

Special Specification 6071

Fiber Optic Cable



1. DESCRIPTION

Furnish and install fiber optic cable in designated locations, install existing fiber optic cable in designated locations, and remove fiber optic cable as shown on the plans and as detailed in accordance with these Specifications.

2. MATERIALS

2.1. **General Requirements.** Provide, assemble, fabricate and install materials that are new, corrosion resistant and in strict accordance with the details shown on the plans and in the specifications.

Furnish, install, splice and test all the required fiber optic cable. Provide, as subsidiary to this item, all splicing kits, fiber optic cable caps, connectors, moisture/water sealants, terminators, splice trays, pig tails and accessories necessary to complete the fiber optic network. Provide all equipment necessary for installation, splicing and testing.

2.2. **Functional Requirements.** The fiber optic cable is the primary central to field communications medium for voice, data and video. Provide cable that is suitable for installation in an underground conduit environment including constant immersion in water. Provide only non-metallic cable.

Splice and/or terminate all fibers in the fiber optic cable as shown on the plans and as specified herein.

Provide all fiber optic glass manufactured by the same manufacturer.

2.3. **Environmental Requirements.** Provide cable that functions within specifications over its full life time at a temperature range of -10°F to +140°F, and when totally immersed in water for indefinite periods of time.

2.4. **Optical Requirements.**

2.4.1. **Cable Configuration.** Provide single mode fiber having a step index profile with a core/cladding size of 8.3/125 microns.

2.4.2. **Attenuation.** Provide single mode fiber with nominal attenuation of 0.35db/.62 mile maximum at a wavelength of 1310 nm and nominal attenuation of 0.25 db/.62 mile maximum at a wavelength of 1550 nm.

2.4.3. **Bandwidth.** Provide single mode fiber with a maximum dispersion of 3.5 pico seconds/nanometer /kilometer at 1310 nm

3. MECHANICAL REQUIREMENTS

3.1. **Fiber Optic Cable.** Provide fiber optic cable with quantity of fibers as shown on the plans.

3.1.1. **Diameter.** Provide cable with an outer diameter of less than .88 inches, containing fibers with a nominal core diameter of 8.3 microns and an outer diameter of 125 microns \pm 1 micron.

3.1.2. **Color Coding.** Provide cable with positive identification of each fiber using color coding of both the fibers and the binders in the cable

- 3.1.3. **Core/Clad Concentricity.** Provide fiber with a Core/Clad concentricity less than or equal to 0.8 microns.
- 3.1.4. **Primary Coating.** Provide fiber with a high density polymer coating of a minimum of 250 micro meters to prevent abrasion of the fiber surface, or as approved by the Engineer.
- 3.1.5. **Buffering.** Enclose individual fibers in an oversized plastic tube filled with a non-hygroscopic compound, or coated with a heavy polymer coating and enclosed in a tight flexible thermoplastic jacket to provide strength for practical handling, to prevent micro bends and to preserve the individual fibers during installation and long-term service.
- 3.1.6. **Tensile Strength.** Provide cable that is capable of withstanding a pulling tension of 600 pounds without changing the characteristics of the optical fibers. Requirements for a higher pulling tension may be provided by the Engineer.
- 3.1.7. **Bend Radius.** Provide cable that is capable of withstanding a minimum bending radius of 10 times its outer diameter during operation and 20 times its outer diameter during installation without changing the characteristics of the optical fibers.
- 3.1.8. **Cable Configuration.** Provide fiber optic cable consisting of an extruded plastic tube filled with a filling compound and containing up to 24 fiber bundles or up to 30 ribbon units stacked in a rectangular array.
- 3.1.9. **Grouping.** Group the fibers in each cable in layers or sub-bundles. Distinctly color-code each group for quick and easy identification, even in dim light. Provide cable whose jacket construction and configuration of internal groups is such that the groups can be easily separated at splice points, permitting 1 set of fibers to be cut and spliced while the others remain continuous. Submit proposed cable designs for the Engineer's approval prior to procurement and installation of cable.
- 3.1.10. **Jacket and reinforcing.** Provide cable where all strength members are made of 2 groups of glass longitudinally applied, diametrical from each other over the cable core or as approved by the Engineer, and enclosed within a high density polyethylene (HDPE) jacket. Provide cable that is fully filled with non-hygroscopic water blocking compound to prevent water and moisture penetration.
- 3.2. **Fiber Optic Jumpers.** Provide fiber optic jumper cables to cross connect the cable distribution panel to the fiber optic transmission equipment. Provide jumpers that are yellow in color for single mode fiber and have strain relief on the connectors. Provide fiber with a 900 micron or 1000 micron polymer coating with tight buffer tube, Kevlar strength member and a PVC jacket.

