SPECIAL PROVISIONS
FOR
TRAFFIC SIGNAL FIBER OPTICS

Woodbury County
IM-NHS-029-7(50)149--03-97

Effective Date
November 21, 2017

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.

150333.01 DESCRIPTION.

This Special Provision is for the furnishing and installing fiber optic cable, tracer wire, splice closures and termination panel housings as well as the splicing and final acceptance testing required to construct a fully-functioning communication system.

150333.02 SUBMITTALS.

A. Shop Drawings and Catalog Cuts.
Prior to construction, submit electronic pdf file(s) of the shop drawings or catalog cuts for the materials to the Engineer for approval. The Engineer shall review the shop drawings/catalog cuts for the purpose of assuring general conformance with the project design concept and contract documents. 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. Provide written notice of any deviations from the requirements of the plans or contract documents. The 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. Use Table 1 Equipment and Materials Submittal List as a guide for the submittal requirements.

B. Final Acceptance.
Perform all the obligations under the contract before the final acceptance of the fiber optic system. Completion of the work will be the date of approval and work acceptance on a written letter from the Engineer. Warranty begins on this date on the final acceptance form.

Final acceptance shall not constitute acceptance of any unauthorized or non-compliant Work or material. The Engineer shall not be barred from requiring the Contractor to remove, replace, repair, or dispose of any Work or material that is defective, unauthorized or that otherwise fails to

comply with the contract documents or from recovering damages for any such Work or material. Final acceptance shall not relieve the Contractor of any obligations and/or responsibilities relating to warranty requirements designated in the contract documents.

A final walk-through shall be conducted with the Engineer and with the City. As part of the walk-through, and prior to Final Acceptance, the Contractor shall locate per Iowa One-Call code all proposed infrastructure shown in the plans. The Engineer and the City will verify the proposed infrastructure locations by spot testing the tracer wire system as constructed.

C. Warranty.

The Contractor shall transfer all required standard materials warranties on the date of final acceptance to the City. Materials warranty periods shall not commence prior to final acceptance of the Work, and shall remain in effect until at least 1 year after the final acceptance for all cables and equipment furnished and installed for this project.

D. As-built Documentation.

As-built record drawings will be the responsibility of the Contractor. As such, it will be the responsibility of the Contractor to maintain a master record set of up-to-date plans throughout construction. The master record set shall document all installations and any deviations from the design shown in the contract documents. The contractor shall provided a final master record set of as-built documentation post-construction in PDF format with final digital mark-ups and notes, using a PDF editor, documenting deviations from the plan and noting additional details for as-built records. The Engineer will review and approve the final master record set of as-built documentation. The Contractor shall be responsible for submitting a final master record set of as-built documentation to the satisfaction of the Engineer.

150333.03 MATERIALS.

A. Wire and Cable.

Tracer wire shall be a single conductor, solid copper, Type XHHW, No. 12 AWG with an orange colored jacket.

B. Fiber Optic Cable.

- The cable shall meet the latest applicable standard specifications by American National Standards Institute (ANSI), Electronic Industries Association (EIA) and Telecommunications Industries Association (TIA) for the single-mode fiber cable of the size specified per the Plans.
- All fiber optic cable for installation on this project shall be provided by the Contractor and shall be Corning brand.
- Fiber optic, single-mode, graded loose tube dielectric cable constructed with industry standard 3 mm buffer tubes stranded around a central strength member.
- 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 and be colored with ultraviolet (UV) curable ink.
- The cable core shall be water blocked with dry water blocking materials to improve access and handling of individual tubes.
- 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.
- Single-mode, dispersion-unshifted fiber meeting ITUT G.652D requirements.
- The 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.
- The fiber shall be designed to provide optimum performance from 1260 nm to 1625 nm intended for 16-channel Course Wavelength Division Multiplexing applications.

- 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 swell-able tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
- The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.
- The jacket or sheath shall be free of holes, splits, and blisters.
- The cable jacket shall contain no metal elements and shall be of a consistent thickness.
- Cable jackets shall be marked with the manufacturer's name, month and year of manufacturer, sequential meter or foot markings, a telecommunication handset symbol 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.
- The maximum pulling tension shall be 600 pounds during installation (short term) and 200 pounds installed (long term).
- 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.

