conduit size (inner diameter trade size and wall thickness/rating), manufacture/date codes, and sequential foot marking.

Conduits shall be ≤ 2" in diameter (unless required by special projects) and shall conform to industry standards and minimum requirements:

- Nominal outer diameter - 2.375"

- Average inner diameter -  $\leq 1.926''$
- Minimum Wall thickness -  $\leq 0.216''$
- Tensile Strength –  $\leq 0.64$  lb per ft.
- Melt Index – 0.4max (ASTM-D1238).
- Condition B – 20% failure max (ASTM-D1693).
- Cell classification -3340 or 34420 (ASTM-D3350).
- Impact – NEMA Standards Publication TC7 (ASTM-D2444).

Conduits shall be factory treated with an atomized silicone or manufactured in a manner to reduce friction during pulling fiber optic cable. The coefficient of friction shall be 0.09 or less.

Conduit shall be resistant to calcium chloride, potassium chloride, sodium chloride, sodium nitrate, benzene, ethyl alcohol, fuel oil gasoline, lubricating oil, and transformer oil and is protected against degradation due to oxidation and general corrosion. Conduit shall be suitable for underground use in an ambient temperature range of -30 to 130 degrees F without degradation of material properties.

All underground conduit installations shall be 2" (conduit type dependent on project/application) with a minimum of 30" of cover as shown on the approved plans and standard detail. The contractor shall use the following methods for placement of the buried fiber optic cable conduit:

- Trenching
- Plowing
- Joint Trench Installation
- Directional Drilling
- Other methods approved by PSL and EOR

The top of the conduit shall be no less than 30" below grade and shall have a minimum slope of 3" away from any buildings, cabinet or other facility entrance point toward pull boxes to allow for necessary drainage away from interior facilities.

If the required depth cannot be accomplished due to soil conditions or obstructions, additional mechanical protection shall be provided as indicated by the EOR and PSL. For underground conduit requiring additional mechanical protection, i.e., boring under railroads, shall boring depth, proximity to other utilities, a HDPE casing of the larger size as depicted on the plans may be required as an outer sleeve/casing as specified by the EOR and approved by the PSL.

The conduit shall be run in straight lines as practical with deflection around existing utility or change of direction is necessary. Where trenching is employed, the

Contractor shall remove any unsuitable soils (multiple rocks greater than 4" in diameter) and replace with clean fine soils and tamper compacted in 12" levels to restore to existing conditions. .

For all new duct placed by open trench method, a continuous marking tape shall be direct buried at 12" below grade and a minimum of 12" above the duct

Every effort shall be made to minimize HDPE couplings. Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer's recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.

Couplings shall be accomplished only by compression push-on (E-LOC), hydraulic press-on or electro-fusion coupling methods. The E-Loc Coupling is a compression coupling that provides a watertight/airtight connection in buried or restrained applications and is allowed for ducts 4" and smaller.

Press-on couplings of for joining ducts up to 8" in diameter are allowed. . Contractor to follow manufacturer's installation procedures to fully insert both conduit sections to the coupling center stop.

Pre-fabricated electro-fusion couplings shall be used in accordance with the manufacturer's recommended automatic self-monitoring fusing machine and installation procedures and shall be used on any directional bore casing pipe greater than 2,500lf in a single continuous segment.

#### 5.1.1.2 INNER-DUCT

Where specified in plans, the Contractor shall provide factory lubricated, industry sized 1.25-inch inside diameter, low friction, coilable, conduit constructed of virgin high-density polyethylene outer duct. Said inner duct shall conform to ASTM D-2239 and meet the following minimum requirements: Smooth wall SDR-11, nominal outer diameter of 1.592 inches, minimum inner diameter 1.360 inches and a minimum wall thickness of 0.106 inches.

Provide conduit with a smooth outer wall and ribbed inner wall and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors and subsequently uncoiled for installation without affecting its properties or performance. Inner-duct shall be orange or and approved by EOR and/or CPSL project representative.

Furnish and install inner duct with an uninterrupted detectable Kevlar pull (mule) tape, with a minimum of 3-feet of excess tape extending out of each end of the outer duct; these pull tapes shall be utilized in future phases for the installation and detection offiber optic cable.

Provide mechanical duct plugs that provide a watertight barrier when installed in an unused inner duct conduit. Provide duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable. All conduits shall come with factory installed duct plugs to keep out dust, dirt, and water.

Provide mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Provide mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized holes for the communications cable. Provide mechanical sealing devices that are removable.

5.1.2 PVC CONDUIT

Use of PVC conduit materials is specifically required in joint trench applications and in other instances, if approved by PSL.

All bends shall consist of a minimum 48” radius sweep. Sweeps shall be fabricated by the manufacturer and shall have no indications of deformations of the pipe circumference or scorching of the conduit, otherwise the material will be rejected.

No more than an equivalent 180° bend radius shall be allowed in any conduit run in-between hand-holes/pull-boxes. PVC conduit shall be manufactured and installed in 20’ lengths with bell and spigot design and all joints solvent welded and fully seated.

5.2 MATERIAL SPECIFICATIONS FOR ABOVE GROUND INSTALLATION

Conduit shall be 2” galvanized rigid steel (GRS), aluminum, Schedule 80 PVC in accordance with ASTM D 1785 or HDPE SDR 11. Rigid steel conduit material utilized shall be compliant with UL-6, ANSI C-80.1 and to Article 346 of the NEC. Aluminum conduits shall be of aluminum 6063 aluminum alloy, T-1 Temper, ANCI C80.5, and NEC 250.118(2). No reducing couplings or reduction in the inside diameter of conduit shall be permitted.

All required connectors, adapters, fittings, conduit straps or “U” guard clamps and incidentals required and necessary for above ground installations shall be galvanized and provided to construct a complete conduit/duct system.

The conduit for above ground use (a riser assembly on a utility service pole for the purpose of bringing power from above ground to underground conduit/duct or bridge mounted or other above ground structure) consisting of galvanized rigid steel (GRS), aluminum, or Schedule 80 PVC conduit in accordance with ASTM D 1785 and as approved by the City.

Schedule 80 PVC conduit, aluminum or Rigid Metal Conduit (RMC) for bridge applicable. All rigid steel conduit material utilized shall be compliant with UL-6, ANSI C-80.1 and to Article 346 of the NEC. All aluminum conduits shall be of aluminum 6063 aluminum alloy, T-1 Temper, ANCI C80.5, and NEC 250.118(2). All required connectors, adapters, fittings, conduit straps or “U” guard clamps and incidentals required and necessary for above ground installations shall be galvanized and provided to construct a complete conduit/duct system. No reducing couplings or reduction in the inside diameter of conduit shall be permitted. No intermediate metallic conduit (IMC) or thin-wall type electrical conduit shall be permitted on this project for outdoor use.

A galvanized metal conduit grounding bushing, or aluminum metal conduit grounding bushing on the terminating ends of all GRS/aluminum conduit runs. The bushings shall have an insert made of plastic or other suitable material to protect wiring installed in the conduit. The bushing shall have a compression-type grounding lug for bonding the conduit to the ground rod in the pull box. Do not field drill sealing bushings.

### 5.3 INSTALLATION REQUIREMENTS

#### 5.3.1 SPLICING OF THE CONDUIT

Splice or join sections of conduit(s) using manufacturer's recommended splice kits or approved couplers. Upon approval, a junction box or pull box may be installed at locations where splicing or coupling of the conduit is necessary due to problems encountered with the installation.

#### 5.3.2 DUCT PLUGS AND MECHANICAL SEALING DEVICES

Following the installation of conduit where the communications cable is not immediately installed use a duct plug to seal the ends of the conduit. Secure the pull line to the duct plug in such a manner that it will not interfere with the installation of the duct plug and provide a watertight seal.

In conduits containing communications cable, seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

#### 5.3.3 CONDUIT SEALS AND COUPLINGS

Conduit in which cable is placed shall be sealed with urethane foam duct seal or a duct plug with appropriate number and size of cable ports to allow for a water tight seal around the cable and conduit without damaging the cable; this material shall be inserted between the cable and the conduit.

### 5.4 TESTING OF CONDUIT

After installation of the conduit and completion of any required restoration process, a mandrel or wire brush with an outer diameter of at least 95% of the internal diameter of the conduit shall be passed through the conduit to clear ducts of any partial obstruction. If the mandrel/brush fails to pass through the conduit, use a mandrel, wire brush or plastic ball that is 80% of the inside diameter of the duct to clear any obstruction. If the defect remains, the defect shall be exposed and the conduit path corrected. The mandrel test would then be repeated to assure that the defect has been satisfactorily corrected.

