

## 678 Communication Systems

### 678.1 Description

- (1) This section describes the furnishing, installing, and testing of communication systems.

### 678.2 Materials

#### 678.2.1 Department-Furnished Materials

- (1) The department will furnish fiber optic cable, splice enclosures, termination panels, ethernet switches, wireless antennas, and cellular modems.
- (2) Furnish cables and connectors required to connect department-furnished components as follows:
  - Furnish cables between ethernet switches and terminal servers or other devices.
  - Furnish outdoor rated cables between wireless antennas and other devices.
  - Furnish Rs-232 patch cables and Cat 5 (E10/100) cables as well as connectors between cellular modems and other devices. Furnish a 19-inch rack mountable shelf.

#### 678.2.2 Fiber Optic Terminations

- (1) Furnish type ST fiber optic connectors that use epoxy or hot melt adhesive and include a ceramic ferrule.

#### 678.2.3 Communication System Testing

- (1) Supply materials and equipment necessary to perform the tests as described in these specifications. Test equipment will remain contractor's property. Use equipment consisting of, but not limited to, the following:
  - Optical time domain reflectometer (OTDR).
  - Optical source/power meter.
  - Patch cabling.
  - OTDR software.

### 678.3 Construction

#### 678.3.1 Fiber Optic Cable

- (1) Install cables into the conduit using a flat woven pull tape. Optionally, install the cable via forced air and a track pushing mechanism. Do not use a single pull tape for more than a single cable pull. Install the pull tape and fiber optic cables according to the testing procedures completed for this project and the pull tape and cable manufacturer's recommendations.
- (2) Install cable according to Siecor recommended procedure SRP 005-011 for fiber optic cable placing - duct. Follow these procedures regardless of the manufacturer of the cable. If the cable manufacturer recommends an operation in conflict with these procedures, submit a request for installation procedure change to the department for approval. Do not exceed a maximum pulling tension of 608 pounds-force during installation and 200 pounds-force after installation.
- (3) If the total signal loss exceeds the allowable loss specified under [678.3.4](#), replace or repair that cable run. If elevated attenuation due to exceeding the pulling tension during installation is determined, replace that cable run.

#### 678.3.2 Fiber Optic Splices

- (1) Use only fusion splicing for splices. Ensure that each splice does not exceed the attenuation limits set forth in [678.3.4](#).
- (2) Do not make mechanical splices.
- (3) Protect each splice in a protective sleeve and secure in the splice tray. Protect bare fibers with a heat-shrink coating before placement in a sleeve or housing. Install the heat-shrink coating in to protect the fiber from scoring, dirt, accumulation, moisture intrusion, and micro bending.
- (4) Install the fiber optic splice enclosure according to the manufacturer's recommended guidelines.
- (5) Perform end-to-end splicing according to the manufacturer's instructions for the supplied splice enclosure units.
- (6) Perform mid-span splicing, drop splicing, for each device location at locations the plans show. Splice according to Siecor recommended procedure SRP-004-013 for mid-span access of fiber optic cable with cable slack present, or appropriate manufacturer instructions. Contain mid-span splices within enclosures.
- (7) Do not deviate from the splice details as the plans show without the engineer's approval.

### 678.3.3 Fiber Optic Terminations

- (1) Install type ST connectors to the fiber optic cable.
- (2) Terminate fibers on the rear of the termination panel with type ST connectors.
- (3) Install fiber optic jumpers of sufficient length to connect the front side of the termination panel to the fiber equipment contained within the cabinet.
- (4) Ensure that each termination does not exceed the attenuation limits specified in [678.3.4](#).

### 678.3.4 Communication System Testing

- (1) Perform communication system testing using certified fiber optic technicians approved under [670.3.2.2](#).
- (2) Provide the date, time, and location of required tests to the engineer at least 24 hours before performing the test.
- (3) After completing cable installation, splicing, and termination, test all fibers for continuity, events losses, and total attenuation of the cable as follows:
  1. Test each individual fiber for event losses using an OTDR. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
  2. Connect the OTDR and the cable with a factory patch cord of a length equal to the dead zone of the OTDR. Optionally, the technician can use a factory fiber box of 325 feet minimum with no splices within the box.
  3. Test each individual fiber for total segment attenuation loss using an optical source/power meter. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
  4. Conduct both tests, OTDR and optical source/power meter, at 1310 nm and 1550 nm for each fiber in the cable.
  5. Conduct both tests bi-directionally for each fiber in the cable.
- (4) After completing the tests, submit 1 hard copy and 1 electronic copy of the test results to the engineer documenting the following test parameters:

