



**SPECIAL PROVISIONS
FOR
ITS INFRASTRUCTURE INSTALLATION**

**Story County
ITS-030-5(274)--25-85
ITS-030-5(295)--25-85**

**Effective Date
July 19, 2022**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150870.01 DESCRIPTION.

- A.** These projects involve installing DOT supplied fiber optic cable, poles, foundations, and cabinets. These projects also involve supplying and installing conduit, handholes, tracer wire, test stations, power supplies and cabling, fiber optic cable, and fiber optic termination and splicing deemed necessary for a complete ITS Infrastructure installation designed for use with future device deployments and other uses planned by the Iowa DOT. The Iowa DOT plans to initiate a separate contract to supply and install the cameras, sensors, and other ancillary equipment in or on the cabinets and poles, as well as other items required to provide a complete and functioning network of ITS devices.
- B. Related Specifications and Standards.**
The work as detailed on the plans for the ITS Infrastructure Installation shall be completed in accordance with the contract documents and the documents listed below.
- NEC, latest edition adopted by the State of Iowa.
 - Telecommunications Industry Association/Electronic Industries Association (TIA/EIA) latest editions.
- C. Contractor's Responsibility.**
- 1. One Call Locating.**
Until final acceptance, provide all utility locates of the work performed under this contract when requested through One-Call services or by the Engineer. Perform any such locations within 48 hours of receiving notice that such locations are needed.
 - 2. Conduit Locations.**
Prior to final acceptance, meet with the Engineer to demonstrate the locate system is working properly throughout the entire locate system.
- D. Disruption to Existing Fiber Networks.**

1. Planned Work Near Existing Fiber Networks.

- a. Ensure continuous operation of the existing fiber networks and systems during construction of the project.
- b. Do not work on splicing, disconnecting, and/or in any way disrupting normal operation of the existing fiber networks or systems without approval from all affected parties. Parties include the Iowa DOT and the Iowa Communications Network (ICN). Provide a written request to the Iowa DOT and the ICN for approval at least 10 calendar days before work is done near an existing fiber network or equipment. Submit a copy of the written request to the Engineer in all cases. In addition to the written request, submit the work plan and schedule for approval by the Engineer. The work plan shall include all fiber strands and the parties possibly affected.
- c. Restore the disrupted system upon completion of the work within the allowable working hours. Failure to restore disrupted systems and equipment within the allowable working hours will constitute an unplanned disruption.

2. Allowable Working Hours

Disruptions to the existing systems shall only occur between Midnight and 6:00 AM on working days unless otherwise approved by the Engineer.

3. Unplanned Disruption.

- a. In the event of an unplanned disruption, simultaneously notify the Engineer and ICN and immediately stop all work in progress and expend all efforts to restore the disrupted system(s) and/or correct the problem causing the disruption. The notice shall include the type of facility damaged and the extent of the damage.
- b. Remain on site until the ICN confirms that the disrupted systems are fully operational. Unplanned disruptions shall result in the assessment of liquidated damages.
- c. No extension of time for delays caused by repairing disrupted systems will be granted.
- d. Any unplanned disruptions determined by the Engineer to be caused by the actions of the Contractor shall be corrected by the Contractor at no additional cost of Iowa DOT.

4. Liquidated Damages.

- a. Unplanned disruptions to the existing fiber-optic network will result in impacts to the traveling public, increase fuel consumption, vehicle operating costs, pollution, and time needed for Iowa DOT administration, engineering, inspection, and supervision, and other inconveniences and harm far in excess of those resulting from delay of most projects.
- b. Accordingly, the Contractor agrees:
 - 1) To pay \$250.00 liquidated damages per 15 minutes, for each 15 minute period that the Contractor fails to restore the proper operation of an existing fiber-optic network element following an unplanned disruption.
 - 2) To authorize the Engineer to deduct these liquidated damages from any money due or coming due to the Contractor.

E. Contractor Submissions.

1. Materials List.

Complete and submit one electronic pdf file of the materials list within 14 calendar days after award of the project contract. Include the name of the materials, supplier and catalog number of each item listed.

2. Construction Schedule.

- a. Within 30 days after award of contract or before the construction kickoff meeting, submit to the Engineer one electronic pdf file of the detailed construction schedule including dates of commencement for each major work item, duration of each major work item and completion of each major work item on each segment of the proposed construction.
- b. Major items of work to be included on the schedule shall include:
 - Installation of conduit, handholes, building entrances, and fiber optic cable
 - Duration of material procurement

- Splicing and termination of fiber optic cables
 - Duration of fiber testing required and submissions of test report
- c. Upon acceptance of the schedule, adhere to these dates as proposed unless modified with the approval of the Engineer.
 - d. Submittal and approval of the proposed construction schedule by the Engineer is required before construction activities can commence.

3. Shop Drawings.

- a. After approval of the Materials List and before any items are ordered, submit the shop drawings for approval according to Article 1105.03 of the Standard Specifications.
- b. The Engineer will review the shop drawings/catalog cuts for the purpose of assuring general conformance with the project design concept and contract documents.
- c. The Engineer will provide approval or rejection of shop drawings within 14 calendar days of the Contractor's submission. Re-submit the shop drawings for approval within 7 days of the Engineer's rejection
- d. Provide written notice of any deviations from the requirements of the contract documents or Special Provisions.
- e. Engineer's approval of shop drawings/catalog cuts does not relieve the Contractor of responsibility for providing satisfactory materials complying with the contract documents. Errors not detected during review do not authorize the Contractor to proceed in error.

4. Materials Procurement

- a. Submit shop drawings, specification data, and samples for acceptance testing (when requested) to the Engineer for approval and/or selection prior to the placing of orders for any equipment and materials.
- b. Order all materials requiring production lead time greater than 4 weeks within 7 calendar days of receiving the approved shop drawing(s).
- c. Submit to the Engineer proof of material purchase order in electronic PDF format.

