

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	87 N-0720-01	2023	347	517

**15.8 FIBER OPTIC CABLE ASSEMBLIES**

Provide cable assemblies (jumpers and pigtails) that are Corning Lanscape Solution cable assemblies or approved equal that meets the following minimum requirements. Provide the cable used for cable assemblies that is made of fiber meeting the performance requirements of these Specifications for the fiber optic cable being connected. Provide Manufacturer's attenuation test results for all cable assemblies. Provide breakout cables that comply with the specifications for pigtails.

**15.8.1 PIGTAILS**

Provide pigtails that are of simplex or duplex construction, in 900 micrometer tight buffer form, surrounded by aramid yarn for strength, with a connector on one end. Provide an outer jacket that is yellow PVC with a nominal diameter of 3 mm, marked with the Manufacturer's identification information. Provide all pigtails a minimum of one meter in length. Provide pigtail connectors that are factory terminated. Field terminations are not permitted. Follow the installation procedures outlined for fiber optic cables for pigtails installed in conduit, except that the pulling tension shall not exceed 200 pounds.

**15.8.2 JUMPERS**

Jumpers may be of simplex or duplex design. Provide all jumpers to be at least six feet in length, sufficient to avoid stress and allow orderly routing. Provide jumpers that have connectors on both ends. Ensure that the outer jacket of duplex jumpers is yellow for all single mode; orange for 62.5µm multimode; aqua for 50µm multimode jumpers. Ensure that the two inner simplex jackets have contrasting colors to provide easy visual identification for polarity. Ensure that all jumper connectors are factory terminated. Do not use field terminations.

**15.8.3 CONNECTORS**

Use LC connectors for all new connectors. Many existing connectors are SC. Use SC to LC jumpers to mate with equipment when required to assure all new connectors are type LC. Do not apply index-matching fluids, gels, or anti-reflection coating to the end of the fiber. Ensure that the connector operating temperature range is -20°F (-28°C) to 165°F (74°C). Ensure that typical insertion loss is 0.2 dB (or better) and the return reflection loss is 50 dB (or better). Ensure that connection durability is less than a 0.2 dB change per 500 mating cycles per EIA-455-21A (FOTP-21). Provide connectors with a blue color body or boot.

**15.8.4 FACTORY TESTING**

Provide all pigtail and jumper connectors that are factory-installed and tested. Do not install connectors in the field.

**15.9 FIBER DISTRIBUTION UNIT (FDU)**

Use the fiber distribution unit (FDU), also referred to as patch panels, to terminate fibers in all cabinets containing fiber terminations. Provide units that are capable of terminating the required number of fibers, as is indicated on the Plans. Use terminations that are SC or LC (as indicated on the plans), bulkhead connectors which match the fiber optic jumper cables used for connection to the optical termination equipment in the controller assembly. Do not allow fiber optic splicing to occur outside of splice trays housed within the fiber distribution units. Provide all units located in POP buildings to be rack mountable in an EIA 23-inch rack. Provide all units located in roadside devices to be rack mountable in an EIA 19-inch rack. Use units that are of the minimum necessary dimensions to terminate the quantity of fibers indicated on the Plans as to maximize the total amount of available rack space. Provide units which terminate 6 or 12 fibers that occupy no more than one rack unit of space within the cabinet. Comply with the requirements of ANSI/TIA/EIA-568-A and ANSI/TIA/EIA-606.

**15.10 FIBER OPTIC CABLE MARKERS**

Provide fiber optic cable markers as shown in the standard details. Fiber optic cable markers shall have information machine printed on the marker. No stickers will be accepted. All fiber optic marker materials shall be outdoor rated and UV resistant. Decals shall be factory printed with a minimum letter height of 1-inch.

**15.11 CONSTRUCTION REQUIREMENTS**

Install all equipment per the manufacturer's instructions and industry standards. Do not exceed equipment and material ratings. When cable is delivered to the site, conduct optical time domain reflectometer (OTDR) tests on-the-spool. See testing section of these specifications.

**15.11.1 INSTALLATION AND SPLICING QUALIFICATIONS**

Submit resumes and references detailing fiber splicing and installation experience for on-site personnel to the Engineer for approval. The subcontractors used on this project are considered part of the contractor's team and are also required to submit resumes and references. Submit to the Engineer references including client project manager, phone number and project experience. Failure to comply may result in a declaration of noncompliance. Provide necessary documentation of subcontractor qualifications to the Engineer upon request.