Operator name	Setup parameters	Pulse width OTDR	Range OTDR
Date and time	Wavelength	Refractory index OTDR	Scale OTDR

- (5) Summarize the results of both the OTDR and optical source/power meter tests in spreadsheet/tabular format adhering to the following requirements:
  - List fiber optic segment name including route, start point, and end point.
  - List all fibers by number.
  - List direction of test as NB, SB, EB, or WB.
  - List total fiber optic cable length for each fiber as documented in the OTDR test.
  - List attenuation in dB of gain or loss for each fiber optic event in the OTDR test.
  - List fiber optic loss event descriptions and locations including splices, miscellaneous events, and terminations.
  - List the attenuation across the cable in dB/mile for each fiber tested.
  - List the total segment loss for each fiber as determined by the optical source/power meter test.
  - Provide bi-directional data including event distances, event descriptions, and attenuation losses for each fiber corresponding to a common start point
  - Provide bi-directional data on separate lines, side-by-side within the same sheet.
  - Provide 1310 nm and 1550 nm test results on separate sheets in identical formats.
- (6) Provide copies of the fiber cable traces taken during the OTDR test to the department on diskette for review. Provide electronic files in a universal file format, or with software to view the files.
- (7) Ensure that test results demonstrate that the dB/mile loss does not exceed plus 3 percent of the factory test or plus one percent of the cable's published production loss. The department will consider the error rate for the test equipment in evaluating results.
- (8) Event losses are an average for each direction tested, and are limited to the following:

EVENT TYPE	ALLOWABLE LOSS
Fusion Splicing	0.10 dB
ST Connector	0.50 dB
Other miscellaneous events	0.10 dB
Total loss across the cable <sup>[1]</sup>	1 dB/mile

<sup>[1]</sup> Including events and cable attenuation.

### 678.3.5 Ethernet Switch

- (1) Install ethernet switches in new or existing field cabinets. Connect to the devices the plans show or engineer directs.

### 678.3.6 Wireless Antenna

- (1) Pole mount wireless antennas as the plans show and conforming to manufacturer's recommendations. Connect to the devices the plans show or engineer directs.

### 678.3.7 Cellular Modem

- (1) Meet with the engineer and field system integrator to discuss specific requirements of the cellular modem and converter before installation. Make electrical and communication network connections to the cellular modem. Mount the cellular modem in a 19-inch rack using a rack or shelf.
- (2) Program and configure the cellular modem according to the manufacturer's instructions. Connect to devices as the plans show.
- (3) Activate the cellular modem and converter for 30 consecutive days. During this period, ensure that the cellular modem operates as specified. If a failure occurs, the engineer will suspend the test until the failure is corrected. Resume testing until 30 days of successful operation is achieved.

### 678.4 Measurement

- (1) The department will measure the Install Fiber Optic Cable Outdoor Plant bid items by the linear foot acceptably completed.
- (2) The department will measure the EACH bid items under this section as each individual unit acceptably completed: except the department will measure Communication System Testing for each service acceptably tested.

### 678.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
678.0000 - 0199	Install Fiber Optic Cable Outdoor Plant (count)	LF
678.0200	Fiber Optic Splice Enclosure	EACH
678.0300	Fiber Optic Splice	EACH
678.0400	Fiber Optic Termination	EACH
678.0501	Communication System Testing	EACH
678.0600	Install Ethernet Switches	EACH
678.0700	Install Wireless Antennas	EACH
678.0800	Install Cellular Modems	EACH

- (2) Payment for the Install Fiber Optic Cable Outdoor Plant bid items is full compensation for installing and testing department-furnished cabling.
- (3) Payment for Fiber Optic Splice Enclosure and Fiber Optic Splice is full compensation for work required under the individual bid items.
- (4) Payment for Fiber Optic Termination is full compensation for providing connectors and jumper cables; and for completing the installation using department-furnished termination panels.
- (5) Payment for Communication System Testing is full compensation for testing and required documentation and certifications.
- (6) Payment for Install Ethernet Switches and Install Wireless Antennas is full compensation for installing the devices; for cables and connectors; and connecting the devices.
- (7) Payment for Install Cellular Modems is full compensation for installing the modem; for cables and connectors including rack mountable shelf; for connecting the devices; for programming and configuration; and for testing.
- (8) The department will not pay for replacements or repairs required under [678.3.1](#).