5. Warranty.

- a. Transfer all required standard materials warranties on the date of final acceptance to the Iowa DOT.
- b. Warranty periods shall not commence prior to final acceptance of the work.
- c. Warranty periods shall remain in effect until at least 1 year after the final acceptance for all cables and equipment furnished and installed for this project.

F. As-Built Documentation.

1. General.

- a. As-built record plans will be the responsibility of, and completed by, the Engineer. As such, it will be the responsibility of the Engineer to coordinate directly with the Contractor to ensure that a master record set of the plans is maintained throughout construction to document all installations and any deviations from the design shown in the contract documents.
- b. Maintain written records of daily construction progress, areas worked, and quantities installed to aid in the completeness of as-constructed documentation by the Engineer.

2. GPS Data Recording Staking Assistance.

- a. The Engineer will be responsible for collecting GPS data of all installations including, but not limited to conduit routing and handholes. All efforts will be made by the Engineer to coordinate with the Contractor and collect daily construction progress.
- b. Coordinate and assist the Engineer in this effort by staking, flagging or otherwise locating all installed features until such time that the GPS data can be collected.
- c. Mark the conduit alignment at least every 50 feet to allow GPS data to be collected. For any segments that are bored, make note on the flag or stake of the bore depth at the location that is being marked.

150870.02 MATERIALS.

A. General.

Provide any items, equipment, or materials not specifically addressed in the contract documents but required to provide a complete and functional installation. The level of quality shall be consistent with other specified items. All miscellaneous electrical equipment and materials shall be listed for its specific application.

B. Device Cabinets.

All device cabinets will be provided by the Iowa DOT. Coordinate with the Engineer the time to accept the device cabinets from Jason Dale (515)239-1995 at Iowa DOT Maintenance Garage in Ames, Iowa, and deliver the device cabinets to the field for installation or to the Contractor's construction yard for storage.

C. Power Installed Foundation.

All power installed foundations will be provided by the Iowa DOT. Coordinate with the Engineer the time to accept the power installed foundations from the Iowa DOT Maintenance Garage in Ames, Iowa, and deliver the power installed foundations to the field for installation or to the Contractor's construction yard for storage.

D. Poles.

All poles will be provided by the Iowa DOT. Coordinate with the Engineer the time to accept the poles from the Iowa DOT Maintenance Garage in Ames, Iowa, and deliver the poles to the field for installation or to the Contractor's construction yard for storage.

E. Wire and Cable.

1. Power Wire.

Single conductor, stranded copper, Type XHHW, black colored jacket in sizes listed in the contract documents.

2. Tracer Wire.

- a. Single conductor copper clad steel, No. 10 AWG with orange colored jacket.
- b. Use a Tracer-Lock Connector (#TL-LUG-SS) or approved equivalent on all mainline and lateral connections.

3. Grounding/Bonding.

Ground all installations using a No. 6 AWG copper, non-insulated wire bonded to copper clad metal, driven electrodes using an exothermic weld.

F. Fiber-Optic Cable.

1. General.

- a. The 96 strand armored fiber optic cable for this project will be provided by the Iowa DOT. This fiber cable can be picked up by the Contractor from the Iowa DOT Ames Central Complex. Contact Jason Dale (515-239-1995) to make arrangements to pick up the fiber cable.
- b. The cable shall meet the latest applicable standard specifications by ANSI, EIA and TIA for the single-mode fiber cable of the size specified per the Plans.
- c. Provide all 12 count fiber-optic cable for installation on this project.
- d. Provide the Engineer the manufacturer's production test provided with the spool for any fiber optic cable provided by the Contractor.
- e. Provide the Engineer with documentation of wasted cable.
- f. The buffer tubes shall be compatible with standard hardware and shall have 12 fibers per tube, the fibers shall not adhere to the inside of the buffer tube, each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B "Optical Fiber Cable Color Coding" and be colored with ultraviolet (UV) curable ink.

- g. The cable core shall be water blocked with dry water blocking materials to improve access and handling of individual tubes.
 - h. The cables shall be designed for point-to-point applications as well as mid-span access and provide a high-level of protection for fiber installed in the outside plant environment.
 - i. The optical fiber shall be fully capable of handling existing and legacy single-mode applications which traditionally operate in the 1310 nm and 1550 nm regions and shall also be designed to operate the full-spectrum from 1260 nm to 1625 nm for optical transmission.
 - j. The optical fiber shall be designed to provide optimum performance from 1260 nm to 1625 nm intended for 16 channel Course Wavelength Division Multiplexing applications.
 - k. The optical fiber shall be manufactured by Corning, OFS or Draka.
 - l. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.
 - m. The jacket or sheath shall be free of holes, splits, and blisters.
 - n. Cable jackets shall be marked with the manufacturer's name, month, and year of manufacturer, sequential foot markings, the symbol for communication cable as required by Section 350G of the National Electrical Safety Code (NESC), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.
 - o. The maximum pulling tension shall be 600 pounds during installation (short term) and 200 pounds installed (long term).
 - p. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.
- 2. Single-Mode, Fiber-Optic OSP Cable – Dielectric Loose Tube.**
- a. Fiber-optic, single-mode, graded loose tube dielectric cable constructed with industry standard 3 mm buffer tubes stranded around a central strength member.
 - b. Single-mode, dispersion-unshifted fiber meeting ITUT G.652D requirements.
 - c. Cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3 mm. Jacketing material shall be applied directly over cable core and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
 - d. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

G. Fiber Optic Cable Accessories and Hardware

1. Outside Plant (OSP) Fiber Splice Closures.

- a. Supply environmental protection of cable and splices from water and dirt and that is designed to be submersed in water and installed underground outside plant use for splicing fiber optic cables in handholes.
- b. The splice closure shall be compatible with all sizes of fiber cables used on this project and large enough to accommodate the number of splices plus an additional 10% at locations where splices are shown on the plans.
- c. The closures shall be a dome type splice closure manufactured from a high-density polyethylene or approved equivalent nonmetallic material with the following properties:
 - Cable entry shall be manufactured of similar material to the dome body and shall seal the closure with re-usable compressed gel cable sealing components that accommodate a wide range of cable sizes.
 - Closures shall be re-enterable and re-sealable without the need for specialized tools or equipment or any additional parts.
 - No encapsulated materials shall be allowed.
 - Be provisioned for a minimum of six cable entries.
 - Hinging splicing trays that provide controlled access to splices and slack storage.
 - Splice and storage compartments accessible via a removable dome-clamp system.
 - The closure shall allow for the storage of at least eight unopened buffer tubes.

