

## SECTION 16712

### FIBER OPTIC COMMUNICATION

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Materials and procedures for installing and testing fiber optic communication systems

##### 1.02 RELATED SECTIONS

- A. Section 02582 - Underground Electrical Ducts and Manholes

##### 1.03 REFERENCES

- A. Electronic Industries Association(EIA) and Telecommunications Industry Association(TIA) Specifications
- B. National Electrical Code(NEC).
- C. Underwriters Laboratory(UL)

##### 1.04 DEFINITIONS

- A. OTDR - Optical Time Domain Reflectometer
- B. SMF - Single Mode Fiber
- C. OSP - Outside Plant

##### 1.05 SUBMITTALS

- A. Provide all submittals in accordance to Section 01300.
  - 1. Provide evidence of training and experience for all fiber optic staff, including but not limited to installation technician, splice technicians and test technicians.
  - 2. For approval:
    - a. A detailed construction an installation procedure covering all aspects for the fiber optic cable installation on this project.
    - b. All Materials for the fiber optic cable installation on this project.
    - c. Fiber labeling setup

3. Submit OTDR test results to the engineer in a neatly bound and printed form for acceptance. Include the current calibration certificate for the OTDR being used.
4. Submit Power Meter/Light Source test results to the engineer for acceptance.

#### **1.06 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.

#### **1.07 WARRANTY**

- A. Correct defective Work within a 2 year period after Date of Substantial Completion.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL**

- A. All materials are UL listed
- B. Provide all incidental materials including but no limited to fiber optic jumpers, cable ties, labels, and connectors.
- C. All materials meet Fluid Penetration Test standards (TIA/EIA-455-82B)

#### **2.02 FIBER OPTIC CABLE**

- A. Fiber must be approved by the USDA Rural Electrification Administration (PE-90).
- B. The fiber optic cable is an Outside Plant (OSP) type, armored dielectric loose tube, single-mode cable.
- C. Include the manufacturer's test documentation. This documentation indicates the attenuation of each cable fiber in dB/km, measured at 1310 nm and 1550 nm for single-mode.

- D. Outside Plant (OSP) Single-mode.
  - 1. Fiber Optic Glass: Corning SMF-28E or approved equal.
  - 2. Gel-Free Fiber Optic Cable: Corning ALTOS Lite or approved equal.
- E. Fiber optic cable must comply with TIA/EIA-4720000-A.
- F. Outer jacket labeling:
  - 1. The date of manufacture and the manufacturer's name.
  - 2. A numerical sequence, at intervals no greater than 10 ft, to determine the length of cable and amount of cable remaining on the reel.
  - 3. "Fiber Optic Cable" at an interval of no greater than 10 ft.
  - 4. Height of the markings is 1/8 inch nominal.

### **2.03 FIBER OPTIC CONNECTORS**

- A. With the following characteristics and as specified in the contract:
  - 1. LC – Connectors (Standard)
    - a. Factory installed pre-polished or field installed Camlock LC connectors.
    - b. Ceramic ferrules.
    - c. Maximum insertion loss: 0.30 dB.
    - d. Connector back reflection: greater than 35 dB.
  - 2. ST – Connectors (to be used only where approved)
    - a. Factory installed or field installed ST or ST compatible connectors.
    - b. Ceramic ferrules and metallic connector bodies.
    - c. Maximum insertion loss: 0.30 dB.
    - d. Connector back reflection: greater than 35 dB.
    - e. Clean all connectors with alcohol wipes and a compressed cleaning gas.

### **2.04 FIBER OPTIC CABLE SPLICE ENCLOSURES**

- A. Provide enclosure with the following minimum characteristics:
  - 1. Provide a water and airtight seal for fiber optic splices in any environment (aerial, buried, underground and vault).
  - 2. Corrosion resistant shell
  - 3. Allow re-entry without replacing the cable seals
  - 4. Strength member tie-off
  - 5. Mechanism to resist cable pull-out.
  - 6. All required accessories to complete the splice
- B. Accommodates up to 48 splices
- C. Contains 2 or more 12-count splice trays
  - 1. Coyote Runt Closures for Underground, Aerial and buried Splices.

