7.2.4 COMMUNICATION (RF) CABLE
Use communication (RF) cables that are 75 ohm co-axial construction with polyethylene dielectric material. Use co-axial shields that have 100% coverage. Use outer jackets for RF cables that are UV resistant and flame retardant. Use RF cables (excluding jumpers with lengths less than three feet) that have an attenuation of less than 6 dB per 100 feet at 1800 MHz. When using RF cables for jumpers of less than three feet, an attenuation of less than 18 dB per 100 feet is required. Install RF cable connectors or provide manufacturer pre-installed RF cable connectors that are appropriate for the type of device as specified in the Plans.

7.3 CONSTRUCTION REQUIREMENTS

7.3.1 PULLING
Use insulating types of pulling compounds containing no mineral oil. Follow the pulling tension limits recommended by the wire and cable manufacturer. Use a dynamometer where mechanical means are used. Cut off section subject to mechanical means.

7.3.2 BENDING RADIUS
Use a minimum bending radius for all cable, except fiber optic cable, that is greater than the manufacturer's minimum bending radius and greater than six times the overall cable diameter.

7.3.3 SPLICES
Use continuous low voltage power conductors from the power supply to the control cabinet and not spliced in pull boxes or junction boxes unless indicated on plan. Install all other cables continuous, without splices, from termination to termination. Where required, splice where shown on the Plans or as approved by the Engineer where required for cable installation. Receive pre-approval by the Engineer for all splices and locations.

If splicing in power supply circuits where the voltage does not exceed 600 Volts AC, utilize splices made with approved spring-type wire connectors. Soldered connections will not be permitted. The insulation for the splice shall consist of two layers of electrical rubber tape, four layers of plastic electrical tape, and two layers of friction tape. Securely apply the tapes over the bare wire splice area and back onto the original insulation a minimum of one inch. Apply a minimum of three coats of approved liquid waterproof compound to the splice. The finished splice's electrical and mechanical characteristics and insulation quality are required to be equal to those of the original cable.

Splice conductors only in pull boxes, terminal compartments, pedestals, or cabinets. Splices are not allowed in conduits. Where possible, install cable continuous, without splices, from termination to termination.

7.3.4 INSTALLATION
Install low voltage control and communications cables in conduit separate from power cables, unless otherwise noted on the Plans. Ground the shield of shielded cables at one end only and as recommended by equipment manufacturer. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

8.0 GROUNDING, POWER SUPPLY ASSEMBLY, AND POWER

8.1 GROUNDING
Ensure that all equipment, devices, wiring, power supplies, and service antennas are protected from external and internal sources, including power surges, lightning, induced voltages, and static discharges. Ensure that ground rods are listed according to UL requirements as detailed in the standard UL 467, Grounding and Bonding Equipment, and meet the requirements of NEC 250. Use electrodes that are solid copper or copper-bonded steel. Use grounding rod attachments that are minimum No. 4 tin-plated bare copper wires. All components of the lightning protection system shall conform to the current edition requirements of UL 96A and NFPA 780.

Exothermically weld all underground ground rod attachments at all connection points. When ground rods are above ground and inside cabinets, mechanical connections or exothermic welds are both permitted. Bond all metal components of the ITS device subsystem, such as the cabinets, racks, and steel poles, to the grounding system with a grounding cable that uses a mechanical connection on the equipment side and an exothermically welded connection at the down cable.

8.2 GROUND RESISTANCE TESTING AND CERTIFICATION
Per NEC Article 250, achieve a resistance to ground measurement of 25 ohms or less in dry conditions between the grounding electrode and the soil (using multiple electrodes or extending links, if necessary). Isolate the ground rod from the connected system during testing. Make all connections to the grounding electrode using exothermic welds.

Connect all grounding electrodes related to the ITS device and its subsystems, and any grounded electrical system within a 100 foot radius (but not beyond the right of way) of the ITS cabinet base, to a single point main grounding electrode, sometimes referred to as the ground window, which shall be driven a maximum of 3 feet from the base of the ITS cabinet. Provide for each grounding electrode an interfacing hemisphere, which is an imaginary cylinder with a radius and depth equal to the length of the electrode, so each additional electrode must be spaced two times the electrode length away from other electrodes. Bury the bonding wires a minimum of 2 feet below the grade.