- d. The splice closure shall contain all splice trays, storage, splice sleeves, organizing materials, and any other incidental materials required to complete the splices at the locations shown in the plans.
 - e. After splicing is complete, the fiber optic cable and closure shall be flash tested for leaks.
 - f. The splice closure shall be TE Connectivity FOSC450-C6-6-NT-0-C-0-V or approved equal.
 - g. Splice trays shall be TE Connectivity # 915167-000 or approved equal.
 - h. Splice sleeves TE Connectivity # SMOUV are recommended.
 - i. Commscope # FAK-MULDRP sealing plugs shall be used or approved equal.
- 2. Single Panel Housing (Holds One Connector Panel and Splice Organizer)**
- a. Surface mounted termination/splice housings shall provide for termination capabilities, splice protection, and associated fiber/pigtail storage.
 - b. Surface mount housing shall be intended for splicing and management, and cross-connect or both for up to 12 fibers.
 - c. Termination adaptor panels shall be duplex SC.
 - d. Top and bottom cable entry grommets for incoming fiber, fiber jumper.
 - e. Manufactured of metal.
 - f. Hinged front door, universal mounting brackets, jumper bend limiters, labels for identifying fiber terminations.
 - g. Wall mountable single panel housing shall be Corning SPH-01P and CCH adaptor panel, or approved equal.
- 3. UPC/SC Factory Terminated Fiber Connector and Pigtails (Include Splice and Connector Sleeve)**
- a. All fiber connectors used on this project, including in shelves, cabinets or panels, shall be factory installed connectors.
 - b. No field terminated connectors will be allowed.
 - c. Connectors shall be SC/UPC having a typical insertion loss (single-mode) of 0.15 dB or less, a maximum loss of 0.35 dB or less, with typical reflectance of -55 dB, and temperature stability from -40°C to +75°C.
 - d. Fiber used for pigtails must be of the same manufacturer as the main fiber cable.
 - e. Pigtails shall be rated for the environment they are installed in.
 - f. Splice pigtails in accordance with the splicing specifications and in fiber shelves or panels using manufacturer splice organizers.

H. Handholes.

1. General.

- a. Supply handholes constructed of epoxy or polyester resin mortar with woven glass fiber reinforcement and an appropriate aggregate dimensioned as indicated in the contract documents.
- b. Handhole materials shall not support combustion when tested in accordance with "Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position" ASTM D-635.
- c. Water absorption shall not exceed two percent of the original weight of material under test conditions per "Standard Test Method for Water Absorption of Plastics" ASTM D-570.
- d. The handhole shall be functional without failure throughout a temperature range of -50°F to +170°F.
- e. The handhole walls shall not deflect more than 0.24 inches per foot of length of box when installed and subject to an ASTM C-857 TIER 22 load.
- f. Handholes shall meet or exceed ANSI/SCTE 77 "Specification for Underground Enclosure Integrity" requirements.
- g. Handhole lid strength shall be tested to 33,750 pounds (Tier 22).
- h. Handhole lids shall be labeled as indicated in the plans or as directed by the Engineer.

2. Test Stations.

- a. Supply Rhino part TVT178OB-EM9125-OR or approved equivalent test stations at all Type 48 inch by 30 inch by 36 inch handholes.
- b. Test Stations shall be 78 inch triangular flexible orange plastic marker with five separate access terminals, isolation lever, and set screw to hold terminal concealment cap on.
- c. Place Engineer approved custom warning decals on all sides.

3. Fiber Marker.

- a. Supply Rhino Part# TVF78OO or approved equivalent markers at Type 24 inch by 36 inch by 36 inch handhole locations noted in the plans.
- b. Markers shall be 78 inch, orange, polyester resin with reinforcing fibers, and remain flexible from -40°F to +140°F.
- c. Place Engineer approved custom warning decals on all sides.

I. High Density Polyethylene Conduit.

1. High Density Polyethylene (HDPE) conduit shall be smooth wall ORANGE in color.
2. Comply with ASTM F 2160 (conduit) and ASTM D 3350 (HDPE material), minimum SDR 13.5.
3. Sequential foot markings printed on HDPE.
4. Continuous reel or straight pieces to minimize splicing.
5. For dissimilar conduit connections provide an adhesive compatible with both materials.

J. Power Connections.

Power connections shall comply with the requirements of the NEC, contract documents, electrical utility, and all generally accepted standards and requirements for the electrical components and power terminations in the individual power source.

150870.03 CONSTRUCTION.

A. General.

1. Stake all handholes and proposed conduit alignment as shown on the plans, a minimum of 1 week prior to construction for approval by the Engineer. The Engineer will authorize any changes in location in writing before performing the installation. No additional compensation will be provided for additional work associated with or resulting from unauthorized changes to the contract documents.
2. The Iowa DOT will stake all pole locations. Do not adjust pole locations without approval by the Engineer. The Engineer will authorize any changes in location in writing before installation.

B. Survey

The Iowa DOT will stake permanent ROW corners per Section 2526 of the Standard Specifications that shall be used to determine the ROW for project ITS-030-5(274)--25-85.