Provide jumpers 3 feet in length or as directed by the Engineer, with one end having an ST connector and the other end having a connector suitable to be connected to the fiber optic transmission equipment selected.

Inspect the Fiber Distribution Frame and provide all necessary items to terminate fibers.

Consider all fiber jumpers as subsidiary to this item.

4. CONSTRUCTION

- 4.1. **General.** Use the latest available installation machinery, jacking equipment, cable pulling machinery (with appropriate tension monitors), splicing equipment, testing equipment, and other miscellaneous tools when installing the cable, splicing the fiber, attaching connectors, and mounting hardware in cabinets.
- Use installation techniques and fixtures that result in ease of maintenance and ready access to all components for testing and measurements.
- 4.2. **Mechanical Components.** Ensure that all external screws, nuts and locking washers are stainless steel. Do not use self-tapping screws unless specifically approved by the Engineer.

Provide parts that are made of corrosion resistant material such as plastic, stainless steel, anodized aluminum or brass.

Protect all materials used in construction from fungus growth and moisture deterioration.

Separate dissimilar metals by an inert dielectric material.

- 4.3. **Installation Requirements.** Install the fiber optic cable with installation techniques that will not degrade the optical and mechanical characteristics of the cables at the time of installation. Trim any trees necessary that interfere with installation of fiber optic cable on temporary poles or existing CPS Energy poles, subsidiary to this item.
- 4.3.1. **Installation in Conduit.** Install Fiber Optic Cable in existing or new conduit as shown on plans and according to installation requirements detailed in this specification. Perform the cable pulling operations in a way that ensures that the minimum bending radius of the cable is not exceeded during the unreeling and pulling operations. Use entry guide chutes to guide the cable into the pull-box conduit ports. Use lubricating compound to minimize cable-to-conduit friction.
- Use corner rollers (wheels) with radii not less than the minimum installation bending radius of the cable. Use a series array of smaller wheels for accomplishing the bend if the array is specifically approved by the cable manufacturer. Continuously measure the pulling tension and do not allow it to exceed the maximum tension specified by the manufacturer of the cable. Use fuse links and breaks to insure that cable tension does not exceed 600 lb.
- When simultaneously pulling fiber optic cable with other cables, use separate grooved rollers for each cable.
- Seal conduits with a 2 part urethane after cable installation.
- 4.3.2. **Installation on Temporary poles.** Install fiber optic cable on contractor provided and installed temporary timber poles as shown on plans and according to installation requirements detailed in this specification. See plan sheets for details of installation. New timber poles required for temporary installation are subsidiary to this item.
- 4.3.3. Installation on CPS poles. Install fiber optic cable on existing CPS Energy poles as shown on plans and according to installation requirements detailed in this specification. See plan sheets for details of installation. Do not damage existing CPS Energy poles.
- 4.4. **Removal Requirements.**
- 4.4.1. Remove Fiber Optic Cable. Remove fiber optic cable from conduit as shown on plans. Dispose of removed fiber optic cable unless plans show for it to be re-used (re-installed). See plans for details. Any fiber optic cable damaged by the contractor that is to be re-used will be replaced by the contractor at no cost to TxDOT with new fiber optic cable meeting the approval of the Traffic Management Engineer. Test in accordance with this specification. The Engineer reserves the right to reject the fiber. Rejection will be based on the fiber optic cable test results.
- 4.4.2. Remove Fiber Optic Cable on Temporary poles. Remove fiber optic cable and steel messenger cable (steel wire strand) from the temporary timber poles and dispose of unless shown otherwise on plans. Remove and dispose of the temporary timber poles. Restore the holes left by the removal of the timber poles to their original or proposed condition by installing same material that surrounds holes (e.g., soil, riprap, etc).
- 4.4.3. Remove Fiber Optic Cable on CPS poles. Remove the fiber optic cable and steel messenger cable (steel wire strand) from the existing CPS Energy poles and dispose of unless shown otherwise on plans. Do not damage existing CPS Energy poles.

