

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	87 N-0673-01	2017	85	99

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

15.10.2 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. Following installation of the cable in conduit, seal all fiber optic conduit entrances in controller assemblies, pull boxes and splice vaults with mechanical duct plugs and sealing compound to prevent the ingress of moisture, foreign materials and rodents. 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.

15.10.3 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.

15.10.4 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.

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.

Provide splice losses that average less than or equal to 0.05 dB/splice between any two optical ports and do not exceed 0.05 dB for any splice. 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.

15.10.5 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.

15.10.6 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.

15.10.6.1 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.

15.10.6.2 TERMINATION SPLICES

Termination splices are splices in an equipment cabinet that join fibers in a cable to pigtailed 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.

15.10.7 CONNECTIONS

Install protective caps on all unmated connectors.

15.10.8 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 GX450 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 (800~960/1710~2500 MHz) Yagi style and have a working temperature of -40°C to 60°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.

16.2.3 ANTENNA CABLE - DIRECTIONAL ANTENNA

Provide riser cables that are of a low-loss co-axial design. Ensure loss per 100 feet does not exceed 5 dB at 1800 MHz. Jumper cables may be used inside cabinets between cellular modems and lightning protection devices. Jumper cables may not exceed three feet in length and may not have losses greater than 18 dB per 100 feet. Provide outdoor rated RF cables with UV resistant outer jacket. Provide plenum rated cable for installations inside of buildings or shelters.

16.2.4 OMNIDIRECTIONAL ANTENNA - LOW PROFILE

Provide an antenna that is a PCTEL BMLPVMBLTENG, BMLPVMBLTENG-VP or approved equal to meet the following minimum requirements. Where specified, use antenna assemblies with cellular modems that are of low-profile, omnidirectional design. Antenna shall not exceed 4 1/2" in height (excluding mounting base, if used) and 1 1/2" in diameter. Provide antenna assemblies that are dual band (700-960/1710-2700 MHz), have a temperature rating of -40°C to +60°C. If mounting directly through a cabinet shelf or other surface, provide an antenna with an integrated Type-N female connector and appropriate Type-N to SMA adapter cable. If mounting to an exterior bracket, provide bracket and suitable antenna base with an integrated lead that includes an SMA connector.

16.2.5 SURGE PROTECTION

Provide lightning protection Wilson 859902 or approved equal.

16.3 CONSTRUCTION REQUIREMENTS

16.3.1 GENERAL

Incidental items include all connectors, adaptors, and cables; including but not limited to RF co-axial cables, DC power cables, AC power cables, Ethernet cables, or any other interface cables. There will be no separate payment for incidental items. KDOT will provide IP addressing. Construct and make all necessary network configurations. Coordinate with KDOT and receive approval for any downtime necessary to connect the cellular modems.

16.3.2 ANTENNA INSTALLATION

Install antennas as per manufacturer's instruction and in accordance with any applicable electrical or construction codes. Align antennas to optimize signal quality (received signal strength indication (RSSI) and signal to noise ratio (S/N)). Determine the appropriate antenna azimuth and align the antenna toward the appropriate cellular communication tower. Supply the necessary test equipment for antenna alignment to achieve the maximum signal transfer.

17.0 POINT-TO-POINT (P2P) ETHERNET RADIO (LICENSED BAND)

17.1 DESCRIPTION

Furnish, install, configure, and test an Ethernet radio. If required to supply a radio, provide an Ethernet radio that meets these specifications. Ensure that the radio provides an acceptable wireless Ethernet communication link when combined with another radio.

17.2 SPECIFICATIONS AND REQUIREMENTS

Provide wireless equipment that meets the following specifications and requirements:

- Point-to-Point (P2P).
- Operate in 11 GHz FCC licensed frequency band.
- Use Time Division Multiplexing (TDM) wireless modulation.
- Allow Quality of Service (QoS) management.
- Support 802.1Q headers to carry VLAN tags and priority markings shall support VLAN tagging per port.
- Use a native Ethernet technology for Payload Interface. Mapping of Ethernet over TDM will not be accepted. Equipment will support FE and GE autosensing interfaces.
- Frame Length Support: Support for "Baby Jumbo" frames up to 1632 Bytes.
- Buffer Size: overall buffer size (used to manage traffic queues) of at least 1 Mb. Usable by a single service, if required by traffic profile.
- RF Bandwidth: 10 MHz, 30 MHz capable.
- Receive sensitivity (BER 10-6): With 10MHz channel spacing, range between -90.5 dBm at QPSK to -73.0 dBm at 256 QAM.
- Support forward error correction.
- Fade and Intermodulation Countermeasures: Support for adaptive equalization, adaptive modulation and space diversity
- Minimum supplied bandwidth 100Mbps. Software expandable to 200Mbps without hardware changes. During testing, actual bandwidth to be verified with RFC2544 throughput and latency tests.
- FCC Part 15 compliant and certified for EMC.
- Type of emission: Licensed only (compliant with FCC Part 101).
- Provide 10/100 BaseT RJ-45 Ethernet port.
- Minimum operating temperature range for P2P radio Outdoor Unit (ODU): -40 to 55 degrees C. Minimum operating temperature range for P2P radio Indoor Unit (IDU): -5 to 55 degrees C.
- Security: Provide user-controlled levels and privileges and user access control.
- Management: Ethernet SNMP remotely, ASCII RS-232 locally or equivalent. Fully managed remotely, allowing downloading of system configuration, equipment software or system operation firmware changes.
- Rack mounted
- Warranty: In-warranty product repairs are covered up to 5 years.
- Advance replacement: Replacement product is shipped express overnight (in most cases) in case of a verified product issue.

17.3 CONSTRUCTION

Provide all radio channel planning, communication path analysis, power level settings, antenna positioning (X, Y and Z axis including tilt), and Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) resolution so that fully functional, operational, and secure communication links are provided. A preliminary design plan has been provided in the plan set, but it is understood that the design may need to change based on field conditions encountered. Take into consideration existing licensed radio networks operated by others. Install, orient, and align the P2P radios in order to optimize performance. Reference and follow installation guidelines provided by the radio manufacturer. Provide all antennas, pipes, mounts, cabling, lightning protection, grounding, configuration, testing, and other subsidiary items and include in this individual bid item.

Furnish all tools, equipment, materials, supplies, and manufactured articles and all operations necessary to install wireless equipment and construct, configure, and test the wireless communications facilities as shown on the plans and as specified herein. Use stainless steel for all hardware and fasteners.

Lightning Protection: For protection of the P2P radio equipment, provide and install bi-directional replaceable gas tube lightning arrestors (Polyphaser Model RGT or equivalent).

NO.	DATE	REVISIONS	BY	APP'D
KANSAS DEPARTMENT OF TRANSPORTATION				
ITS EQUIPMENT SPECIFICATIONS				
ITS-SII		VERSION DATE: 05-29-17		
APP'D				
DESIGNED	DETAILED	QUANTITIES	TRACED	
DESIGN CK.	DETAIL CK.	QUAN. CK.	TRACE CK.	