Measure the ground resistance with an instrument designed specifically to measure and document earth/ground resistance, soil resistance, and current flow. Perform testing in the presence of the Engineer or their approved representative. Do not bury the exothermic connections to the ground rod until grounding has been approved by the Engineer. Record the approximate ground rod distance from the foundation for future location identification. Conduct the test by using the fall-of-potential method as described in the IEEE Standard 142-2007. Provide the Engineer with written test results for each testing location prior to backfilling the grounding electrode. Include in the test results the instrument model and date of calibration for the device used in the testing and the local environmental conditions at the time of testing. Certify and sign the test results. The 60-day acceptance test for any device at each site will not start until ground resistance testing reports are submitted to the Engineer for that particular site.

8.3 DESCRIPTION
Provide a complete interface between the project electrical distribution system and the utility company providing power service. New service points will be established as indicated on the Plans. As necessary, provide a service pole or pedestal, meter socket, circuit breakers, weatherproof enclosure for the breakers, risers, grounding materials, fittings, and adapters. Circuit breakers and disconnect switches required as indicated on the Plans. Any work to bring the power from outside of the right-of-way to the right-of-way will be completed by utility company providing power service. Comply with the National Electrical Code (NEC) for all work. Pay particular attention to grounding specifications regarding netural and ground connections at ITS power supply assemblies and cabinets.

Perform the following: Process an application for electrical service for each location, coordinate with the Utility to ensure the proper location of electrical services provided by the utility, provide the Utility with the construction schedule so that power is available when needed. Coordinate with the Utility for installation of the power meter. Contractor is required to install conduit and conductors as required and as directed by Utility between power source and the ITS power service. Contractor shall work with Utility to meet conduit and conductor requirements. Contractor to coordinate with Utility and assume all fees. Assume all fees until KDOT or KC Scout assumes ownership. Notify and coordinate with the Engineer when KDOT or KC Scout is to assume ownership of the proposed sources of power.

Contact names and phone numbers for utilities at each site is listed on the Plans. Power coordination will be reviewed at the pre-construction meeting. All utility hookups are incidental.

8.4 MATERIALS
Comply with the details shown in the Plans. Consult the utility company providing power service regarding their service installation requirements and furnish the service equipment in compliance with codes and regulations, and their requirements.

8.4.1 POWER SUPPLY ASSEMBLY, TYPE 1.
Supply and install new Type 1 power supply assemblies in accordance with the details shown on the Plans. Include meter socket and disconnect on a new Type 1 overhead service pole. Use conductor and disconnect size as indicated on the Plans.

8.4.2 POWER SUPPLY ASSEMBLY, TYPE 2.
Supply and install new Type 2 power supply assemblies in accordance with the details shown on the Plans. Provide power supply assemblies that contain a main circuit breaker frame and trip rating as indicated on the Plans. When breaker lugs are not large enough for the conductor size, provide and install a power distribution block in a NEMA 4 enclosure on the secondary side of the disconnect.

The customer door shall have a latching handle with provision for padlocking in the closed position. Provide a temporary padlock. KDOT will replace the padlock with a KDOT-supplied padlock at final acceptance.

8.4.3 SERVICE POLE
Where service poles are required; either new, modification to existing, or replacement of existing, use a service pole that is 35 feet minimum height made of Class 4 or 5 wood. Ground the pole with a ground rod per the utility company's requirements. Where conduit is attached to the pole include a service entrance cap on the top of the conduit run. Design this cap to prevent ingress of water into conduit. Include guy wires where requested by the utility company.

8.4.4 TRANSFORMERS
Provide and install step-down transformers (480 VAC to 120/240 VAC) and step-up transformers (120/240 VAC to 480 VAC) where indicated on the Plans. Use a transformer assembly in all instances where the control cabinet location requires a transformer to ensure that proper voltage is provided to the control cabinet being serviced by the transformer assembly. Use Jefferson Electric phase encapsulated transformers or approved equal that meet these following minimum requirements.

Step-down transformer: The transformer assembly shall consist of a NEMA 3R rated cabinet/enclosure and an appropriate 480 VAC to 120/240 VAC transformer, service disconnect (480 Volt side), and distribution panel (120/240 volt side). The transformer primary voltage shall be 480 VAC and the secondary voltage shall be 120/240 VAC single phase 0.5Hz, grounded neutral. The volt-ampere rating shall be as shown in the Plans.