C. Device Cabinets.

1. General.

- a. Install cabinets in accordance with the contract documents and the manufacturer's recommendations.
- b. Do not penetrate the top of any cabinets without prior authorization by the Engineer.
- c. Do not allow screws used for mounting shelves or other mounting purposes to protrude beyond the outside wall of the cabinet.
- d. All exterior connections shall be watertight.

- e. Contact the Engineer a minimum of 1 week in advance to arrange a field review prior to placing the cabinets.

2. Mounting.

- a. Orient cabinets as shown in the contract documents unless otherwise directed by the Engineer.
- b. Ensure sufficient clamps, nuts, hardware, etc., as required for the specified mounting type, are furnished with each cabinet.
- c. Seal all conduit openings in the device cabinet using ETCO duct plugs or as directed by the Engineer.

D. Power Installed Foundation.

1. General.

- a. Install the power installed foundations in accordance with the contract documents and the manufacturer's recommendations.
- b. Contact the Engineer a minimum of one week in advance to arrange a field review prior to placing the power installed foundation.
- c. Notify the Engineer immediately if an obstruction conflicts with a proposed power installed foundation location. The Engineer will relocate or determine another effective means of supporting the structure to eliminate the conflict. Payment will not be made for re-work or extra work as the result of an unauthorized relocation of a power installed foundation.

2. Installation Details.

- a. Construct all power installed foundations as located by the Engineer and set level and to the proper elevation.
- b. Hand dig with shovel after power installed foundation is in place in order to install conduits into the provided conduit entrances.
- c. Install a sufficient number of conduits sized as indicated in the contract documents. All conduits shall be located as indicated in the contract documents.

3. Improper Construction.

Remove and reconstruct, at no additional cost to the Engineer, all power installed foundations improperly constructed or with improperly installed anchor bolts, conduit, or any other foundations components as determined by the Engineer.

E. Poles.

1. General.

- a. If pole has structural damage do not erect and notify Engineer.
- b. Repair any surface damage to galvanized components using a zinc-rich paint acceptable to the Engineer.

2. Pole Erection.

- a. Erect poles (including camera mounting system and poles) and securely bolt to the power installed foundation base plate such that the pole is vertical to the centerline of the nearest adjacent major roadway.
- b. Use leveling nuts on each anchor bolt installed below the pole flange. Adjust the pole's vertical position by adjusting both the upper and lower nuts.

F. Wire and Cable.

1. General.

- a. All installations and connections shall comply with the contract documents and all generally accepted codes and standards.
- b. The Engineer shall resolve all conflicts.

2. Tracer Wire.

- a. Install, splice, and test for continuity tracer wire in all conduit installations as indicated on the contract documents.
- b. Where new tracer wire is installed:
 - Splice tracer wire only in handholes to form a continuous network using splice kits listed for wet locations.
 - Leave 50 foot coil of tracer wire in all Type 48 inch by 30 inch by 36 inch handholes to be terminated at the test station.
 - Test all tracer wire for continuity, with approval by the Engineer prior to final acceptance.
- c. **Labeling Requirement.**
 - Place tags on all tracer wire identifying the direction of the tracer wire at every test station.
 - Tracer wire tags shall be self-laminating polyester material.
 - Tracer wire tags shall have black text with a white background.
 - Tracer wire tags shall be Panduit part number S075X150YAJ or approved equal.

3. Grounding/Bonding.

- a. Ground all installations as indicated in the contract documents.
- b. Installation of grounds is incidental to the cost of the connected items of work.
- c. Ground all installations in accordance with the requirements of NEC. Supply and install additional grounding rods and equipment as necessary to satisfy such requirements at no additional cost to the Contracting Authority.

G. Fiber-Optic Cable.**1. General.**

- a. Remove fiber-optic cable from the reel in a manner acceptable to the Manufacturer and Engineer.
- b. Do not twist or bend the fiber-optic cable in excess of the limits recommended by the manufacturer.
- c. As the cable is fed into the duct and conduit system use a manufacturer approved water-based cable lubricant for all fiber-optic cable installations.
- d. Protect at all times all proposed cables, cable ends, and any exposed portions of fiber-optic cable from damage including water intrusion.
- e. Replace in kind any existing pull tape or tracer wire that is used as a pull rope for fiber-optic cable installation. The cost of any tracer wire or pull tape replacement shall be subsidiary to the fiber-optic cable installation.

2. Fiber-Optic Cable Testing.

- a. Visually inspect fiber-optic cable prior to installation. Report any defects to Engineer.
- b. Pre-installation (on-reel), test all strands of fiber (uni-directional) with an Optical Time Domain Reflectometer (OTDR) at 1310 nm and 1550 nm to verify attenuation, continuity and length of the cable. Measured length by the OTDR shall match manufacturer cable foot markings plus manufacturer provided helicity. Perform all tests in the presence of the Engineer and provide the Engineer with up to two copies of any software required for viewing electronic files of the OTDR traces. Fiber test results submitted to the Engineer that exceed the max attenuation loss specification will be identified as Out of Specification.
- c. Post installation, test all strands of fiber (uni-directional) with an OTDR at 1310 nm and 1550 nm to verify attenuation, continuity and length of the cable. Measured length by the OTDR shall match manufacturer cable foot markings plus manufacturer provided helicity. Measured post installation length shall match pre-installation (on-reel) length +/- 50 feet for each strand. Perform all tests in the presence of the Engineer and provide the Engineer with up to two copies of any software required for viewing electronic files of the OTDR traces. Fiber test results submitted to the Engineer that exceed the max attenuation loss specification will be identified as Out of Specification.