- 4.5. **Splicing Requirements.** Splice or terminate all optical fibers as shown on the plans or as directed by the Engineer
- DO NOT EXCEED A SPLICE LOSS OF 0.03 DB FOR ANY SPLICE UNLESS SHOWN OTHERWISE ON PLANS.
 - Use fusion technique for all splices. Provide fusion splicing equipment that is approved by the Engineer and that is cleaned, calibrated and specifically adjusted to the fiber and environmental conditions at the start of each shift.
 - Provide splice enclosures, organizers and incidentals, and cable end preparation tools and procedures that are compatible with the cable type being delivered and approved by the Engineer.
 - Package each spliced fiber in a protective sleeve or housing. Completely re-coat bare fibers with a protective 8 RTV, gel or similar substance, prior to application of the sleeve or housing in order to protect the fiber from scoring, dirt or micro bending.
 - Use rack mounted organizer trays to hold the spliced fibers, with each fiber neatly secured to the tray.
 - Terminate or splice all fiber inside fiber optic cable interconnect panel modules. The module is a fully enclosed unit capable of supporting the specified cable as shown on the plans.
 - Provide interconnect panel modules that are 19 in. rack mountable or as shown on the plans and compatible with any existing equipment.
 - Provide modules able to support a minimum of 48 ST connectors in bulkheads.
 - Provide splice trays capable of holding either fusion splices or mechanical splices.
 - Provide cabinets that contain cabinet mounting brackets with four outside plant cable clamps for strain relief. Install the cable according to the manufacturer's recommended standards for the cable distribution panel selected.
 - Include a maintenance loop of at least 10 ft. of cable, coiled up and tied inside the interconnect module or cabinet that fiber optic cable terminates in to allow for future splices in the event of a damaged splice. The maintenance loop of cable is not paid for directly but is subsidiary to this item.
 - Record all splice losses in tabular form and submit to the Engineer for approval.
 - Use an Optical Time Domain Reflectometer (OTDR) to test splices made between 2 cables. Test these splices at the required wavelength and provide printouts of the splice tests to the Engineer.
- 4.6. **Termination Requirements.** Provide matching connectors in cabinets where the optical fibers have to be connected to terminal equipment.
- Do not exceed 0.4 dB connector loss for complete connection to the terminal equipment. Qualify and accept connectors based on connector-to-connector mating using similar fibers.
 - In the Control Center and at the ends of the system, remove 5 ft. of the unused optical fibers from the buffer tube(s) and place the coiled fibers into a splice tray approved by the Engineer. Clean the water blocking compound from all fibers destined for splice tray usage.

5. TESTING REQUIREMENTS

- 5.1. **General.** As per TxDOT policy, performance testing is to be done on all materials and equipment not previously tested and approved. If technical data are not considered adequate for approval, samples may be requested for test by the Engineer. The contract period will not be extended for time loss or delays caused by testing prior to final TxDOT approval of any items.

Equipment referenced to this specification is subject to Design Approval Tests and Factory Demonstration Tests at the equipment manufacturer's facility, to determine conformance with all the specification requirements. The Engineer may accept certification by an independent testing laboratory in lieu of the design Approval Tests, to verify that the Design Approval Tests have previously been satisfactorily completed. Arrange for, and conduct the tests, in accordance with the specification requirements stated herein.

Ensure that all inspection requirements have been satisfied prior to submission for TxDOT's inspection and acceptance. The Engineer reserves the right to have his/her representative witness all Design Approval Tests and Factory Demonstration Tests.

Results of each test will be compared with the requirements specified herein. Failure to conform to the requirements of any test will be counted as a defect, and equipment will be subject to rejection by the Engineer. Rejected equipment may be offered for retest, provided all non-compliances have been corrected and retested and evidence thereof submitted to the Engineer.

Final inspection and acceptance of the fiber optic cable will be made after the completion of the installation and testing and approval of the documentation described above.

5.2. **Manufacturer's Certification.** Include with each reel of fiber optic cable the manufacturer's test data showing conformance to the requirements described in this Special Specification.

5.3. **Pre-installation Tests.** Test fiber optic cable at site storage area prior to installation.

Test each optical fiber in the cable from 1 end with an OTDR compatible with wavelength and fiber type. Test for continuity, length, anomalies, and approximate attenuation. Record each measurement with color, location and type of fiber measured. In the event that a meaningful measurement cannot be made from one end, perform the test from the opposite end of that fiber. If the tested loss exceeds the loss from the manufacturer's test data the Engineer will reject the cable.

