Testing results must meet the loss budget as shown below:

	Test Wavelength:	
Allowed Loss Per:	1310 nm	1550 nm
Kilometer	0.40 dB	0.35 dB
Splice (Average)*	0.05 dB	0.05 dB
Connector (Average)**	0.20 dB	0.20 dB

*A maximum loss of 0.30 dB is allowed for any single splice. If fewer than four splices exist in the fiber being tested, a maximum loss of 0.05 dB is allowed for each splice.
**A maximum loss of 0.40 dB is allowed for any single connector. If the distance between a field splice and FDU is less than 50 feet, a maximum combined loss of 0.50dB is allowed.

The OTDR measured back reflection (reflectance) loss shall be less than -40dB. Averaging time for OTDR traces shall be at least 30 seconds. OTDR pulse width shall be appropriate for the length of trace that is being tested; auto-test values by OTDR should be reviewed by contractor and a series of pulse widths used to determine best trace for each run. Acquire approval from the Engineer for any exceptions and document them at the time of testing.

If the maximum loss is exceeded for any splice, cut and re-splice the fiber. A minimum of two attempts at cutting and re-splicing fiber should be made to correct the loss. If the loss still exceeds the maximum listed, verify with the Engineer that the loss will be acceptable. Provide documentation of each attempted test.

Provide documentation that all testing equipment has been calibrated within the last year. KDOT reserves the right to require a new calibration certificate for OTDRs, Power Meters, or Fusion Splicers if it is felt that equipment has been mishandled or damaged.

Coordinate with the owner of leased fiber (e.g., KTA, CenturyLink/Lumen, etc.) as necessary for access to test locations to verify testing and confirm results. If problems are identified on leased fiber, the Contractor shall document issues and work with KDOT to notify providers and remedy the identified issues. Additional expenses from extra site visits to establish and test connectivity as a result of coordination with the owner of leased fiber or backbone splicing shall be approved by KDOT in advance. Losses within leased fiber are not the responsibility of the Contractor. If leased fiber power meter results fail, results may still be accepted. Instances will be evaluated on a case-by-case basis.

20.9 TECHNICAL REFERENCE MANUAL (TRM)
Coordinate with the Engineer to locate and compile all project, device, and component information required by these specifications into a Technical Reference Manual (TRM). Organize and submit all information electronically via a USB flash drive or online drop box system in the formats noted on Table S.15.2 on sheet ITS-S15.

A complete draft of the TRM, including all fiber test results, must be submitted prior to commencement of the 60-day test period for any device or system. KDOT's ITS Unit will provide written approval and confirmation that all materials were received and that equipment is ready for testing prior to commencing any test periods.

The Engineer will review the draft TRM during the 60-day test period and will provide comments to the Contractor for any corrections to be made prior to the termination of the 60-day test period. Final acceptance of any system or project will not be granted until a final, updated version of the TRM has been submitted to and accepted by KDOT's ITS Unit.

The following sections must be included in the TRM:
1. Table of Contents
2. Project Information, Documents, and As-Built Plans
3. Device Documentation & Warranties
4. Test Results
5. Splice Vault / Pull Box Documentation
6. GPS Documentation
7. Cabinet Documentation Records

See Table S.15.1 and S.15.2 on ITS-S15 for a checklist of all items to be submitted as part of the project.

20.9.1 TABLE OF CONTENTS
Following the cover page of the TRM, include a linked or bookmarked table of contents for the entire TRM. Each section and subsection as noted in Table S.15.2 must be included and linked.

20.9.2 PROJECT INFORMATION, DOCUMENTS, AND AS-BUILT PLANS
In this section, include any relevant information or documents obtained or developed for the project.

Provide all approved permits obtained for the project, including railroad, waterway, bridge, city, or county permits.

Additionally, include a table listing all new power service locations with corresponding addresses, service types, and utility contact information.

After all cable and conduit has been installed, contact Kansas OneCall to perform locates for all cable included in project. Include email(s) from Kansas OneCall showning status of all locates as complete. The project will not be accepted if utilities cannot be located correctly. The Contractor will be responsible for correcting utilities so they can be located.