- d. The fiber-optic cable is to have a maximum attenuation of 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm when measured with an OTDR. Fiber test results submitted to the Engineer that exceed the max attenuation loss specification will be identified as Out of Specification.
 - e. Replace, as directed by the Engineer, any defect discovered during final acceptance at no additional cost to the Iowa DOT. Consider a defect to be any cable with an OTDR measured length that differs from the actual cable footage, excluding manufacturer's helicity.
 - f. In addition, an Optical Loss Test Set (OLTS) shall be used to test the fiber. Provide the Engineer with up to two copies of any software required for viewing electronic files of the OTDR traces.
 - g. Each splice is to have an averaged loss value of 0.07 dB or less when measured bi-directionally with an OTDR at 1310 nm and 1550 nm. Splice test results submitted to the Engineer that exceed the 0.07 dB or less specification will be identified as Out Of Specification (OOS).
 - h. Each connector is to have an averaged loss value of 0.25 dB or less when measured bi-directionally with an OTDR at 1310 nm and 1550 nm. Connector test results submitted to the Engineer that exceed the max loss of 0.25 dB specification will be identified as OOS.
 - i. All test equipment shall be factory certified within the last year. Provide copies of the certification ten days prior to testing.
 - j. Record test results on a form supplied by the Contractor, with data compiled in PDF format through the meter manufacturer's software. No additional alteration using software from the Contractor beyond the meter manufacturer's software will be allowed. Submit test results in a format approved by the Engineer. Hand over completed test forms on each fiber to the Engineer. Provide native test (electronic version) with no alterations and meter software for viewing of fiber traces. At a minimum, test results shall show the following:
 - Cable and fiber identification (as approved by Iowa DOT).
 - Operator Name.
 - Date and Time.
 - Setup and test parameters including wavelength, pulse width, range, scale and ambient temperature.
 - Test results for OTDR test averaged for total fiber trace, splice loss/gain (dB), connector loss (dB), all events greater than .05 dB, and total length from OTDR.
 - k. OTDR testing shall use a launch and receiving cable. Each cable shall be a minimum 3290 feet, or greater than the dead zone for the OTDR used for this test, whichever is larger.
- 3. Cable Installation.**
- a. Use a suitable cable feeding method between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct.
 - b. Use dynamometers and breakaway pulling swings to ensure that the pulling line tension does not exceed 600 pounds.
 - c. The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. Attach a pulling eye and swivel to the cable to prevent the cable from twisting.
 - d. Do not force cables around sharp corners and take precautions during installation to prevent the cable from being kinked or crushed.
 - e. Minimum bending radius during installation shall not be less than 20 times the outside diameter of the cable or as recommended by the manufacturer, whichever is greater.
 - f. Pulling of the cable shall be hand assisted.
 - g. Iowa DOT approved installation methods include pulling, high air speed blowing, air-assist, push/pull installation, and air blown cable. Installation shall comply with all manufacturers' recommendations for cable installation including pulling tensions, bending radii, and methods, including use of rollers.
 - h. Carefully inspect the cable for jacket defects. If defects are noticed, immediately stop the pulling operation and notify the Engineer. The Engineer will make a determination of acceptability or shall reject the cable.

- i. Install the fiber cable in continuous runs as marked on the plans. End of reel splices or butt splices not shown in the plans will be pre-approved by the Engineer and are incidental to the cost of the installation of the cable. If approved, perform the end of reel or butt splices in existing splice vaults as shown on the plans. The cost associated with the end of reel or butt splices including splice closures, storage baskets, splice trays, protective sleeves, and all accessories will be included in their respective items and shall not result in additional cost to Iowa DOT.
 - j. No splices shall be allowed unless indicated by the plans or approved by the Engineer.
 - k. Seal all conduit openings using ETCO duct plugs or approved equal, or as directed by the Engineer, at all conduit openings at the junction boxes and handholes after cable installation.
- 4. Facilities Protection.**
- a. In the event it is suspected that cable damage has occurred prior to final acceptance, test the cable with an OTDR within 72 hours after notification and submit a copy of the OTDR test to the Engineer upon completion.
 - b. Replace or repair, as directed by the Engineer, any damage occurring before final acceptance at no additional cost to the Iowa DOT. Perform any repairs or replacements as soon as reasonably possible unless otherwise approved by the Engineer.
 - c. Repair or replace any defect in the installed cable at no additional cost to the Iowa DOT. Consider a defect to be any condition resulting in a negative or adverse effect on current or future operations of the completed fiber-optic communication system as determined by the Engineer.
 - d. Repair or replace any existing wiring that is damaged during fiber-optic cable installation, as directed by the Engineer, at no additional cost to the Iowa DOT.
- 5. Slack Coils.**
- a. Leave sufficient slack at each end of the cable to allow proper cable splicing and termination. The minimum slack amount shall be as follows or as indicated in the plans:
 - Handhole, Type 24 inch by 36 inch by 36 inch – 100 feet
 - Handhole, Type 48 inch by 30 inch by 36 inch – 150 feet
 - End Handhole, Type 48 inch by 30 inch by 36 inch – 75 feet
 - b. Neatly coil slack cable in handholes. Bind the slack coils at a minimum of three points around the coil perimeter.
 - c. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames and terminals.
 - d. For storage purposes, the minimum bending radius shall not be less than ten times the outside diameter of the cable or as recommended by the manufacturer, whichever is greater.
- 6. Cable Identification.**
- a. Place tags on all fiber-optic cable identifying the owner and direction of the cable.
 - b. Tags shall be used to label fiber optic cable in every cabinet, handhole, and building termination.
 - c. Tags shall be self-laminating vinyl material.
 - d. Tags shall be Panduit part number PST-FO or approved equal.
 - e. Tags shall clearly identify where each individual cable run originated and where it ends (handhole to handhole, handhole to cabinet, handhole to building, etc.). Include mileposts for handholes.
 - f. Handwritten tags are not allowed.
 - g. Tags shall use indelible ink or etching which does not fade in sunlight, or in buried or underground applications.
 - h. Tags shall be of a material that does not become brittle or deteriorate for a period of 20 years due to moisture, sunlight, soil minerals, chemicals or other environmental elements.
 - i. Engineer will approve tag content before installation.