In addition, ensure that a member of the contractor's team, that has two years experience in the installation, testing, use and maintenance of fiber optic cable and fiber optic splicing equipment and has been approved by the Engineer, is on site at all times during the fiber optic cable installation and fiber optic splicing work until successful completion of the work. Receive approval from the Engineer for any substitution of this individual. The Engineer may stop activity on this project as a result of the absence of this on-site personnel from the project and may continue to charge time to the contractor and will not grant a time extension. Demonstrate successful completion of fiber optic installation and splice training courses. Provide any certificates.

Ensure that installations provide ease of maintenance, with all component parts being readily accessible for inspection and maintenance.

**15.11.2 CABLE INSTALLATION**

Submit the manufacturer's recommended procedures for pulling and for blowing of the fiber optic cable to the Engineer for review and approval at least 2 weeks prior to installing cables. Contractor is required to have the equipment and experience to install cable by either method: pulling or blowing. KDOT reserves the right to choose the method of installation. Use mechanical aids to assist cable installation. Use a breakaway swivel to ensure that the tension does not exceed 80 percent of the manufacturer's recommended tension. Ensure that the cable grips for installing fiber optic cable have a ball bearing swivel to prevent the cable from twisting during installation. Ensure pulling of cable is with even tension. Properly seal cable ends during installation.

Use cable pulling lubricant recommended by the cable manufacturer and a non-abrasive pull tape conforming to the provisions described under "Conduit" elsewhere in these Specifications. When blowing cable, use cable blowing lubricant specifically designed for installation of cable by blowing. Ensure that the lubricant will cover the fiber optic cable for the entire pull. Provide cable slack as indicated on the Plans. Record sequential markings (the number of feet printed on the cable) at all splice vaults; organize and submit this information to the Engineer.

During cable installation, keep the bend radius at a minimum of twenty times the outside diameter of the cable. Install cable with no splices except those indicated on the Plans. After installation, cut off and discard the first 10 feet of the cable. These 10 feet have not been included in the conduit and cable table and are considered incidental to other items of work. Ensure that no residual tension remains on the cable after installation, except the weight of the cable.

Do not perform any "end of day" or "end of shift" cable cuts on any fiber optic cables. For all cable used as a trunkline cable, use full, uncut, virgin reels or spools.

**15.11.3 CABLE DAMAGE DURING INSTALLATION**

If the cable becomes damaged during installation, stop operations and notify the Engineer immediately. There will be no extra payment or revisions to contract completion time for the replacement of the damaged cable.

**15.11.4 SPLICING**

When a buffer tube is required to be opened in order to perform fusion splicing, cut only the fibers to be terminated/spliced at a location according to the Plans. Unused fibers or fibers that are continuous through a splice location (expressed fibers) are to be coiled, and neatly routed around the inside edges of the splice tray. Splice optical fibers using the fusion splice method. Ensure alignment is via fiber cores and splicing equipment has fully automated X, Y, and Z axis (3-axis) alignment using a light injection/detection system. Use splicing equipment that has an auto fusion time control to monitor the power level through the splice to complete the fusing process when splice loss is a minimum. Complete all cabinet terminations and branch splicing prior to mainline or trunkline splices to ensure network connectivity for testing and communications. All splices and terminations must meet the requirements outlined in section 20.7: Fiber Optic Tests.

At splice locations where branch cables intersect with trunkline cables, do not open the buffer tubes of the trunkline cable unless a splice is required within that particular buffer tube. Ensure that these "straight through" buffer tubes remain unopened and simply be "expressed" through the splice enclosure; stowed in the bottom of the splice closure beneath the splice tray/s.

Protect all splices with a thermal shrink sleeve, 60 millimeters long. Place the completed splices in a splice tray. Place the splice tray in the splice closure or housing. Refer to the "Fiber Optic Cable Segment Diagram" in the Plan Set concerning the required labeling text for each cable segment.

An "end of reel/spool" trunkline splice is allowed every 10,000 cable feet minimum. Contain full cable splice in a single splice enclosure of adequate size. Redline the location of the trunkline splice enclosure/s onto the plan set and formally submit along with the fiber optic cable system test report. End-of-reel/spool splicing is considered incidental to the lump sum ITS site bid item for which no additional payment will be made.

**15.11.5 SPLICE ENCLOSURES**

Use a fiber optic splice enclosure contained inside a splice vault for underground splicing. Contain all fibers that require splicing within one enclosure. Upon completion of the splices, secure the splice trays to the inner enclosure. Seal the enclosure using a procedure recommended by the manufacturer that will provide a waterproof environment for the splices. Ensure a tight salt-resistant and waterproof seal is made which will not leak upon aging.

Fasten the enclosure securely to the wall of the pull box in a manner that allows the cables to enter at the end of the closure without violating the minimum bending radius for the cables, while maximizing the clearance from the bottom of the pull box.