Include an As-Built version of the plans in this section with any field alterations or changes noted in red. Legibly mark plans in a contrasting, reproducible color to depict any changes or deviations made during construction, including buried or concealed construction or utility features. Record locations of all buried utilities that differ from the location indicated or that were not included on the contract plans. As-Builts must include marked-up communication schematic drawings. Supplement as-built documents with detailed sketches as necessary.

20.9.3 DEVICE DOCUMENTATION & WARRANTIES
Provide a list of all components and parts used in the project. Include a brief description, part or model number, and listing of recommended suppliers including e-mail addresses, phone numbers, or website links. For each item, include the warranty start date and effective warranty period. Also include component serial numbers for cameras, detectors, and DMS.

Include electronic copies of any warranty submittals.

Include all final and approved submittals and shop drawings as an electronic PDF file with bookmarks of each component or cable. Be sure to include any structural weld drawings and general wiring/block schematics.

Additionally, provide a copy of each user manual for all vendor-supplied software and equipment. Tab or highlight any fault diagnostic or repair procedures and any preventative maintenance procedures to facilitate field maintenance or repairs.

Include all lowering device installation certifications from the manufacturer indicating that the lowering devices were installed correctly. Include the installation and operation specifications and manuals for the lowering device in this section if they were not already included in the approved submittals.

20.9.4 TEST RESULTS
Include copies of all results for each test conducted for the contract. Test results should be labeled clearly with locations on the header of each page. This includes, but is not limited to:
1. Ground Resistance Test Results
2. ITS Component Test Results
   a. CCTV Camera
      i. Standalone
      ii. 60-day/Final Acceptance
   b. CCTV Lowering Device Test Results
   c. DMS Test Results
      i. Standalone
      ii. Commissioning
      iii. 60-day/Final Acceptance
   d. VDS Test Results
      i. Standalone Test
      ii. 60-day/Final Acceptance
   e. Ethernet Radio Systems
      i. Wireless data communications link
      ii. Throughput
3. Fiber Optic Test Results
   a. Power Meter
   b. OTDR
   c. Total Fiber Loss Budget

20.9.5 SPLICE VAULT / PULL BOX DOCUMENTATION
For each fiber optic splice vault and communications pull box, include the following documentation: a photo of the inside of each vault or box, a brief location description, the vault or box identifier as labeled on the plans, a description of the cables within the vault or box, sequential fiber markings taken within three feet of conduit entry, and any other pertinent information that would be useful for future maintenance activities. Upon completion of splicing, take a picture of each splice tray, labeling each fiber and each tray with clear identifiers.

For at least one electrical pull box per project, include a photo of the outside of the box after installation.

The data for each vault may be presented in a PDF format or included as attached data in a shape or KMZ file. All data must be embedded in the GPS points provided and should not reference external storage locations.

20.9.6 GPS DOCUMENTATION
Provide electronic GPS documentation of all items installed or used in the project. Include plan identifiers/labels for each item. GPS documentation may be submitted as a shape or KMZ file or as an electronic list of GPS coordinates in an Excel document. If providing an electronic list, provide the list as a PDF within the TRM and as an electronic Excel file.

GPS points should be included for all the following installed devices: DMS Foundations, CCTV Foundations, Detector Poles, Cabinets (Pad and Pole Mounted), Pull Boxes, Splice Vaults, Wireless Towers, Power Supply Assemblies (Type 1 and 2), Service Poles, Transformers, Junction Boxes, and all Conduit or Cable Runs. Also collect GPS coordinates of existing devices or features utilized or modified during the project. GPS coordinates for conduit runs must be taken every 100 feet for trenched or plowed conduit and every 20 feet for bored conduit. Collect depth and elevation data (Z-coordinates) for bored conduit.

Include a photo of both the front and back of the inside (doors open) of each cabinet in the GPS documentation section. Also include pictures of all Fiber Distribution Units in POP Buildings, Hub Cabinets, or Communications Shelters that were modified with the project.