The PSL may accept alternative testing to demonstrate that the conductor can be pulled through the conduit if a written justification is submitted by the contractor.

**6 LOCATE PROCEDURES**

**6.1 CALL BEFORE YOU DIG**

The federally mandated, national phone number, 811, helps prevent you from unintentionally hitting underground utilities lines.

Before you begin projects that involve digging, dial 811 to locate underground fiber optic, electric, gas or other utility lines. Digging without this information can cause communication outages, power outages, and it's extremely dangerous.

Simply tell the 811 Operator where you're planning to dig and what type of work you will be doing, and your local utility companies will be notified immediately. After calling 811, utilities have 48 standard work day (Monday thru Friday) hours to come out and mark their lines with a color-coded paint or flagging system.

Before going to the site, confirm you've received responses from all member companies. They may be waiting for additional information or actions from you, including white lining, providing a gate code, unlocking a gate, etc., before locating.

At the site before digging, make sure to confirm the marks match the positive response codes. All utilities are required to respond to your ticket with a response code letting you know if its marked, no conflict or there may be some additional instructions or notes about the locate. If a utility has the locate ticket stated at "Marked" but there are no locates you should always contact the utility member whose marks are in question before digging.

**6.2 CITY LOCATE – CABLE MANAGEMENT SYSTEM (CMS)**

All contractors awarded underground work for the City of Port Saint Lucie (CPSL) should always include trace wire when placing new communication conduits and/or fiber optic lines.

The CPSL employs a Norscan electronic locate Cable Management System (CMS) with the CMS segmented into four (4) distinct geographic sections of the City. The CMS should always be used and maintained to preserve the continuity while placing new communication conduits and/or fiber optic lines within the City.

All contractors deploying tracer wire within the City shall be required to verify with the CPSL Fiber Optic Project Manager if any necessary "fixed current" "Line Terminating Units (LTU)" are to be required to maintain the low impedance path to ground between the CMS transmitter at the CPSL City Hall and the section endpoint. There should not be more than 25 LTUs in a section of the City unless previously approved for expansion up to a maximum of 35 LTUs/section.

The CMS ensures the AC voltage supplied into the locate wire plant from the Multi-Tone Module provides the low impedance path to ground for AC voltage locate frequencies over 250 Hz.

Prior to any project connection into the CMS, the Contractor shall call the project designated CPSL Utility or Fiber Network Technician, 24 hours prior to proceeding with any new connection into the existing CMS, to verify the CMS is not showing any faults on the CMS Controller Unit for the specific section of the City where the Contractor is required to make the interconnection.

If there is an existing fault, the CPSL shall remediate the condition precedent to the

Contractor interconnection, or the contractor shall be allowed to continue with their segment interconnection after a 24-hour period.

Any Contractor adding a new locate segment or branch of locate wire into the existing locate system, must demonstrate an easily locatable tone to the end of the branch by a locate wand in the presence of CPSL Utility Locate or Consulting Inspector after complete installation and splicing of their entire project limit modification.

If the Contractor has introduced a fault, the Contractor shall identify and remediate any fault to ground by accessing the nearest line terminating unit to the segment added the segment, isolating the resistive fault and performing remediation of locate wire.

The CPSL may have additional CMS monitoring capabilities deliver -48VDC potential between the conductor and the ground to clean up additional resistive faults that can be manually or remotely switched to a given section of the City with 24 hour locate advance notice.

Additional "Splitters" may be required where multiple directions of trace wire plant converge at a single point to properly extend the electronic locate system in all multiple directions within a single section. Splitters and Liner Terminating Units must be compliant with CPSL QPL for use in the CPSL Cable Management System.

This will ensure City of Port St. Lucie fiber optic lines will be properly located when contractors call 811.

**7 LOCATE TRACER WIRE**

Tracer wire shall be placed inside conduits, terminating on a properly placed Line Terminating Units at the nearest pull box, cabinet, closure, or facility. Tracer wire endpoint shall be identified on project plans to confirm if tracer is to be run into any Traffic, Utility or other Department device cabinet or facility.

Tracer Wire shall be a minimum of 14 gauge and may be either Orange or Green in color. The tracer wire shall be continuous and un-spliced between pull boxes, except in places where a directional drill occurs with an approved waterproof splice.

A continuity test shall be performed after new trace wire placement before connection into the existing LMS system to confirm no damage or separation of the tracer wire has occurred during the installation of wire.

**8 MARKING TAPE**

Marking tape shall be bright orange color, minimum 3" wide.

Marking tape shall be per the QPL, as specified, with "CAUTION BURIED FIBER OPTIC LINE BELOW" printed every 3' in black letters.

The tape shall be a dielectric, polyolefin film tape that is tear resistant, and corrosion resistant. The tape shall be constructed using material and ink colors, which will not change when exposed to acids and other destructive substances commonly found in the soil.

A marking tape shall be placed in the trench during cable installation, directly above the cable, 6-12” below grade. All conduit installed by use of directional boring shall not include the marking tape. Marking tape shall be installed for the full length of the cable or conduit run.

**9 PULL TAPE, MULE TAPE, POLY LINE (Jetline)**

Mule tape listed on the CPSL QPL shall only be utilized if fiber optic cable is to be installed by the pull method. In the case of conduit without fiber being pulled, a detectable mule tape shall be left in the duct/s for future use.

Pull or Mule tape shall have the following properties:

- Tensile strength of 1200 lbs
- Flat, not round, construction
- Printed foot markings.
- Pre-lubricated for reduced pulling tension at start of cable pull, low susceptibility to absorption of moisture: moisture resistant.
- Wire continuity testing shall be done.

Poly (Jet) Line shall have the following properties:

- Tensile strength of 200 lbs
- Spiral wrap twine construction
- No Printed foot markings.
- Rot & Mildew resistant.

**10 CABLE ROUTE MARKERS**

Markers shall be tubular in design and constructed of Type III high-density polyethylene material ultraviolet stabilized to help prevent their components from color fading, warping, absorbing water and deteriorating with prolonged exposure to the elements. Marker posts shall be orange in color.

The marker assemblies shall include the descriptive information “CITY OF PSL FIBER OPTIC CABLE – CALL BEFORE DIGGING (800) 638-4097” printed in black on an orange reflective background material that will not fade or deteriorate over time. The printed message shall be visible from all directions approaching the assembly.

As field conditions dictate, fiber markers shall be placed at approximately 500 ft intervals or as approved by the City on the rights-of-way line but should be placed to avoid visual clutter in urban areas. Markers shall be placed at every pull box and midpoint. In unique situations, they could be shortened up to 250 feet or lengthened out to 750 feet, as approved by the City.

As field conditions dictate, fiber markers shall be placed at approximately 750-foot intervals or as approved by the City on the rights-of-way line, but should be placed to avoid visual clutter in urban areas. Markers should be as close to the property lines as possible. In unique situations, they could be shortened up to 250 feet or lengthened out to 750 feet, as approved by the City.

**11 HUB SITES**

Hub sites shall be installed at predetermined locations. The hub sites will provide full access and interconnections to ALL fibers in each cable that appear at these locations. The purpose of these locations is to provide an adaptable level of re-routing capabilities, which will be especially advantageous during emergency repair situations as well as routine and planned fiber network

modifications. The re-routing capabilities gained from the locations will allow for network connectivity to be restored within minutes to hours, instead of hours to days, and will allow for fiber cable repairs and modifications to take place during normal working hours instead of overtime. The advantages gained in re-routing capabilities far outweigh any perceived disadvantages of increased exposure above ground.

Hub sites shall consist of a hub cabinet secured to a concrete pad. The Hub Cabinet specifications and construction shall be in accordance with the following:

- Enclosure shall be made from .125 thick aluminum type 5052-H3.
- The enclosure shall be weather tight, have provision for a screened air exhaust opening at the top of enclosure, all external hardware to be stainless steel.
- The enclosure should be equipped with 2 equal sized doors with three-point latching system with nylon rollers at the top and bottom. Door handle is 3/4" diameter stainless steel and can be padlocked. The doors must be tamper resistant.

The hub cabinet shall also include:

- 12 Volt 103 AH power supply rechargeable sealed lead battery
- Air-cooled Panel mounted Air conditioner with BTU/H Capacity 4000, 95/95 Rating BTU/H 3340, Ambient Temp, F, Max/Min, 125/0, Volts 115/100 or 230/200, Hz 60/50, Running Amps 13.6/13.3 or 5.8

The Contractor is to provide shop drawings for review prior to construction.