Step-up transformer: The transformer assembly shall consist of a NEMA 3R rated cabinet/enclosure and an appropriate 120/240 VAC to 480 VAC transformer, service disconnect (120/240 volt side), and secondary over-current protection, via circuit breaker or fuse (480 volt side). The transformer primary voltage shall be 120/240 VAC and the secondary voltage shall be 480 VAC single phase 0.5Hz, grounded neutral. The volt-ampere rating shall be as shown in the Plans.

Construct the cabinet and door from 5052-H32 sheet aluminum alloy with a thickness of 0.125 inches. Form all welds neatly and free of cracks, blow holes, and other irregularities. Ensure that there are no burrs on all inside and outside edges of the cabinets/enclosures. Provide a sloped top on the cabinets/enclosures to prevent the accumulation of water on its top surface. Construct signs that are riveted to the access doors to the transformer and service disconnect stating "DANGER HIGH VOLTAGE". The latching handle is to have a provision for padlocking in the closed position. Provide temporary padlock. KDOT will replace the padlock with a KDOT supplied padlock at final acceptance.

Where required by the plans, mount the step-down transformer to the side of the ITS cabinet facing away from traffic. Ensure all cabling runs from the transformer to the cabinet panel board are tied tightly to the rack to prevent excess slack in the cable.

Provide all transformer assembly equipment and accessories furnished on the project that is new, of prime quality, and has not been used previously on other projects or in other locations. All items of the same type shall be identical and totally interchangeable.

Use transformers that include a fused service disconnect appropriately sized for the intended load and to safely clear a fault. Submit the size of the service disconnect for approval.

Use transformers that are single phase, dry type units with two 5% augmentation taps.

The weight of the transformer shall not exceed 250 pounds. Label the transformer (i.e. step-down or step-up) and identify on the exterior all incoming and outgoing voltages. Use transformers that are the quiet type. Do not use sound levels in excess of 45dB.

8.4.5 FITTINGS AND ADAPTERS
Where large conductor sizes of 1/0 or greater are shown on the plans, provide shop drawings that show the type of fitting/adapter being proposed and the locations in which these fittings/adapters are being proposed to accommodate proper termination (lugs/splices) within panels, pull boxes, and cabinets for a complete system assembly that can be installed in a tidy, professional manner. Utilize fitting/adapter with a set screw to secure the conductors. Do not use a crimp style fitting/adapter.

8.5 SURGE PROTECTION - LOAD SIDE
Surge protection for all power supply assemblies and cabinets should meet the following minimum specifications:
1. Voltage Protection Rating (VPR) of 700V, L-N, L-G, N-G
2. Surge current 40kA per phase
3. Failure indicator
4. Operating temperature range: -20°F (-28°C) to 165°F (74°C)
5. Operating humidity: 95% RH non-condensing
6. 5 year minimum manufacturer warranty
7. Nominal discharge current (In) rating of 10kA

Terminate all cables on surge protectors. Ensure all surge protection devices are grounded properly to the ground bus via a dedicated ground cable to the cabinet grounding bus bar. Ensure ground wires from all equipment have the shortest lead length possible with direct connection to the cabinet ground bus bar. Avoid cable loops and bends for all ground bonds and wires.

8.5.1 POWER SUPPLY ASSEMBLY SURGE PROTECTION
Provide a Citel M50-120T or approved equivalent. Power supply assembly surge protection must meet UL 1449 Type 1 Listed, current edition. Supply each power supply assembly with a 120/240 or 240 /480 Volt AC heavy-duty parallel surge protector on the load side of the main breaker.

8.5.2 CABINET POWER SUPPLY SURGE PROTECTION
Provide a Citel M50-120T or approved equal. Devices must be listed to UL 1449 Type 2, current edition, to protect the control equipment from power surges and over voltages. This includes incoming power lines, the power supply, and outgoing lines when applicable. Supply all cabinets with 120/240 Volt AC heavy-duty parallel surge portector on the AC service input. Provide all cabinets except DMS-only cabinets with surge protection that meets SCCR of 100k AIC or available short circuit current, whichever is greater. Proivde DMS-only cabinets with surge protection that meets SCCR of 200k AIC or available short circuit current, whichever is greater.

NO.	DATE	REVISIONS	BY	APP'D

KANSAS DEPARTMENT OF TRANSPORTATION

ITS EQUIPMENT SPECIFICATIONS

ITS-S04 VERSION DATE: 02-12-21

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

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