5.4. **Post Installation Tests.** After installation, test each optical fiber in the cable again for the loss characteristics. Test both directions of operation of the fiber.

Test cable again after each splice and connector installation, and submit results to the Engineer as basis for acceptance. Use OTDR and/or power meter/optical light source testing equipment, as specified by the cable manufacturer for this testing.

5.5. **Test Procedure.** Submit all test procedures and data forms for the pre-installation and post-installation tests to the Engineer for approval. Furnish data forms containing all of the data taken, as well as quantitative results for all tests. Have an authorized representative of the Contractor sign the data forms. Send at least 1 copy of the data forms to the Engineer.

6. DOCUMENTATION REQUIREMENTS

Provide ten complete sets of operation and maintenance manuals containing the following at a minimum:

- Complete and accurate schematic diagrams showing the fiber optic cable plant.
- Complete performance data of the cable plant showing the losses at each splice joint and each terminal connector.
- Installation, splicing, terminating and testing procedures.
- Complete parts list including names of vendors.
- Complete maintenance and trouble-shooting procedures.
- Two months prior to installation, submit 10 copies of the Contractors Installation Practices for approval. Include practices, list of installation equipment, splicing and test equipment. Detail field quality control procedures as well as procedures for corrective action.

7. EXPERIENCE REQUIREMENTS

The Contractor involved in the installation, splicing and testing of the fiber optic cable must meet the following requirements:

- Two years' experience in the installation of fiber optic cables, including fusion splicing, terminating and testing of single mode fibers.
- Two installed systems where fiber optic cables are in outdoor conduits and the systems are in continuous satisfactory operation for at least 1 year. Submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the customers' operating and maintenance personnel who can be contacted regarding the fiber optic systems.
- One fiber optic cable system (which may be 1 of the 2 in the preceding paragraph) which the Contractor can arrange for demonstration to the Engineer and/or his representatives.
- Splicers who have been trained on and are experienced using the specific splicing equipment to be used.

8. MEASUREMENT

Fiber Optic Cable (Single Mode) will be measured by the foot of cable furnished, installed in conduit, spliced, connected, and tested in accordance with these specifications. Fiber Optic Cable (Single Mode) on TEMP poles will be measured by the foot of fiber optic cable furnished, installed on contractor provided and installed timber poles, spliced, connected, and tested in accordance with these specifications. Fiber Optic Cable (Single Mode) on CPS poles will be measured by the foot of fiber optic cable furnished, installed on existing CPS Energy poles, spliced, connected, and tested in accordance with these specifications. Remove Fiber Optic Cable will be measured by the foot of fiber optic cable removed from conduit. Remove Fiber Optic Cable on TEMP poles will be measured by the foot of fiber optic cable removed from TEMP poles.

Remove Fiber Optic Cable on CPS poles will be measured by the foot of fiber optic cable removed from CPS Energy poles. Install Existing Fiber Optic Cable in conduit will be measured by the foot of existing cable installed in conduit, spliced, connected, and tested in accordance with these specifications. Install Existing Fiber Optic Cable on TEMP poles will be measured by the foot of existing cable installed on TEMP poles, spliced, connected, and tested in accordance with these specifications. Install Existing Fiber Optic Cable on CPS poles will be measured by the foot of existing cable installed on CPS energy poles, spliced, connected, and tested in accordance with these specifications.

9. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Cable (Single Mode)" of the type specified, "Fiber Optic Cable (Single Mode) on TEMP poles" of the type specified, "Fiber Optic Cable (Single Mode) on CPS poles" of the type specified, "Remove Fiber Optic Cable" of the type specified, "Remove Fiber Optic Cable on TEMP poles" of the type specified, "Remove Fiber Optic Cable on CPS poles" of the type specified, "Install Existing Fiber Optic Cable in conduit", "Install Existing Fiber Optic Cable on TEMP poles", and "Install Existing Fiber Optic Cable on CPS poles".

This price is full compensation for furnishing (except for Existing Fiber Optic Cable) and installing all cables, for providing and installing temporary poles, for pulling through conduit or duct, for installing on temporary poles and/or existing CPS Energy poles, for testing, splicing, connecting, removing, and re-reeling, and for all materials, labor, tools, equipment, documentation, training and incidentals.