Within each hub cabinet, each fiber optic cable existing at the location shall be pulled into the cabinet and be terminated separately. Each cable shall be terminated into its own individual patch panel found in section 1.3 of this document. More than one fiber cable shall *not* be terminated into one patch panel.

Each fiber in the fiber optic cable shall be terminated by fusion splicing it into a pigtail found in section 1.4 of this document. Each pigtail shall be terminated into a 12-port adapter plate. Individual 12-port adapter plates shall be used per each row of the patch panel for a total of 24 accessible connector ports per row of the patch panel. Expansion kits shall be used to increase the storage capacity of the patch panel to provide accessible connector ports for 96 fibers per cable, even if the number of fibers in the cable is less than 96. Fiber optic pigtails shall be placed into the adapter plate ports starting with the lowest number fiber (#1 or Blue fiber or the blue buffer) in the upper left-most port and increasing from left to right and with the last fiber (#96 or Aqua fiber of the Black buffer) in the lower right-most port.

**12 MDF (Main Distribution Frame) Indoor Facilities/Lift Station Panels**

The following items are to be used in indoor facilities such as server rooms and at Lift Station Panels as described.

**12.1 Panels & Modules**

The modular coupler that would be required for Lift Station panel work depends on required number of connections.

Typically a duplex, UPC, 12F, Single-mode (OS2) panel shall be used when interconnect or cross-connect capability is required to securely mate 12 fiber strands connectors in a panel

configuration. The design adapter shall have blue housing and the housing material shall be of metal. The adapter style shall be standard, LC Compatible, and ceramic.

12.2 Module Coupler-Rack Mountable Hardware

This module unit shall be used inside a building when fusion splicing a 96 fiber is needed.

The Splice Module with Pigtailed shall be preloaded and pre-routed for quick fusion splicing of either individual or ribbon fiber pigtailed. The fiber cable type shall be single fiber (250 mm), single mode. The design hardware shall include the connector configuration LC, fiber count 12, module type CCH, with 12 splice protector single fiber heat-shrink. The number of splice protectors is 12. The connector type is LC, with 12-port with 3 meter length. The optical specification of the hardware is a typical module insertion loss, typical 0.15 dB and maximum of 0.40dB. The design adapter shall be LC.

12.3 Enclosures

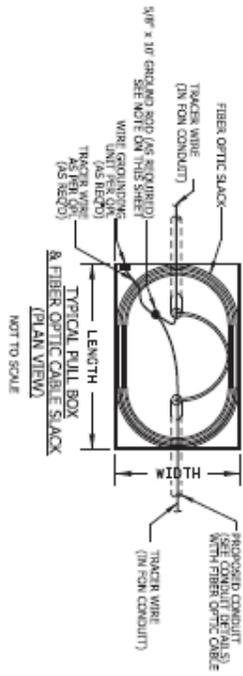
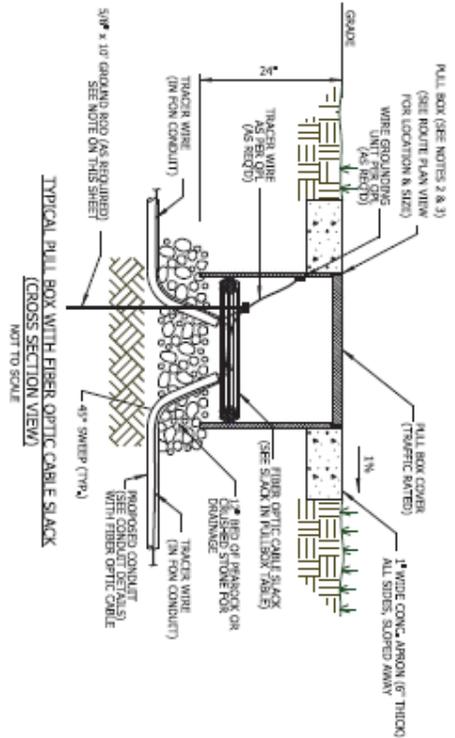
There are several types of enclosures that would be required for various applications. Typically:

- (1) For inside a building, Closet Connector Housing (CCH) provide interconnect and cross-connect capabilities between the outside plant, riser or distribution cables and optoelectronics. The housing must accept CCH connector panels CCH cassettes and CCH modules. The unit must be able to mount a rack 19-in, 23-in or cabinet mount. The dimension of the unit shall be (7 in x 19 in x 17 in) for proper rack placement. The design hardware consists of locking availability of front or rear, number of panels per housing of 12, panel or module type CCH and splice tray options of CCH Splice Cassette.
- (2) For Lift Station panels, the Single Panel Housing (SPH) shall provide storage, protection, and termination of optical fiber cables. This unit shall include 1 panel per housing for a CCH module and include a 12-slot, 0.4-in splice holder which will accommodate up to 12 heat shrink single splices (double-staked) and/or six heat-shrink ribbon splices. The dimension of the unit shall be (6.3 in x 5.5 in x 2.0 in).

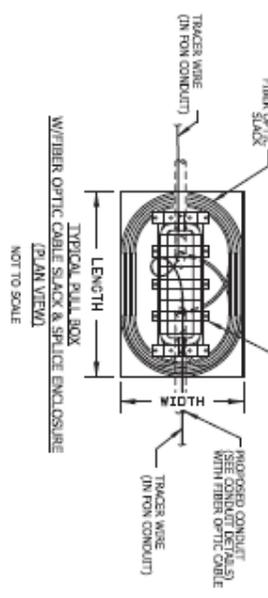
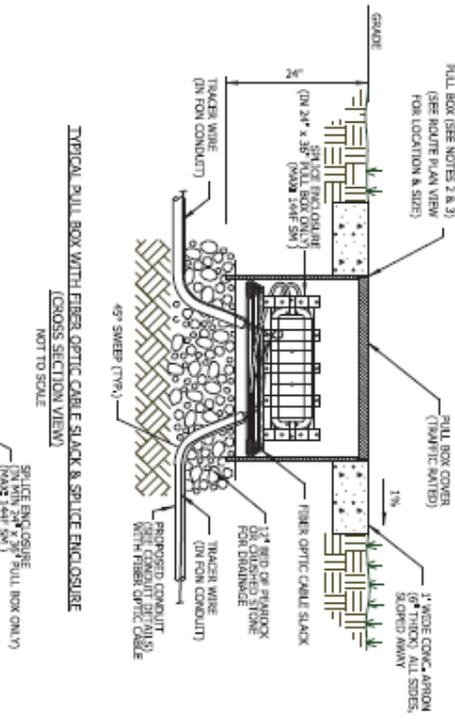
12.4 Indoor Splice Trays

The indoor splice tray shall be able to provide optimum physical protection for fusion and mechanical splicing methods. The trays shall be engineered for indoor splice hardware with both loose tube and tightbuffered optical cable designs. The tray shall consist of rugged aluminum base and cover with crimpable metal tabs for buffer tube strain-relief. The tray shall be black powder coated. The design hardware shall have heat shrink splice protectors, splice tray category of 2S, splice tray capacity for 12 fibers. The unit dimensions shall be compatible to fit into the rack.

# Appendix A



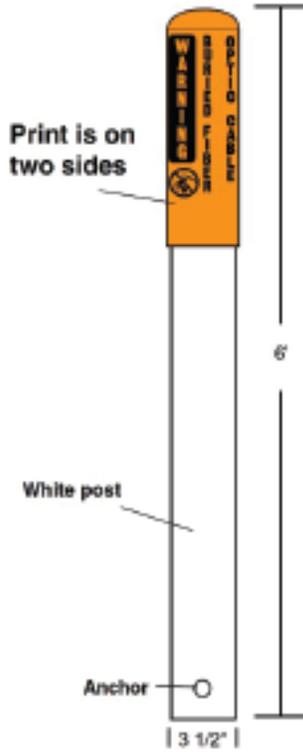
**NOTE:**  
 1) NO PULL BOXES SHALL BE INSTALLED IN THE BOTTOM OF SWALES OR DITCHES.  
 2) ALL PULL BOXES SHALL BE INSTALLED FLUSH WITH FUTURE GRADE.  
 3) ALL SPTS OF PULL BOXES SHALL BE BURIED, WHERE FUTURE GRADE IS ABOVE EXISTING GRADE. PLACE CLEAN FILL MATERIAL AROUND PULL BOX & SLOPE AWAY AT 1% MINIMUM.  
 4) PULLBOX SHALL INCLUDE 50 FEET OR SLACK FIBER OPTIC CABLE.  
 5) EACH CABLE ENTERING A SPICE ENCLOSURE SHALL BE CLEAN, LABELED WITH A WEATHER-PROOF TAG, TAG WITHIN 1' OF THE SPICE ENCLOSURE, WHICH SHALL INDICATE CABLE TYPE, PRODUCT BRAND WITHIN 1' OF THE SPICE ENCLOSURE, AND DIRECTION AND ORIENTATION AND TERMINATION POINT.