The accuracy of all GPS readings and data collected must be within three feet. GPS points must be in decimal latitude and longitude.

20.9.7 CABINET DOCUMENTATION RECORDS
For each cabinet in the project (installed, modified, or existing), provide an electronic copy of the cabinet documentation to be included in the document pouch/folder. The following documents must be included for each cabinet: Patch Panel Diagrams, Cabinet and Device Wiring Diagrams, Cabinet Elevation Drawings with detailed labels, Site Communication Schematics, and a copy of any maintenance logs.

Print an 8 ½" by 11" hard copy of all documentation for each cabinet and place within the cabinet's document pouch/folder. Final acceptance will not be granted until both the hard copies are placed in each cabinet and electronic copies are included in the TRM.

21.0 TRAINING

21.1 DESCRIPTION
Conduct training courses for KDOT operations and maintenance staff on operating components of the ITS system if requested by KDOT. Design training courses to ensure that KDOT staff achieves a full knowledge and appreciation of the design, operation and maintenance of equipment. Training may consist of field device operations and maintenance training, field communications operations and maintenance training, and system (outside plant) operations and maintenance training.

21.2 MATERIALS
Provide all training documentation, and coordination with vendors to provide teaching staff. Provide the training to consist of lectures and demonstrations that shall provide practical (hands-on) training and experience.

Provide 5 hard copies of the training manuals and 1 electronic copy of the training manuals.

Provide a detailed training plan and a syllabus for each course for the approval of the Engineer. Include in the information: tentative dates for courses, locations, and an outline of topics and names of instructors. Provide this information to the Engineer at least 30 days in advance of the training course.

21.3 CONSTRUCTION REQUIREMENTS
Provide up to a 2-day training class to train operations and field maintenance personnel at KDOT's request. Include in-field demonstrations.

22.0 BASIS OF ACCEPTANCE FOR ITS SYSTEM

The ITS system will be accepted when all test results, documentation including but not limited to the TRM and as-built plans are received and approved by the Engineer, all test periods are successfully completed, and all training is completed.

Prior to acceptance, KDOT will contact Kansas One-Call to confirm new utilities can be located and are in the correct position. The project will not be accepted if utilities cannot be located correctly. The Contractor will be responsible for correcting utilities so they can be located.

23.0 MAINTENANCE AND WARRANTY

23.1 MAINTENANCE
Maintain all equipment and cables installed in this project until the ITS system has passed all testing requirements specified herein and has been accepted by KDOT. Once the operational test period has successfully been completed, turn over the maintenance of the ITS system to KDOT.

23.2 WARRANTY
Equipment Warranty: Obtain, assign, and furnish to the Engineer written manufacturer's warranties for all Contractor-provided products and electronic equipment consistent with those provided as customary trade practice.

Contractor Warranty: Provide a Contractor's warranty providing for satisfactory in-service operation of the ITS during the 60 day test period for each ITS component. Comply with the following for Contractor provided equipment: if defects develop during this period, replace or repair the provided equipment, at the expense of the Contractor, including all labor, material and associated costs, as necessary to restore required performance. Comply with the following for KDOT provided equipment: if defects develop in KDOT provided equipment, KDOT will provide a replacement and Contractor shall replace equipment, at the expense of the Contractor, including all labor, material and associated costs, as necessary to restore required performance. KDOT labor costs resulting from equipment replacement will not be charged to the manufacturer or the Contractor.

NO.	DATE	REVISIONS	BY	APP'D

KANSAS DEPARTMENT OF TRANSPORTATION

ITS EQUIPMENT SPECIFICATIONS

ITS-S13 VERSION DATE: 08-23-21

APP'D			
DESIGNED	DETAILED	QUANTITIES	TRACED
DESIGN CK.	DETAIL CK.	QUAN. CK.	TRACE CK.

KDOT Graphics Certified 04-05-2022

Plotted : 25-SEP-2023 18:45
Drawn By : lcvohs
File : ITS-S13.dgn
KDOT Graphics Certified