**15.11.6 FIBER DISTRIBUTION UNIT (FDU)**

Secure the main cable into the FDU in a workman like manner. No bends to exceed a 2.0 inch minimum bend radius. Sparingly and carefully use wire pulls as to not pinch the fiber. Organize and secure fiber optic cables within the cabinet using hook and loop wire ties. Zip ties are not permitted.

**15.11.6.1 SLACK CABLE**

Leave sufficient amount of fiber optic cable in the FDU to facilitate removal of splice cassettes to allow splicing to occur on a splice table.

**15.11.6.2 LAST LINE**

All terminations and splices within the cabinet are incidental to the site bid item and will not be paid on an individual splice price basis - this includes any splicing from a pre-terminated pigtail or FDU to a branch fiber when the splicing occurs within the cabinet.

**15.11.6.3 TERMINATION SPLICES**

Termination splices are splices in an equipment cabinet that join fibers in a cable to pigtails or connector modules. Place the termination splices in a splice cassette and place the splice cassettes in the fiber distribution unit (FDU). Loop the individual fibers at least one full turn within the splice cassette to avoid micro bending. Maintain a 2.0 inch minimum bend radius during installation and after placing fibers in the cassette. Individually restrain each fiber in a splice cassette. Place the optical fibers in the splice cassette to provide no discernible tensile force on the optical fiber. Label every Closet Connector Housing Module by placing appropriate labels with pin/port numbers 1 through 12 on the Module; Label the fiber optic SFP Ports on every Ethernet Switch with the text (TX1, RX1, TX2, RX2). Terminate all fibers required for system operation as shown in the Plans. All termination splices are incidental to the site bid item and will not be paid on an individual splice price basis. This includes any splicing from a pre-terminated pigtail or FDU to a branch fiber when the splicing occurs within the cabinet.

**15.11.6.4 INSPECTION AND CLEANING**

All FDUs and patch panels must be cleaned to meet IEC 61300-3-35 standards, and equipment paperwork (including yearly calibration) shall be made available to the engineer upon request.

Before mating two optical surfaces together, both surfaces must be visually inspected with an approved fiber inspection camera. If debris is detected by the camera, the surfaces shall be cleaned using an approved cleaning pen or lint-free wipes. Use at least 98% isopropyl alcohol. After cleaning, inspect the surfaces again before mating to verify they are clean. Only clean surfaces if debris is detected to prevent smearing on the surface. While surfaces are not being inspected, they should be protected with dust caps or patch cords.

Immediately after installation and testing, all optic panels shall be wrapped in protective wrap such as cellophane to prevent ingress of debris. The protective wrapping will be removed upon handover to KDOT.

**15.11.7 CONNECTIONS**

Clean all connections to meet IEC61300-3-35 standards. Cleaning shall only be completed if camera detects debris, and connectors shall be cleaned in a similar process to 15.11.6.4.

**15.11.8 FIBER OPTIC CABLE TESTING**

Perform Fiber Optic Cable Testing in accordance with the requirements set forth in the testing section of these Specifications.

**16.0 CELLULAR MODEMS**

**16.1 GENERAL**

Furnish all tools, equipment, materials, supplies and manufactured articles and perform all operations necessary to install cellular modems as shown on the Plans and as specified herein.

**16.2 MATERIALS**

**16.2.1 CELLULAR MODEM**

Provide a modem that is a Sierra Wireless MP70 (ethernet model with four ports) or approved equal, as indicated on the Plans. The following minimum requirements apply: Support automatic scheduled over the air Preferred Roaming List (PRL) updates and be supported on Verizon network, ALEOS embedded intelligence or equivalent functionality, high speed processor, embedded machine protocols, class 1 division 2 certified, serial and Ethernet interface. Provide associated antennas, antenna cables, and power supplies with the modem at no additional charge. KDOT will activate all cellular modems.

**16.2.2 DIRECTIONAL ANTENNA**

Provide an antenna that is a Wilson 314411 or approved equal to meet the following minimum requirements. Use antenna assemblies with cellular modems that are of the dual-band (698~960/1710~2700 MHz) Yagi style and have a working temperature of -35°C to 50°C. Provide a vandal-resistant type antenna base. Mount antenna to the top of the ITS device pole or structure as shown in the details with mounting hardware that is approved by the Engineer.

Plotted : 25-SEP-2023 18:45

Drawn By : lovohs  
File : ITS-S10.dgn

KANSAS DEPARTMENT OF TRANSPORTATION				
ITS EQUIPMENT SPECIFICATIONS				
ITS-S10		VERSION DATE: 02-12-21		
APPD	DESIGNED	DETAILED	QUANTITIES	TRACED
	DESIGN CK.	DETAIL CK.	QUAN. CK.	TRACE CK.