**NOTE:**  
 1) NO PULL BOXES SHALL BE INSTALLED IN THE BOTTOM OF SWALES OR DITCHES.  
 2) ALL PULL BOXES SHALL BE INSTALLED FLUSH WITH FUTURE GRADE.  
 3) ALL SPTS OF PULL BOXES SHALL BE BURIED, WHERE FUTURE GRADE IS ABOVE EXISTING GRADE. PLACE CLEAN FILL MATERIAL AROUND PULL BOX & SLOPE AWAY AT 1% MINIMUM.  
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MANUFACTURER	MODEL	MATERIAL	LONG SATING	LENGTH	WIDTH	DEPTH	SLACK
REFER TO P&ID	-	POTYMER CONCRETE	22,500 LBS	30"	17"	24"	50 LF
REFER TO P&ID	-	POTYMER CONCRETE	22,500 LBS	36"	24"	24"	200 LF
REFER TO P&ID	-	POTYMER CONCRETE	22,500 LBS	48"	30"	24"	220 LF

PROJECT NUMBER: 21995  
 DATE: 10/31/2022  
 SHEET: 34  
 DRAWING: 34  
 CITY OF PORT ST LUCIE  
 PROJECT NAME AND DESCRIPTION: CITY OF PORT ST LUCIE - FIBER OPTIC EXPANSION PROJECT  
 PULLBOX DETAILS  
 DESIGNED BY: JAP  
 PREPARED BY: JAP  
 CHECKED BY: JAP  
 APPROVED BY: JAP  
 PROJECT LOCATION: 13824 GLEN COURT, Jupiter, Florida 33478  
 PROJECT CONTACT: Predhion Contracting Services, Inc. (561) 763-9737 Office



Qty: 50 each  
 Size: 6'  
 Material: Polydome  
 Color: Orange with black text  
 Scale: Shown @ 50%

Please inspect this proof carefully. We cannot be responsible for misspelled words, information or layout if Ok'd by the customer. This shows how your custom print job will be printed. Colors are a representation only and may vary from actual manufactured product.

FINAL ARTWORK APPROVAL O.K. to print? \_\_\_\_\_ YOUR P. O. #SNS010001180940  
 Date: \_\_\_\_\_ Name: \_\_\_\_\_ DRAWING # 09-0510

# Appendix B

## Sample Shop Drawing Cut Sheets

## Allied **PVC Electrical Conduit**



Formerly Georgia Pipe

### UL LISTED RIGID SCH-40 & SCH-80 PVC ELECTRICAL CONDUIT

Allied ½" through 6" PVC Electrical Conduit is Underwriters Laboratories listed and is subject to in-process quality control testing to assure compliance with the appropriate manufacturing standards.

Allied PVC Electrical Conduit is manufactured to conform to NEMA TC-2 specifications and is UL listed.

**For Commercial, Industrial and Utility usage:**

Allied PVC Electrical Conduit is proven durable and effective for years of maintenance-free performance in underground, encased and exposed applications in accordance with the National Electrical Code.

**Corrosion Proof:**

Resistant to most chemicals, PVC is not affected by any corrosive soils or salts.

**Non-Magnetic and Non-Galvanic:**

Properties of Allied PVC Electrical Conduit assure good insulation and no power loss or conductor heating.

**Self Extinguishing:**

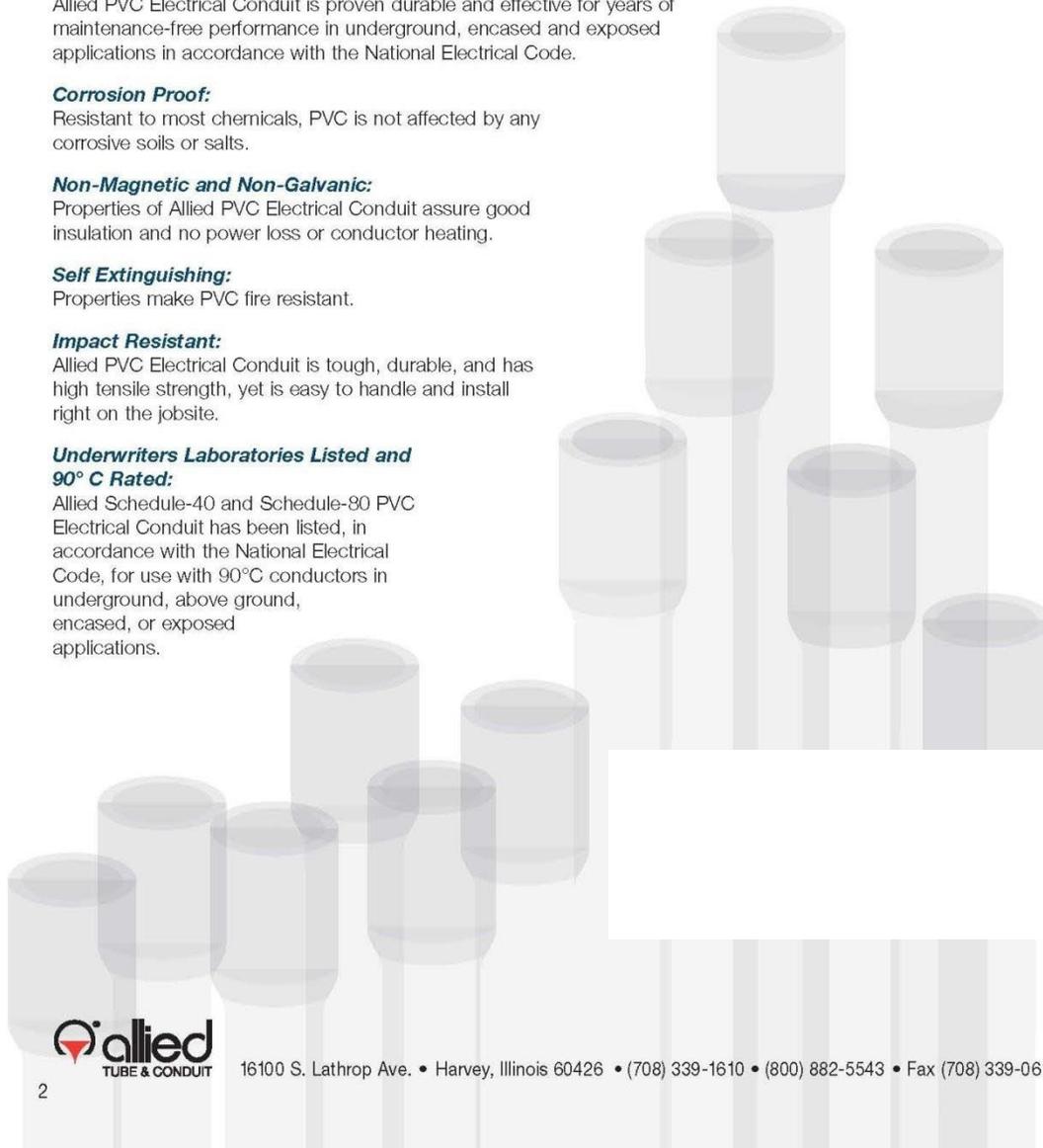
Properties make PVC fire resistant.

**Impact Resistant:**

Allied PVC Electrical Conduit is tough, durable, and has high tensile strength, yet is easy to handle and install right on the jobsite.

**Underwriters Laboratories Listed and 90° C Rated:**

Allied Schedule-40 and Schedule-80 PVC Electrical Conduit has been listed, in accordance with the National Electrical Code, for use with 90°C conductors in underground, above ground, encased, or exposed applications.



16100 S. Lathrop Ave. • Harvey, Illinois 60426 • (708) 339-1610 • (800) 882-5543 • Fax (708) 339-0615

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## Allied **PVC Electrical Conduit**

Formerly Georgia Pipe

### UL LISTED RIGID SCH-40 ELECTRICAL CONDUIT RATED FOR 90 DEGREE CELSIUS WIRING

Allied Schedule-40 is sunlight resistant and manufactured in accordance and complies to:

Underwriters Laboratories, Inc. UL-651

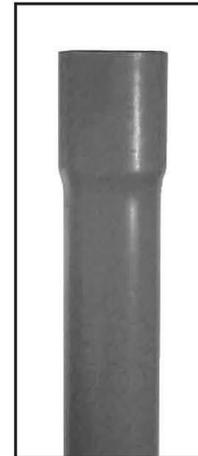
NEMA TC-2



Meets or exceeds the requirements of NEMA TC-2 and UL-651 for Schedule 40 Conduit.