C. Fiber Optic Hardware.

1. Single Panel Housing.

- Surface mounted termination/splice housings shall provide for termination capabilities, splice protection, and associated fiber/pigtail storage.
- Splicing the drop cable to the pigtails in a splice closure outside of the panel housing is not allowed.
- Surface mount housing shall be intended for splicing and management, and cross-connect or both for up to 12 fibers.
- Termination adapter panels shall be duplex SC.
- Top and bottom cable entry grommets for incoming fiber, fiber jumper.
- Manufactured of metal.
- Hinged front door, universal mounting brackets, jumper bend limiters, labels for identifying fiber terminations.
- Wall mountable single panel housing shall be Corning SPH-01P and CCH adaptor panel, or approved alternate.

2. 6 Duplex SC Connector Adapter Panel.

- Termination adapter panels shall be duplex SC
- Adaptor panels should be the same manufacturer as the panel housing.

3. UPC/SC Factory Terminated Fiber Connector and Pigtail (Include Splice and Connector Sleeve).

- All fiber connectors used on this project, including in shelves, cabinets or panels, shall be factory installed connectors.
- No field terminated connectors will be allowed.
- 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.
- Fiber used for pigtails shall be of the same manufacturer as the main fiber cable.
- Pigtails shall be rated for the environment they are installed in.
- Pigtails shall be spliced in accordance with the splicing specifications and in fiber shelves or panels using manufacturer splice organizers.

4. Fiber Optic Splice Closure (with Storage Baskets).

- Fiber optic splice closures shall be rated for Outside Plant (OSP) environments.
- 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.
- 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 (including splices required for the future) are shown on the plans.
- The closures shall be a dome type splice closure manufactured from a high density polyethylene or approved alternate 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 port entries. Each cable port entry shall be able to accommodate multiple drop cables using the appropriate sealing kits.
  - 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.
- 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.
- After splicing is complete, the fiber optic cable and closure shall be flash tested for leaks.
- The splice closure shall be Comm Scope TE Connectivity, or approved alternate.

5. Duplex Fiber Optic Jumper.

- Provide fiber optic jumper connector types as indicated in the plans; LC Duplex to SC Duplex.
- Jumper ferrule shall be ceramic.
- Housing color and boot color shall be blue. Outer jacket color shall be yellow.
- Typical insertion loss shall be 0.15 dB or less.
- Proposed LC Duplex to SC Duplex Fiber Optic Jumper shall be 6.5 feet in length.

D. Locate Box.

- Provide an outdoor-rated station protector on the outside of the traffic controller cabinets.
- Run a ground wire to the main ground bar of the traffic signal controller and run the fiber locate wires to the pedestals in the station protector. All tracer wires shall be interconnected to the ground post.
- Locate box shall be TII 349-2LG or approved alternate.

150333.04 CONSTRUCTION.

A. Wire and Cable.

- Install and test for tracer wire continuity in all conduit installations as indicated on the Contract Documents. The Engineer shall witness continuity testing. The Contractor shall submit continuity test reports to the Engineer for final acceptance.
- Splicing tracer wires will not be allowed unless approved by the Engineer. Maintain solid, uncut wire continuity of the tracer wire through pulling handholes. If Engineer approved, splice tracer wires only in handholes to form a continuous network using UL tested for wet location splice kits.
- Terminate each tracer wire run at signal cabinet locate boxes and handholes in test stations.
- Place tags on all tracer wire identifying the owner and direction of the wire at each termination point and test station.

- Tags shall clearly identify cardinal direction and where each individual tracer run originated and where it ends (handhole to handhole, handhole to cabinet, handhole to building, etc.)
- Ground all installations as indicated in the contract documents.
- Installation of grounds is incidental to the cost of the connected items of work.
- 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 Iowa DOT.