## **2.05 SPLICE ENCLOSURE FIBER DETAILS**

- A.** Provide 3 ft of buffer tube slack from end plate.
- B.** Provide label for each buffer tube located 1 inch from the splice tray. Description on label will identify as to which fiber cable and direction cable is coming from.
- C.** Provide 3 to 4 ft of fiber optic strands, outside of buffer tube, from each cable before splicing.

## **PART 3 EXECUTION**

### **3.01 INSTALLERS**

- A.** Demonstrate two years total and one year continuous work experience with the splicing, termination and testing of fiber optic cable.
- B.** Perform all work with qualified staff

### **3.02 PREPARATION**

- A.** Do not perform fiber splices that are not shown in approved splice details without prior written authorization engineer.
- B.** Restore Contractor damaged facilities within 48 hours.
- C.** Lubricate cable with a lubricant designed for fiber optic cable installation.
- D.** Use shear pins or other failsafe means to prevent exceeding the maximum cable pulling tension specified by the cable manufacturer.
- E.** Maintain the following minimum bend radii:
  - 1.** 20 times Cable Diameter during installation.
  - 2.** 10 times Cable Diameter installed.
- F.** Maintain the following minimum slack requirements:
  - 1.** Splice Points: 100 ft from installed splice enclosure to conduit on all cables.
  - 2.** All Other Junction Boxes: 50 ft.
  - 3.** Cabinets: 50 ft.
- G.** Replace any fiber optic cable segment not meeting the requirements of the specifications in its entirety between full splice points shown in the contract.

### **3.03 FIBER OPTIC CABLE PREPERATION**

- A.** Solvent requirements:
  - 1. Must not remove any color from individual fibers (Refer to TIA/EIA-598-A) or buffer tubes.
  - 2. Not harmful to the polyethylene cable jacket.

### **3.04 ENTRY AND REENTRY OF FIBER OPTIC SPLICE ENCLOSURES**

- A.** Perform all work in an environmentally controlled atmosphere. Acceptable environments to work on splice enclosures include office type environments in buildings, splice trailers, and splicing tents with floors. All splicing, testing, connecting, or opening of fiber ends must not occur in locations with freezing temperatures, rain, snow, or wind-blown dust.
- B.** Perform fusion splices as follows:
  - 1. Use equipment with automatic fiber alignment and automatic light injection with detection devices or profile alignment algorithms to estimate splice losses.
  - 2. Provide splice enclosure as a protection for all splices and stripped cable.
  - 3. House all splices in splice trays or organizers.
  - 4. Use glass capillaries, heat shrink tubing, or silicone sealant to provide additional protection and strain relief.
  - 5. Comply with maximum splice loss allowance of 0.05 dB.

### **3.06 CABLE LABELING REQUIREMENTS**

- A.** Label all fiber optic cables in every accessible location with a high quality permanent label, indicating the location and type of circuit (e.g., drop cable, distribution-48 count).
- B.** Use Panduit MP-150-C or equivalent.

### **3.07 ACCEPTANCE TESTING**

- A.** Contact the Engineer five business days before performing all acceptance testing (Post Termination and Splicing OTDR and Power Meter).
- B.** Perform all fiber optic testing with an OTDR capable of producing output files compatible with the Siecor OTDR 383PCW Version 1.21 or higher.
- C.** Repair any damaged fiber strands using fusion splicing methods and repeat all tests described below.