#### Schedule 40 PVC Conduit Dimensions (10' lengths with belled ends)

Trade Size	No.	O.D.	Min. I.D.	Wall	Wt/Ft	Ft/Pallet
1/2	8102	.840	.622	.109	.164	6000
3/4	8103	1.050	.824	.113	.218	4400
1	8104	1.315	1.049	.133	.321	3600
1 1/4	8105	1.660	1.380	.140	.434	3300
1 1/2	8106	1.900	1.610	.145	.518	2250
2	8108	2.375	2.067	.154	.695	1400
2 1/2	8110	2.875	2.469	.203	1.096	930
3	8112	3.500	3.068	.216	1.435	880
3 1/2	8114	4.000	3.548	.226	1.729	630
4	8116	4.500	4.026	.237	2.043	570
5	8120	5.563	5.047	.258	2.776	380
6	8124	6.625	6.065	.280	3.600	260



#### SPECIAL INFORMATION

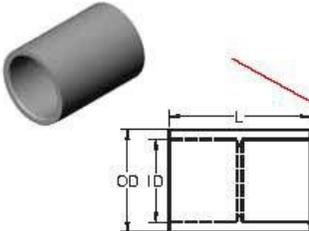
- 20' lengths available on special request.
- Minimum shipment: full pallet quantity per size.

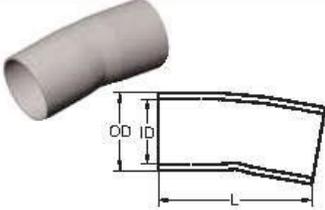
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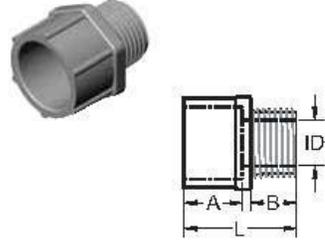


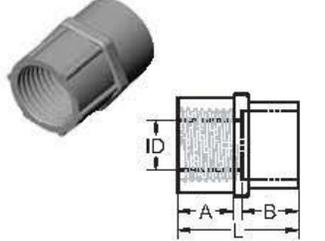
3

**FITTINGS - Couplings and Adapters**

COUPLINGS						
	Size (in)	Part Number	Unit Quantity	Outside Diameter (OD) (in)	Inside Diameter (ID) (in)	Length (L) (in)
	1/2	59601	150	1.080	0.840	1.437
3/4	59602	100	1.300	1.050	1.703	
1	59603	50	1.590	1.315	2.031	
1 1/4	59604	50	2.000	1.680	2.156	
1 1/2	59605	25	2.230	1.900	2.281	
2	59606	40	2.720	2.375	2.406	
2 1/2	59607	20	3.320	2.875	3.187	
3	59608	30	4.000	3.500	3.437	
3 1/2	59609	20	4.500	4.000	3.625	
4	59610	20	5.000	4.500	3.750	
5	59611	10	6.120	5.565	4.187	
6	59612	5	7.370	6.625	4.562	

5° COUPLINGS						
	Size (in)	Part Number	Unit Quantity	Outside Diameter (OD) (in)	Inside Diameter (ID) (in)	Length (L) (in)
	2	802731	15	2.375	2.049	4.0
2 1/2	802732	12	2.875	2.445	5.5	
3	802733	10	3.500	3.042	6.0	
3 1/2	802734	15	4.000	3.521	7.0	
4	802735	15	4.500	3.998	7.0	
5	802736	4	5.565	5.018	7.5	
6	802737	6	6.625	6.031	11.0	

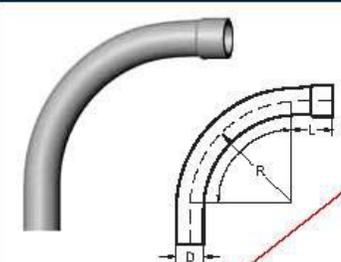
TERMINAL ADAPTERS							
	Size (in)	Part Number	Unit Quantity	A (in)	B (in)	Inside Diameter (ID) (in)	Length (L) (in)
	1/2	59615	200	0.750	0.700	0.591	1.550
3/4	59616	150	1.000	0.675	0.790	1.750	
1	59617	100	1.115	0.625	1.000	1.860	
1 1/4	59618	50	1.300	0.640	1.311	2.125	
1 1/2	59619	30	1.425	0.725	1.530	2.250	
2	59620	50	1.150	0.800	1.970	2.100	
2 1/2	59621	25	1.900	0.800	2.346	2.930	
3	59622	50	2.000	0.815	2.915	3.055	
3 1/2	59623	30	1.715	1.000	3.385	3.055	
4	59624	30	1.990	0.815	3.850	3.215	
5	59625	12	2.000	1.725	5.015	5.985	
6	59626	10	2.130	1.875	6.025	6.500	

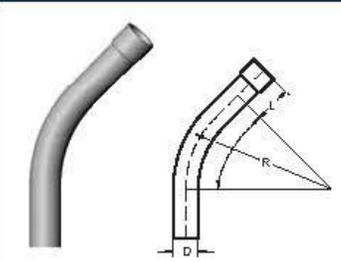
FEMALE ADAPTERS (NPT Tapered Thread)							
	Size (in)	Part Number	Unit Quantity	A (in)	B (in)	Inside Diameter (ID) (in)	Length (L) (in)
	1/2	59630	150	0.800	0.825	0.620	1.725
3/4	59631	100	0.800	1.000	0.820	1.900	
1	59632	50	1.000	1.200	1.065	2.300	
1 1/4	59633	30	1.015	1.300	1.395	2.425	
1 1/2	59634	25	1.050	1.290	1.575	2.440	
2	59635	30	1.075	1.375	2.050	2.550	
2 1/2	59636	20	1.675	1.985	2.470	3.780	
3	59637	25	1.630	2.150	3.090	4.100	
3 1/2	59638	20	1.800	2.000	3.540	3.985	
4	59639	15	1.755	2.185	4.025	4.210	
5	59640	10	2.065	3.000	5.035	5.240	
6	59641	6	2.065	3.000	6.045	5.235	

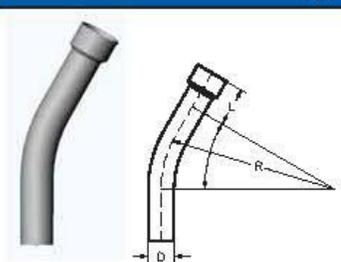
RIGID PVC CONDUIT FITTINGS

[www.tycoelectrical.com](http://www.tycoelectrical.com)

**FITTINGS - Bends (Bell End Elbows)**

90° ELBOWS - Bell End						
	Size (in)	Part Number	Unit Quantity	Diameter (D) (in)	Length (L) (in)	Radius (R) (in)
	1/2	802752	35	0.840	1.500	4.00
3/4	802753	50	1.050	1.500	4.50	
1	802754	25	1.315	1.875	5.75	
1 1/4	802755	20	1.680	2.000	7.25	
1 1/2	802756	15	1.900	2.000	8.25	
2	802757	10	2.375	2.000	9.50	
2 1/2	802758	100	2.875	3.000	10.50	
3	802759	50	3.500	3.125	13.00	
3 1/2	802761	50	4.000	3.250	15.00	
4	802762	50	4.500	3.375	16.00	
5	802763	25	5.565	3.625	24.00	
6	802764	25	6.625	3.740	30.00	

45° ELBOWS - Bell End						
	Size (in)	Part Number	Unit Quantity	Diameter (D) (in)	Length (L) (in)	Radius (R) (in)
	1/2	802765	70	0.840	1.500	4.00
3/4	802767	50	1.050	1.500	4.50	
1	802768	50	1.315	1.875	5.75	
1 1/4	802769	30	1.680	2.000	7.25	
1 1/2	802770	15	1.900	2.000	8.25	
2	802771	10	2.375	2.000	9.50	
2 1/2	802772	12	2.875	3.000	10.50	
3	802773	10	3.500	3.125	13.00	
3 1/2	802774	1	4.000	3.250	15.00	
4	802775	1	4.500	3.375	16.00	
5	802776	1	5.565	3.625	24.00	
6	802777	1	6.625	3.750	30.00	