- j. For fiber installations with joint Iowa DOT/other agency (or entity) use where the fiber will be owned by the other agency (or entity), install typical identifiers and/or markings for that fiber.

H. Handholes.

1. Install the type and size of handholes at the locations indicated in the contract documents.
2. Set top of all handholes to depths as indicated in the contract documents for different handhole types and installation locations.
3. Install coarse aggregate bedding below the handhole as identified in the contract documents.
4. Conduit shall enter the handhole from the bottom and extend conduit ends between 4 and 6 inches above the aggregate bedding.
5. Side penetrations of the handholes are not permitted.
6. Terminate each tracer wire run in test stations at Handhole, Type 48 inch by 30 inch by 36 inch locations.
7. Install ground rods at all Type 48 inch by 30 inch by 36 inch handholes and as indicated in the contract documents.
8. Plug all open conduit ends within the handhole in a manner acceptable to the Engineer.
9. Rodent proof all handholes to the satisfaction of the Engineer.
10. Conduit entrance into junction boxes shall be through slip holes. Fasten conduit to the box using sealing type locknuts.

I. Conduit.

1. General.

- a. Follow all general guidelines covering the construction of buried conduit.
- b. Install conduit by plowing, jacking, pushing, boring, or other approved methods within the public right-of-way and in a manner that minimizes atypical damage from construction operations.
- c. The minimum bending radius of HDPE conduit shall be the larger of 20 times the outside diameter or the HDPE manufacturer's recommendations for minimum bending radius.
- d. Open trench installation is only permitted within 25 feet of any handhole, structure, or other similar improvements, and any other requested locations approved by the Engineer.
- e. At the discretion of the Engineer, verify the integrity of the conduit structure in a manner acceptable to the Engineer.
- f. Tunneling under the pavement or water jetting shall not be permitted.
- g. No excavations are permitted to cross any roadways or any other paved or other similarly improved areas. At these locations, install conduits by boring method unless otherwise directed or approved in writing by the Engineer. Where indicated in the Contract Document and at all roadway and stream crossings, install conduit sections with external protection as specified herein.
- h. No direct-buried cable is allowed.
- i. Unless otherwise indicated in the contract documents, installation of Schedule 40 PVC conduit or approved alternative is allowed only in open trench runs or when approved by the Engineer.
- j. Seal all conduit openings using ETCO duct plugs or approved equal, or as directed by the Engineer, at all conduit openings at the junction boxes, handholes, and building entrances.

- k. Thread and cap all rigid steel conduit ends with standard conduit caps until wiring is installed. Before wiring is installed, replace caps with threaded insulating bushing in accordance with Article 2523.03, N of the Standard Specifications.
- 2. Installation Clearances.**
- a. Depth of all bores shall be a minimum of 48 inches unless otherwise specified in the plans.
 - b. Maintain the typical offsets from referenced locations as shown in the plans.
 - c. Maintain the minimum depth throughout the length of all conduit installations.
 - d. Maintain a minimum of 2 feet of separation when underground conduits parallel an existing facility.
 - e. Maintain a minimum of 2 feet vertical separation when crossing existing utilities.
- 3. Conduit Splicing.**
- a. Install conduit with minimal splices between handholes and structures as shown on contract documents.
 - b. All mechanically joined conduit splices shall use compression couplings designed for underground placement and blown-in fiber installation.
 - c. Butt fusion welding and solvent welding of conduits will not be allowed.
 - d. All conduit splices shall be designed to be watertight to 200 psi.
 - e. Conduit splicing is incidental to the connected items of work.
- 4. Facilities Protection.**
- a. Protect and maintain the conduit throughout construction and until final acceptance.
 - b. To avoid possible damage to buried conduit from exposure to traffic, livestock and other hazards, complete trenching of laterals, trenching around culverts, construction of aerial inserts and similar operations as soon as practicable behind all segment installations.
 - c. If more than 48 hours lag is expected behind a segment installation, install additional protective measures acceptable to the Engineer.
- 5. Backfilling.**
- a. Backfill trenches and other excavations in lifts of 6 inches or less in compacted depth. Compact each layer thoroughly before placing subsequent layers.
 - b. Remove all cinders, broken concrete, or other hard or abrasive materials in the backfill material before commencing backfilling operations.
 - c. Remove and dispose of surplus and unsuitable materials upon completion of the backfilling operations in the area.
 - d. Place and carefully hand tamp backfill under and around the structures in lifts not to exceed 4 inches in loose thickness. Use a suitably sized mechanical tamper for all areas inaccessible to rollers.
 - e. Perform operations in a manner that minimizes soil erosion and employs appropriate storm water pollution prevention measures during all construction operations.
 - f. Maintain work areas in a neat, clean, and orderly condition at all times.
 - g. Upon completion of conduit/cable placing operations and any other work in an area, remove all debris, materials, tools, and equipment from the area and restore the disturbed area(s) to original or better condition within 24 hours or as soon as practicable as determined by the Engineer. Backfill all excavations and grade all disturbed areas during the restoration process.
 - h. Remove and dispose of rock and debris excavated and remaining after backfilling as directed by the Engineer.
- 6. Surface Restoration.**
- a. Replace or reconstruct features removed as a part of the work, such as sidewalks, driveways, curbs, roadway pavement, unpaved areas, or any other items.
 - b. Immediately repair or replace any unauthorized disturbance or damage. Replace improved landscaping, lawns, scrubs, and hedge removed or damaged during construction in a manner acceptable to the Engineer. Re-sod damaged lawns using like grasses.
 - c. Complete restoration according to the applicable sections of the Standard Specifications.

7. Multiple Duct Installation.

Install multiple ducts, in continuity, at locations indicated in the contract documents unless authorized in writing by the Engineer.