**D. OTDR Testing Requirements:**

1. After completing the required work, test every fiber strand passing through any open splice tray.
2. Conduct all traces with a pigtail or fiber box between the OTDR and the fiber under test. Use pigtail of sufficient length as to show the connector, or the start of the strand under test.
3. Do not exceed launch transition of 0.6 dB.
4. Conduct all traces at both 1310 nm and 1550 nm.
5. Unless otherwise noted, uni-directional traces are acceptable.
6. Provide traces with the following information:
  - a. Horizontal Axis: Distance in Feet and Kilometers.
  - b. Vertical Axis: Attenuation scale in dB.
  - c. Traces showing attenuation versus distance.
  - d. Cursors positioned at cable ends.
7. Tabulate for each trace: method, fiber type, wavelength, pulse width, refractive index, range, search threshold, reflection threshold, end threshold, warning threshold, backscatter, jumper length, file date, file time, fiber ID, cable ID, OTDR location, far end location, operator initials.
8. Provide an event table showing all events having more than 0.05 dB loss, containing event type, position from OTDR end, loss and reflectance.
9. For cables less than 3300 ft (1 km) in length, the maximum total allowable attenuation is 1.0 dB.
10. Identify fibers by strand number.
11. Submit results in printed form on 8 ½-inch x 11-inch paper in a suitable binder organized by cable and strand number.
12. A cover sheet is required for each binder indicating which cable(s) were tested, the OTDR users name, the reviewers name, the type of test performed and the date(s) of the test.
13. Cover sheets for final test results bearing the reviewers signature, the date, and a statement indicating that the installation complies with the requirements of this section is required.
14. The Contractor's employee who has reviewed the traces is required to sign or initial them. A check mark is required on all traces that satisfy the requirements identified herein. For intermediate test results, flag any discrepancies that may exist with a short description of the proposed corrective action (e.g. resplice).

**E. Post Installation / Pre-Splicing Test:**

1. **Fibers Tested:** Normally, one strand per buffer tube. Test every strand when evidence of physical damage, excessive pulling tension, and kinks exist, or when any damaged strand is found.

2. Light Frequency: 1310 nm and 1550 nm.
  3. Direction: Uni-directional.
  4. Location of test: One field location for each cable installed.
  5. Test after installing cable in duct but before splicing.
  6. Tested by: Qualified Staff.
  7. Acceptance Criteria:
    - a. Cable attenuation 0.4 dB/km at 1310 nm.
    - b. Cable attenuation 0.25 dB/km at 1550 nm.
    - c. Strand lengths are consistent.
    - d. Launch Transition < 0.6 dB.
    - e. No event > 0.10 dB.
  8. Trace available for one strand in every buffer tube in the cable.
- F. Post Termination and Splicing Test:**
1. Test every strand in all cable segments including connectorized strands of drop cables.
  2. Light Frequency: 1310 nm and 1550 nm.
  3. Direction: Unidirectional.
  4. Location of test: Every field location required to obtain access to each cable segment.
  5. Test after terminating and splicing at all points described in the contract.
  6. Cable Tested by: Certified Staff.
  7. Acceptance Criteria:
    - a. Cable attenuation 0.4 dB/km at 1310 nm excluding splices described in the contract or authorized by the Engineer.
    - b. Cable attenuation 0.25 dB/km at 1550 nm excluding splices described in the contract or authorized by the Engineer.
    - c. Strand lengths are consistent.
    - d. Launch Transition < 0.6 dB.
    - e. No event > 0.30 dB.
    - f. Maximum splice attenuation 0.05 dB per splice unless otherwise described in the contract.
  8. Trace available for each strand in all cable segments.
- G. Power Meter/Light Test:**
1. Connect the light source to the connectorized fiber at the location identified on the Fiber Optic Light Source Power Meter Test Form provided by the Resident Engineer or Department Fiber Representative at the pre-construction meeting. Connect a power meter to the other end of the fiber at the location identified on the Test Form. Record the results and submit the completed form to the Engineer.
  2. Use the light frequencies of 1310 nm and 1550 nm, or as indicated in test forms.

3. Perform the test bi-directional.
4. Test every field location required to obtain access to each cable segment.
5. Perform all testing using a qualified staff member.
6. Acceptance Criteria:
  - a. Cable attenuation as called for in test plans.
  - b. Test is available for each strand indicated in test plans.  
Otherwise, test will be available for each strand in each cable segment.
7. All work to conform to the NEC.

**\*\* END OF SECTION 16712 \*\***