45° ELBOWS - Bell End ELBOWS - Bell End						
	Size (in)	Part Number	Unit Quantity	Diameter (D) (in)	Length (L) (in)	Radius (R) (in)
	1/2	802778	50	0.840	1.500	4.00
3/4	802779	35	1.050	1.500	4.50	
1	802780	50	1.315	1.875	5.75	
1 1/4	802781	30	1.680	2.000	7.25	
1 1/2	802782	50	1.900	2.000	8.25	
2	802783	30	2.375	2.000	9.50	
2 1/2	802784	10	2.875	3.000	10.50	
3	802785	10	3.500	3.125	13.00	
3 1/2	802786	1	4.000	3.250	15.00	
4	802787	1	4.500	3.375	16.00	
5	802788	1	5.565	3.625	24.00	
6	802789	1	6.625	3.750	30.00	

# ELECTRICAL CONDUIT



## SUBMITTAL AND DATA SHEET

### SCHEDULE 40 AND SCHEDULE 80 CONDUIT NSF NRTL\* ANSI/UL 651 AND NEMA TC-2

RIGID NON-METALLIC CONDUIT FOR USE IN BOTH ABOVE GROUND AND UNDERGROUND INSTALLATIONS

#### SCHEDULE 40 CONDUIT

Rated for 90°C Conductors

SIZE	AVERAGE O.D.	NOM. I.D.	MIN. T.	APPROX. WT/100 FT
1/2	0.840	0.622	0.109	18
3/4	1.050	0.824	0.113	24
1	1.315	1.049	0.133	33
1-1/4	1.660	1.380	0.140	45
1-1/2	1.900	1.610	0.145	56
2	2.375	2.067	0.154	76
2-1/2	2.875	2.469	0.203	126
3	3.500	3.068	0.216	163
3-1/2	4.000	3.548	0.226	197
4	4.500	4.026	0.237	234
5	5.563	5.047	0.258	319
6	6.625	6.065	0.280	411
8 ::	8.625	7.942	0.322	622

Schedule 40 is furnished in standard 10' lengths with one bell end.  
20' lengths are available upon request.  
:: Non-UL or -NSF listed

#### SCHEDULE 80 CONDUIT

Rated for 90°C Conductors

SIZE	AVERAGE O.D.	NOM. I.D.	MIN. T.	APPROX. WT/100 FT
1/2	0.840	0.546	0.147	22
3/4	1.050	0.742	0.154	30
1	1.315	0.957	0.179	42
1-1/4	1.660	1.278	0.191	60
1-1/2	1.900	1.500	0.200	72
2	2.375	1.939	0.218	98
2-1/2	2.875	2.323	0.276	160
3	3.500	2.900	0.300	213
3 1/2	4.000	3.364	0.318	256
4	4.500	3.826	0.337	310
5	5.563	4.813	0.375	430
6	6.625	5.761	0.432	590

Schedule 80 is furnished in standard 10' lengths with one bell end.  
20' lengths are available upon request.

\* NATIONAL RECOGNIZED TESTING LABORATORY (NRTL) BY OCCUPATIONAL HEALTH AND SAFETY ADMINISTRATION (OHSA)

# Allied RIGID Specifications

## PROVIDES FULL ELECTRICAL SYSTEM PROTECTION

Allied RIGID is precision manufactured for dependable, long-lasting value and protection for the electrical raceway system.

Manufactured from high-strength steel, Allied RIGID combines damage-resistant strength with ductility to assure easy bending, cutting and joining. It also provides smooth, continuous raceways for fast wire-pulling. No need to worry about damage to the conduit system even when pulling through multiple 90° bends.

Allied RIGID is hot-dipped galvanized inside and out. It is top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.

Allied RIGID is impact and crush resistant for maximum conductor protection.

The 3/4" taper NPT threads (ANSI B1.20.1) are full cut and hot galvanized after cutting. Color-coded end-cap thread protectors keep the threads clean and sharp and also provide instant trade size recognition. Even-inch sizes are color-coded blue, 1/2-inch sizes are black, and 1/4-inch sizes are red.

## EMI SHIELDING

Allied RIGID greatly reduces electromagnetic fields, effectively shielding computers and sensitive electronic equipment from the electromagnetic interference caused by power distribution systems. For further information, visit our website for a free download of the GEMI (Grounding and Electromagnetic Interference) analysis software and related research papers.

## FULL CODES AND STANDARDS COMPLIANCE

Allied RIGID is U.L. listed and is recognized by the National Electrical Code. It meets Underwriters Laboratories Safety Standard U.L. 6, and is manufactured to ANSI C80.1, both of which have been adopted as Federal Specifications in lieu of WWC 581. Allied RIGID is recognized as an equipment grounding conductor by NEC Article 250. Documentation for compliance with NEC Article 250 is available from Allied.

Installation of Rigid Metal Conduit shall be in accordance with the National Electrical Code and U.L. General Information card #DYIX.

Master bundles conform to NEMA standard RN2.

## SPECIFICATION DATA

RIGID Metal Conduit shall be hot-dip galvanized steel equal to that manufactured by Allied Tube & Conduit Corporation. Threads shall be hot galvanized after cutting. RIGID shall be produced in accordance with U.L. Safety Standard #6 and ANSI C80.1 and shall be listed by a nationally recognized

testing laboratory with follow-up service. Where Kwik-Couple RIGID is used it shall also meet U.L. Safety Standard #514-B. It is noted that these U.L. standards have been adopted by the federal government and separate military specifications no longer exist.

For more information, contact Allied at (800) 882-5543, or visit our website at [www.atcelectrical.com](http://www.atcelectrical.com)

## Weights and Dimensions for Galvanized Rigid Tubing

Trade Size Designator		Approx. Wt.* Per 100 Ft. (30.5M)		Nominal Outside Diameter <sup>1</sup>		Nominal Wall Thickness		Quantity In Master Bundle	
U.S.	Metric	lb.	kg	in.	mm	in.	mm	ft.	m
1/2	16	82	37.2	0.840	21.3	0.104	2.60	2500	762.5
3/4	21	109	49.4	1.050	26.7	0.107	2.70	2000	610.0
1	27	161	73.0	1.315	33.4	0.126	3.20	1250	381.3
1-1/4	35	218	98.9	1.660	42.2	0.133	3.40	900	274.5
1-1/2	41	263	119.3	1.900	48.3	0.138	3.50	800	244.0
2	53	350	158.7	2.375	60.3	0.146	3.70	600	183.0
2-1/2	63	559	253.5	2.875	73.0	0.193	4.90	370	112.9
3	78	727	329.7	3.500	88.9	0.205	5.20	300	91.5
3-1/2	91	880	399.1	4.000	101.6	0.215	5.50	250	76.3
4	103	1030	467.1	4.500	114.3	0.225	5.70	200	61.0
5	129	1400	634.9	5.563	141.3	0.245	6.20	150	45.8
6	155	1840	834.5	6.625	168.3	0.266	6.80	100	30.5

<sup>1</sup> For more information only; not a spec requirement.

NOTE: Length = 10 ft. (3.05m) with a tolerance of +/- .25" (6.35mm).

\* NEMA Standard

## Weights and Dimensions for K

Trade Size Designator		Approx. Wt. 100 Ft. (30.5M)							
U.S.	Metric	lb.	kg						
2-1/2	63	559	253.5						
3	78	727	329.7	3.500	88.9	0.205	5.20	300	91.5
3-1/2	91	880	399.1	4.000	101.6	0.215	5.50	250	76.3
4	103	1030	467.1	4.500	114.3	0.225	5.70	200	61.0

<sup>1</sup>Outside diameter tolerances: +/- .025 in. (.64mm) <sup>2</sup>For more information only; not a spec requirement.



AFC Cable Systems® • Allied Tube & Conduit • Cope® Cable Tray • Power-Strut® Metal & Fiberglass Framing



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## Appendix C

**QPL- Fiber Optic Products**

Contractor to select products from Qualified Products List for submission for “project approval” based on specific project scope, intended utilization and requirements.