8. Plowing.

- a. Use equipment and construction methods subject to the approval of the Engineer that cause minimal displacement of the soil.
- b. Furnish competent supervision at all times at the site of plowing operations to assure compliance with the contract documents.
- c. The equipment shall be capable of extending the plow in order to maintain the required minimum depths under all terrain conditions.
- d. The reel carrier shall be of adequate size and be configured so that the reel sizes being used can be safely handled.
- e. Avoid damaging any paved surfaces, ditches, or other similar surface features. Immediately repair any damage to such features to the satisfaction of the Engineer.
- f. Perform plowing in accordance with standard industry practices using a prime mover with hydrostatic type steering and a vibratory plow. The design of the plowshare shall be such that the buried conduit passing through the plow shall not bind and shall not be bent in a radius less than 20 times the outside diameter of the conduit and maintains the structural integrity of the conduit. The feed chute shall have a removable gate for the purpose of inspection and to allow the conduit to be removed from or inserted into the feed chute at any intermediate point between splice locations. The conduit path inside the feed chute shall have low friction surfaces and be free of burrs and sharp edges to prevent damage to the conduit as it passes through. Smooth any welds before use. Internal guide rollers shall not be used. Exercise care during the plowing operation to avoid conduit damage. Feed the conduit into the ground through the plow loose and at no tension.
- g. Excavate as needed start and finish pits and pits at points of intersection in advance of plowing. Expose ends of casings and crossings of foreign utilities before the start of plowing operations for a conduit segment. Exercise care in the use of trenching and excavating tools and equipment to avoid damaging installed and intersecting conduits or other facilities.
- h. Restore plow furrowed areas to conform to the surrounding terrain using a rubber-tired tractor or heavy truck or a vibratory roller having a weight of 3 tons and a drum width between 4 and 6 feet or by other suitable means approved by the Iowa DOT.

9. Conduit in Trench.

- a. Use equipment and construction methods subject to the approval of the Engineer that cause minimal displacement of the soil.
- b. Excavate open trench straight as practicable. Shape the trench to be smooth, free from any sharp edges, and clear of debris and loose rock. Excavate only gradual grade changes.
- c. Do not leave trenches unattended at any time or open during non-working hours unless approved in writing by the Engineer. Install barriers or other protective measures to prevent livestock or persons from falling into an open trench when appropriate.
- d. Notify the Engineer immediately if solid rock is encountered at any location. Excavate rock trenches using a rock saw or other suitable equipment. The excavation, backfill, and road crossings in solid rock areas shall conform to the requirements stated above unless specifically exempted in this section.
- e. Rock excavation shall be considered extra work and shall be paid as a separate cost item. Obtain approval from the Engineer before commencing any rock excavation.

10. Bored Crossings.

- a. Use equipment and construction methods subject to the approval of the Engineer that cause minimal displacement of the soil.
- b. Bore all crossings beneath roadways, streets, other paved surfaces, railroads, or other structure in accordance with requirements and regulations of the authority having jurisdiction and as directed in the contract documents.

- c. Limit bore hole sizes to the outside diameter of the conduit being placed.
- d. Locate bore pits a minimum of 2 feet from the edge of pavement or shoulder unless otherwise directed by the Engineer.

J. Fusion Splices.

1. Use fusion splices to splice all continuous fiber runs in splice closures and factory terminated connector pigtails.
2. Splices are allowed only in the splice closures as located on the plans.
3. Maximum attenuation per splice as estimated by the fusion splicer shall not exceed 0.02 dB. Any splice exceeding 0.02 dB at the time of splicing shall be re-spliced.
4. Splice shall provide three axis core alignment using light injection and loss measurement techniques.
5. No mechanical splices of fiber cable will be allowed.
6. All fusion splice equipment shall be factory serviced within the last year. Provide copies of factory service 10 days prior to splicing.
7. Maintain on site at all times, all materials necessary to immediately install temporary and/or permanent repairs to active fiber damaged during the course of work, including availability of additional splicing equipment.

K. Splicing Requirements

1. Obtain approval from the ICN Network Operations Center (NOC) prior to any splicing work.
2. Maintenance windows for splicing are restricted to Monday night through Thursday night.
3. Complete cable cuts (insertion splice locations) require 2 weeks minimum notice to the ICN NOC. Separate splicing work at insertion splice locations by a minimum of 2 weeks.
4. Multiple maintenance windows per week may be scheduled for splicing that does not impact ICN traffic depending on NOC approval.
5. Only one splicing crew is allowed per night. Multiple locations may be spliced in the same night. Notify ICN NOC prior to splicing work and upon completion of splicing before moving to the next location.
6. Prior to splicing, notify the following:
 - a. ICN NOC
 - b. Econolite (Iowa DOT Maintenance Contractor)
 - c. Iowa DOT Traffic Management Center (TMC)

L. Splicing Cutover Plan

The cutover splicing shall occur one night between 12:00 midnight and 6:00 a.m. Along with the cutover splices at each end of the new fiber optic cable, the buffer tubes for the midspan splice at 580th Street shall be broken out and the splice closure installed to accommodate the future branch splices to the camera cabinet. The splicing at HH 1-1 shall occur one night between 12:00 midnight and 6:00 a.m.

150870.04 METHOD OF MEASUREMENT.

A. Device Cabinets.

Measurement and payment for installation of device cabinets shall be paid for at the contract unit price per each for the pay item Install Pole Mount Cabinet.

B. Power Installed Foundation.

Measurement and payment for installation of power installed foundations shall be paid for at the contract unit price per each for the pay item Install Power Installed Foundation.

C. Poles.

Measurement and payment for installation of steel pole shall be paid for at the contract unit price per each for the pay item Install Steel Pole (45').

D. Wire and Cable.

Measurement and payment for all wire and cable shall be paid for at the contract unit price per linear foot for the pay items 1C No. 10 Tracer Wire, No. 6 XHHW Copper (Power), No. 6 XHHW Copper (Ground).