**A. CASING SPACERS -12" Width min.**

- APS - Advance Products Systems PSI - Pipeline Seal and Insulator
- Cascade

**B. CONTROL CABINET FASTENERS**

- Stainless Steel Tapcons
  - TCHSXXXXXX(;P)
    - “xxxxx” = size (i.e. 3/16” x 1-1/4” would be TCHS316114
    - “;P” = power (is power is N/A leave blank)

**C. HDPE (High Density Polyethylene Pressure Pipe) & PVC (Polyvinyl Chloride) PIPE**

- Directional Bore – Size by Project Spec from 1”, 1.25”, 2”, 3” or 4”
  - HDPE SDR 11 or equal, Smoothwall
- Open Trench – Size by Project Spec from 1”, 1.25”, 2”, 3” or 4”
  - HDPE SDR 11 or equal, Smoothwall
  - HDPE SDR 13.5 or equal, Smoothwall
  - PVC Schedule 40 (Communications Only) or 80 (electrical)

**Couplers**

- Clear Lock, ELOC, Double ELOC
- Manufacturers
  - Dura-line, Blue Diamond, Carlon, Endot or FDOT APL product

**D. RIGID CONDUIT**

- Galvanized Rigid Steel, 2” or various Tyco, NEC certified or FDOT APL product

**E. DELINEATOR MARKER**

- RAI Products 6’, 8’ or approved equal DM6-REF, DM8-REF

**F. LOCATE/TRACER WIRE, CONNECTORS & LINE MANAGEMENT MODULES**

- Wire #14 THHN/THWN, 600V, Green/Orange
- Manufacturers
  - Southwire, General Cable, Encore or equal
- Water Proof Connector: Dryconn CH90120 or equal
- Ground Conductor Connector: 3M DBR/Y-6 or equal
- LMS Switch Box 4-way: ACT 4456-150
- LMS Side Leg Terminator: ACT 444-150-352
- LMS Pedestal Protector: ACT 442-150-300
- Head Unit, CMS c/w AUIC, MTM: Norscan 4200
- Transmitter Protection Assembly: Norscan 51200
- Line Termination Unit: Norscan 2310
- Wire Grounding Unit: Norscan 2745-6
- Wire Grounding Unit: Norscan 2755-6

**G. MULE TAPE - FIBER OPTIC**

- Pull tape, Polyester, 3/8", 1200lbs tensile strength, traceable, for ALL SPARE Ducts only
- Pull tape, Polyester, 3/8", 1200lbs tensile strength – allowed for Installation processes
- Poly Line, 200lb tensile strength– allowed for Installation processes

**H. Underground Marking Tape – Open Trench Only**

- Detectable Tape, 3", Black on Orange
- 3M – Scotch 365 or equal
  - Marked: "CAUTION BURIED FIBER OPTIC LINE BELOW"

**I. LUBRICANT - ANTI-SEIZE**

- Cable Pulling Lubricants Polywater or equal
- Bolt Anti-seize Oxlic Never Seize or equal
- Employ Fiber Optic, LZ Universal or Cable Blowing consistent with installation process

**J. PULL & SPLICE BOX - FIBER OPTICS**

- Pull & Splice boxes must be concrete polymer meeting (ANSI/SCTE) 77 2013 Specification for Underground Enclosures with loading integrity:
  - Tier 22 Lids for all areas within 6’ of travel lane with occasional heavy traffic
  - Tier 15 Lids for all areas within limited heavy traffic
- Minimum Sizes
  - Signalization and lighting applications 13" x 24" x 12"
  - Fiber optic cable applications
    - Mid run slack points 17" x 30" x 24"
    - Splice points, Midspan Single Drop 24" x 36" x 24"
    - Multi-backbone 4 way Backbone 30" x 48" x 36" two piece lid
    - Multi-backbone 4 way Backbone 48" x 48" or larger all two piece lid
- Pull & Splices must be marked with "City of PSL" Placecards
- Manufacturers
  - Quazite, Old Castle, American Polymer Company or FDOT APL product

**K. FIBER OPTIC (FO) CABLE – Singlemode (SMF)**

- *Corning "current year" Local Area Networks and Data Center Core Products Catalog may be approved based on specific project requirement*
- All FO Cable to be Corning all-dielectric, dry-filled, loose-tube, dispersion-unshifted, with low water peak, gel free, and suitable for underground and aerial outside plant installation meeting ITUT G.652.D requirements
- Cable glass attenuation must be
  - Corning SMF28e 0.4/0.35/0.3 dB/km (limited to maintenance)
  - Corning SMF28e+ 0.35/0.35/0.25 dB/km or approved equivalent (new projects)
  - Corning Binderless SMF28e+ 0.35/0.35/0.25 dB/km or approved equivalent (new projects)
  - Corning Ultra Low Loss 0.34/0.34/0.22 dB/km (new projects)
- Cables shall employ Corning FastAccess® or Microduct Sensing Cable with FastAccess® Technology
- Cables shall be 12fiber/buffer tube and be marked with sequential markings every foot
- Cable Counts are to be established by Department and project requirement as identified by cable part #s reflecting Cable Count. Example 96count - 096EU4-T4700D20

- Corning Cable Part number examples:
- ALTOS Gel-Free Cable Non-Armored SMF28e+ 0.35/0.35/0.25 dB/km
  - xxxEU4-T4700D20 – where xxx is the # of fibers in the cable
- ALTOS Gel-Free Cable Non-Armored Binderless SMF28e+ 0.35/0.35/0.25 dB/km
  - xxxEU4-T4700D20 – where xxx is the # of fibers in the cable
  - ALTOS Gel-Free Cable Non-Armored Ultra Low Loss 0.34/0.34/0.22 dB/km
    - xxxZU4-T4722D20 - where xxx is the # of fibers in the cable
- STANDARD Backbone is either 96F or 144F Count (to be noted in project plans)
- STANDARD Drop Cable is reflected in the chart in above specifications for ALL Traffic & Utilities Projects

**L. FIBER OPTIC (FO) CABLE – Multimode (MM) – OM4 50/125µm 10G Multimode (ISP Projects ONLY)**

- *Corning “current year” Local Area Networks and Data Center Core Products Catalog may be approved based on specific project requirement*
- For loose-tube applications: FO Cable to be Corning all-dielectric, dry-filled, loose-tube, laser-optimized, gel free, and suitable for outside plant installation meeting ISO/IEC 11801 requirements
  - Cable glass attenuation must be Corning ClearCurve® OM4 2.3dB/km (@ 850nm) /0.6 dB/km (@ 1300nm)
  - Cables shall employ Corning FastAccess® or Binderless FastAccess®,
  - Cables shall be 12fiber/buffer tube and be marked with sequential markings every foot
  - Cable Counts are to be established by Department and project requirement as identified by cable part #s reflecting Cable Count. Example 48count - 048TU4-T4790D20
- For tight buffer applications: FO Cable to be Corning all-dielectric, dry-filled, tight buffer, laser-optimized, gel free, and suitable for indoor installation meeting NEC Article 770 and OFNP & FT-6 listed.
  - Cable glass attenuation must be Corning OM4 2.8dB/km (@ 850nm) /1.0 dB/km (@ 1300nm)
  - Cables shall be marked with sequential markings every foot
  - Cable Counts are to be established by Department and project requirement as identified by cable part #s reflecting Cable Count. Example 12count - 012T88-31190-29
- Corning Cable Part number examples:
  - Loose-tube Application: ALTOS LT, Gel-Free, All-Dielectric Cable with FastAccess® 50 µm multimode (OM4)
    - xxxTU4-T4790D20 - where xxx is the # of fibers in the cable
  - Tight-buffer Application: MIC Tight-Buffered, Plenum, All-Dielectric Cable 50 µm multimode (OM4)
    - xxxT88-3x190-29 - where xxx is the # of fibers in the cable

**M. FO TERMINATION CABINETS**

- Provide termination housings to accommodate connector panels fusion splice trays, factory terminated pigtail connectors or field fanouts and optical connectors for mechanical connections in a wall or rack mount patch panel for these sites:
  - Main Distribution Frame (MDF) – Indoor Facilities (Rack Mount)
  - Lift Station SCADA Panels (OSP Wall Mount)
  - Traffic Cabinets (OSP Wall or Shelf Mount)
- FO Termination Housings - Corning
  - Lift Station Cabinets: SPH-01P
  - Signal Cabinets: CCS-01U, CCH-01U or SPH-01P
  - Signal Hub Cabinets: PCH-02U to PCH-04U (FO count dependent)
  - Parks & Recreation: CCS, PCH or CCH model (FO count dependent)
  - Inside Building: CCH-01U to CCH-04U (FO count dependent) or WIC-02P
  - Outside FOC to Inside FOC Splice Housing: Corning CSH-03U

- FO Splice Trays - Corning
  - SCF-ST-099, SCF-ST-112, SCF-ST-116
  - Cabinet configuration uses may change as directed or approved by City personnel

**N. FO TERMINATION CONNECTOR PANELS**

- Provide connector panels for coupling of mechanical connectors of a cable terminated on one side of the panel to patch cables on the other side.
- Provide LC connectors and coupler panels in termination housings but accommodate legacy ST and SC connector types as appropriate.
- Provide connector panels matching connector type (SC, LC) and cable mode (SM, MM) consistent with Department or project.
- *Fusion Spliced Factory Terminated Pigtails / Splice On-Connectors ONLY are allowed for Traffic, Utility SCADA, IT WAN & Parks Dept. (No Unicams or Hot Melts allowed)*

- Coupler Panels Corning
  - 12-24F LC, SM: CCH-CP12-A9, CCH-CP24-A9
  - 12F SC, SM: CCH-CP12-59
  - 12-24F LC, SM Angled: CCH-CP24-B3, CCH-CP12-B3
  - 12F ST, OM4: CCH-CP12-H3
  - 12F SC, OM4: CCH-CP12-E7
  - 12F LC, OM4: CCH-CP12-E4
- Modular Coupler Pigtails Including Coupler Panel, Pigtail Connector and Splice Tray
  - 12-24F Module SM, LC, UPC: CCH-RM12-A9-P03RH; CCH-RM24-A9-P03RH
  - 12F Module SM,SC: CCH-RM12-59-P03RH
  - 12-24F Module SM, LC, APC: CCH-RM12-B3-P03RH; CCH-RM24-B3-P03RH
  - 12-24F Module OM4, LC: CCH-RM12-E4-P03SH; CCH-RM24-E4-P03SH
  - 12F Module OM4, SC: CCH-RM12-E7-P03SH
  - 12F Module OM4, ST: CCH-RM12-H3-P03SH
- Coupler Cassettes Including Coupler Panel, Pigtail Connector and Splice Tray
  - 12-24F Cassette SM, LC, UPC: CCH-CS12-A9-P00RE; CCH-CS24-A9-P00RE
  - 12F Cassette SM,SC: CCH-CS12-59-P00RE
  - 12-24F Cassette SM, LC, APC: CCH-CS12-B3-P00RE; CCH-CS24-B3-P00RE
- Fan Out kits
  - Indoor: Corning-FAN-BT25-12
  - Outdoor: Corning-FAN-OD25-12

**O. FO PIGTAILS & JUMPERS**

- Pigtails Corning OS2 Singlemode
  - SC UPC, 900um, SM, xx' (length TBD): CH-900-12KIT
  - LC UPC, 900um, SM, xx' (length TBD): CH-LC900-12KIT
- Jumpers, Corning OS2 Singlemode
  - SC-SC, 2F Zipcord, SM, UPC, xxx' (length TBD): 727202G5120xxxM
  - LC-LC, 2F Zipcord, SM, UPC, xxx' (length TBD): 040402G5120xxxM
  - LC-LC, 2F Zipcord, SM, APC, xxx' (length TBD): 222202G5120xxxM
  - ST-LC, 2F Zipcord, SM, UPC, xxx' (length TBD): 610402G5120xxxM
  - ST-SC, 2F Zipcord, SM, UPC, xxx' (length TBD): 617202G5120xxxM
  - SC-LC, 2F Zipcord, SM, UPC, xxx' (length TBD): 720402G5120xxxM

- Pigtailed Corning OM4 Multimode
  - 06F, ST, 50um, MM, xxx' (length TBD): 005006B81NFxxxM
  - 12F, ST, 50um, MM, xxx' (length TBD): 005012B81NFxxxM
  - 06F, LC, 50um, MM, xxx' (length TBD): 000506B81NFxxxM
  - 12F, LC, 50um, MM, xxx' (length TBD): 000512B81NFxxxM
- Jumpers Corning OM4 Multimode
  - LC-LC, 2F Zipcord, MM, xxx' (length TBD): 050502B81NFxxxM
  - LC-ST, 2F Zipcord, MM, xxx' (length TBD): 055002B81NFxxxM

**P. FIBER OPTIC SPLICE CLOSURES (FOSC)**

- FOSC enclosures shall provide housing to restore the mechanical and environmental integrity of the fiber optic cable during a sheath opening or joining; provide splice slack organizers and splice trays; and accommodate pressurization
- FOSC enclosures are to meet Telcordia Technologies' GR-711-CORE standards
- Manufacturers
  - Tyco FOSC FOSC-450 Series FOSC-450- C, D both 4 & 6 Port
    - Splice Tray: FOSC-ACC-C-Tray-24
    - Slack Basket: FOSC-ACC-C-Basket
  - Corning FOSC SCF-6C22-01, SCF6C28-01, SCF8C28-01
    - Splice Tray: SCF-ST-099, SCF-ST-112, SCF-ST-116

**Q. HUB CABINET - FIBER OPTIC (Parks & Recreation)**

- Use NEMA cabinets and accessories that are listed on the Department's Approved Product List (APL). Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture
- Manufacturers
  - Southern Mfg or FDOT APL approved equal
  - WE332DED-00 with KVM
- Keyboard Video Mouse (KVM) – rack mount
  - KVM (B021-000-17) with Dell Part A0594186 or KVM (DKMMLED185-G01) with Dell Part A7546778 or approved equal
  - Tripp Lite's NetDirector 1U Rackmount Console with 17-inch LCD panel, full 88-key keyboard, and touchpad, all in 1U rack mountable housing or approved.

**R. RHUB CABINET - FIBER OPTIC (Parks & Recreation)**

- Remote Hub Cabinet with associated devices
  - Southern Manufacturing: Cabinet - WE2488-022
  - Calnex: DC Converter 24-48VDC - 48S24.6HCM
  - Konnect-IT: KN-D10-GRY, KN-ECDGRY, KN-2J10, KN-EB3
  - ComNet: Media Converter - CNFESFPMCPOE30/M
  - ComNet: Terminal Server - CNFE3DOE2/M

**S. Uninterruptible Power Supply & UPS CABINET - (Traffic)**

- Local Cabinet housing Uninterruptible Power Supply
  - Alpha Mfg: Cabinet – SE48-1616
- Additional Power & Surge Components
- Asco, Surge Protective Device-(SPD) Low Voltage Catalog #160 & 185
- Alpha Technologies, UPS (all ITS Cabinets) w/ Batteries FXM 1100 Series
- Alpha Technologies, UPS (all New Signals) w/ Batteries FXM 2000 Series



Product Number	Total Ports	GE Combo Uplinks (4G) <sup>1</sup>	Additional Combo Ports	RJ-45 Copper Ports (T)	SFP Fiber Ports (S)	PoE/PoE+ Ports (P, GP)	Default Software
IE-4000-4TC4G-E	8	All models have 4 GE combo uplink ports	4 (FE)				All models ship with LAN Base image <sup>2</sup>
IE-4000-8T4G-E	12			8 (FE)			
IE-4000-8S4G-E	12				8 (FE)		
IE-4000-4T4P4G-E	12			4 (FE)		4 (FE)	
IE-4000-16T4G-E	20			16 (FE)			
IE-4000-4S8P4G-E	16				4 (FE)	8 (FE)	
IE-4000-8GT4G-E	12			8 (GE)			
IE-4000-8GS4G-E	12				8 (GE)		
IE-4000-4GC4GP4G-E	12			4 (GE)		4 (GE)	
IE-4000-16GT4G-E	20			16 (GE)			
IE-4000-8GT8GP4G-E	20			8 (GE)		8 (GE)	
IE-4000-4GS8GP4G-E	16				4 (GE)	8 (GE)	

Switch model	Downlinks total 10/100/1000 or PoE+ copper ports	Uplink configuration	Default primary power supply	Fans
<b>Compact models</b>				
<b>C9200CX-12T-2X2G</b>	12 ports data	2x 1G copper, 1x 1G CU PD 802.3bt Class 6, 2x 10G SFP+ fixed uplinks	Powered by 802.3bt class 6 PoE Optional auxiliary 80W AC or DC power adaptor	Fanless
<b>C9200CX-12P-2X2G</b>	12 ports PoE+	2x 1G copper, 2x 10G SFP+ fixed uplinks	315W AC internal	Fanless
<b>C9200CX-8P-2X2G</b>	8 ports full PoE+	2x 1G copper, 2x 10G SFP+ fixed uplinks	315W AC internal	Fanless
<b>C9200CX-8UXG-2X</b>	8 ports UPOE (4 mGig ports up to 10G, 4 ports up to 1G)	2x 10G SFP+ fixed uplinks	315W AC internal	Fanless