E. Fiber-Optic Cable.

1. Measurement and payment for all fiber-optic cable shall be paid for at the contract unit price per linear foot for the pay item 12 SM Dielectric Fiber Optic Cable and 96 SM Armored Fiber Optic Cable, Install.
2. Fiber-optic cable length is calculated from plan dimensions as the linear, one-way length of new and existing conduits. No allowance has been added to this quantity.

F. Handholes.

Measurement and payment for all handholes shall be paid for at the contract unit price per each for the pay items Handhole, Type 24"x36"x36" Handhole, Type 48"x30"x36".

G. Conduit.

1. Measurement and payment for all conduit shall be paid for at the contract unit price per linear foot for the pay items 2 Inch HDPE Conduit, Plowed and 2 Inch HDPE Conduit, Bored.
2. Conduit length is calculated from plan dimensions as the linear, one-way length of new conduits. No allowance has been added to this quantity.

H. Fiber Optic Splicing and Termination.

Measurement and payment for all fiber splicing and terminations shall be paid for at the contract unit price per each for the pay item Fiber Optic Splice Closure (With Storage Baskets), Fiber Optic Splice Tray (24), Fiber Optic Splice (With Protective Sleeves), Six Duplex SC Connector Adapter Panel, Pigtail (Includes UPS/SC Factory Terminated Connector, Splice & Protective Sleeve), and Single Panel Housing (Holds One Connector Panel With Splice Organizer).

I. Fiber Optic Acceptance Testing

The Lump Sum price for Fiber Optic Acceptance Testing shall be full compensation for providing testing equipment, testing materials, labor, test results reporting and coordination with the department.

150870.04 BASIS OF PAYMENT.

A. Device Cabinets.

Payment is full compensation for:

1. The furnishing and installation of all pole mounted cabinets,

2. Including all internal components and accessories required to provide a complete cabinet installation per the contract documents,
3. Providing and installing all mounting materials, cable pulling, routing and management, cable termination, and all necessary electric grounding materials, and
4. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

B. Power Installed Foundation.

Payment is full compensation for:

1. The installation of all power installed foundations.
2. Including all surface excavations, repair or restoration of any nearby areas.
3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

C. Poles.

Payment is full compensation for:

1. The installation of all poles and accessories,
2. Including all conduit entrances and attachments, all necessary electric grounding materials, and
3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

D. Wire and Cable.

Payment is full compensation for:

1. The furnishing and installation of all wire and cable.
2. Including the proper installation of the wire and cable into existing conduit and new conduit systems, supply and installation of splices and connectors, and slack, coiled, or stored wire or cables.
3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.
4. Prior to final acceptance, meet with the Engineer to demonstrate the locate system is working properly throughout the entire locate system.

E. Fiber-Optic Cable.

Payment is full compensation for:

1. The furnishing 12 strand dielectric fiber optic cable, testing of all cables, and installation of all cables and wire per the contract documents.
2. Furnishing all materials, labor, tools, consumable items and other incidental items necessary to meet the requirements of the contract documents.

F. Handholes.

Payment is full compensation for:

1. The furnishing and installation of all handholes.
2. Including all surface excavations, repair or restoration of any nearby areas, concrete, proper water/moisture drainage materials, all necessary electric grounding materials and installation.
3. Furnishing and installing all test stations at Handhole, Type 48"x30"x36" locations.
4. Furnishing and installing all fiber markers at Handhole, Type 24"x36"x36" locations.
5. Work associated with intercepting existing conduit to install handhole.
6. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

G. Conduit.

Payment is full compensation for:

1. The furnishing and installation of all conduits per the contract documents.
2. Including all surface excavations or surface preparation work, repair or restoration of any disturbed areas to pre-construction conditions, proper water/moisture drainage materials.
3. Conduit mounting on new or existing infrastructure.
4. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

H. Fiber Optic Splicing Termination.

Payment is full compensation for:

1. The splicing and termination of all fiber cable per the contract documents.
2. Furnishing all materials, labor, equipment, tools, and other incidental items necessary to meet the requirements of the contract documents.

I. Fiber Optic Acceptance Testing.

Payment for Fiber Optic Acceptance Testing will be paid at the lump sum contract price.

ADDITIONAL ATTACHMENT**Equipment and Materials List for Submittal Requirements.****Iowa DOT PROJECTS ITS-030-5(274)--25-85 & ITS-030-5(295)--25-85**

DESCRIPTION	MANUFACTURER	CATALOG NUMBER
HANDHOLE, TYPE 30"x17"x24"		
HANDHOLE, TYPE 24"x36"x36"		
HANDHOLE, TYPE 48"x30"x36"		
FIBER MARKER		
TEST STATION		
GROUND ROD		
EXOTHERMIC WELDING KIT		
CABINET		
HDPE CONDUIT		
DUCT PLUGS		
DUCT SEAL		
1C #10 TRACER WIRE		
TRACER WIRE SPLICE KIT		
#6 XHHW COPPER CABLE (POWER)		
#6 XHHW COPPER CABLE (GROUND)		
12 SM DIELECTRIC FIBER OPTIC CABLE		
CONTROL CABINET, PAD MOUNTED		
POLE MOUNT CABINET MOUNTING ASSEMBLIES		
OTDR METER (WITH CALIBRATION INFORMATION)		
FUSION SPLICER		
FIBER OPTIC SPLICE CLOSURE		
FIBER OPTIC 12 SPLICE TRAY		
FIBER OPTIC 24 SPLICE TRAY		
MODULE CONNECTOR HOUSING SPLICE CASSETTES (WITH SPLICE ORGANIZER)		
6 DUPLEX SC CONNECTOR ADAPTOR PANEL		
SINGLE PANEL HOUSING (HOLDS 1 PANEL WITH SPLICE ORGANIZER)		
UPC/SC FACTORY TERMINATED FIBER CONNECTOR AND PIGTAILS (INCLUDE SPLICE & PROTECTOR SLEEVE)		