B. Fiber Optic Cable

- Remove fiber optic cable from the reel in a manner acceptable to the Manufacturer and Engineer.
- Install fiber optic cable in conduit as indicated in the contract documents.
- Direct bury of fiber optic cable is not allowed.
- Do not twist or bend the fiber optic cable in excess of the limits recommended by the manufacturer.
- As the cable is fed into the duct and conduit system the Contractor shall use a manufacturer approved water-based cable lubricant for all fiber optic cable installations.
- Protect at all times all proposed cables, cable ends, and any exposed portions of fiber optic cable from damage including water intrusion.
- Any existing pull tape or tracer wire that is used as a pull rope for fiber optic cable installation shall be replaced in kind. The cost of any tracer wire or pull tape replacement shall be subsidiary to the fiber optic cable installation.
- All fiber optic cable shall be installed in conduits.
- A suitable cable feeding method shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct.
- Dynamometers and breakaway pulling swings shall be used to ensure that the pulling line tension does not exceed 600 pounds.
- The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. A pulling eye and swivel shall be attached to the cable and used to install the cable through the duct conduit system to prevent the cable from twisting.
- Cables shall not be forced around sharp corners and precautions shall be taken during installation to prevent the cable from being kinked or crushed.
- 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.
- Pulling of the cable shall be hand assisted.
- 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 and bending radii.
- The cable shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately and the Engineer notified. The Engineer shall make a determination of acceptability or shall reject the cable.
- Butt splices are not allowed, unless approved by the Engineer. The fiber cable shall be installed in continuous runs as marked on the plans. End of reel splices or butt splices not shown in the plans shall be pre-approved by the Engineer and are incidental to the cost of the installation of the cable. If approved, the end of reel or butt splices shall be performed in 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 shall be included in their respective items and shall not result in additional cost.
- No splices shall be allowed unless indicated by the plans or approved by the Engineer.
- In the event it is suspected that cable damage has occurred by the Engineer prior to final acceptance, Contractor shall test the cable with an OTDR within 72 hours after notification and submit a copy of the OTDR test to the Engineer upon completion.

- Contractor shall 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.
- Contractor shall 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.
- Any existing wiring that is damaged during fiber optic cable installation shall be replaced or repaired, as directed by the Engineer, at no additional cost to the Iowa DOT.
- Place tags on all fiber optic cable identifying the owner and direction of the cable at each termination point and in every handhole and cabinet.
- Tags shall clearly identify where each individual cable run originated and where it ends (handhole to handhole, handhole to cabinet, handhole to building, etc.).

C. Fiber Optic Hardware

- Fusion splices shall be used to splice all fiber, per the plans, in splice closures and factory terminated connector pigtails.
- Splices shall be allowed only in the splice closures and panel housings as shown on the plans.
- Maximum attenuation per splice as estimated by the fusion splicer shall not exceed 0.08 dB. Any splice exceeding 0.08 dB at the time of splicing shall be re-spliced.
- Splice shall provide three axis core alignment using light injection and loss measurement techniques.
- No mechanical splices of fiber cable will be allowed.
- All fusion splice equipment shall be factory certified within the last year. Provide copies of the certification 10 calendar days prior to splicing.

D. Locate Box

- The box shall be mounted to the exterior of the signal cabinet.
- A ground wire shall be attached to a lug within the box from the signal cabinet.
- Tracer wires shall be labeled at the termination points per this Special Provision.

E. Fiber Optic Acceptance Testing

- Submit the following documents to the Engineer for approval at least 14 calendar days prior to the acceptance testing.
  - Fiber test plan and schedule
  - Fiber cut-over plan and schedule
- Perform all testing and the fiber cut-over with the presence of the Engineer or the Engineer's representative(s).
- Post installation, 100% of the new cables' fiber count shall be tested bi-directionally with an Optical Time Domain Reflectometer (OTDR) at 1310 nm and 1550 nm; in addition, an Optical Loss Test Set (OLTS) shall be used to test all fibers at both wavelengths. Existing fibers that are spliced to or re-spliced as part of this contract shall also be tested in both directions and at both wavelengths. The Contractor shall provide the Engineer with up to five copies of any software required for viewing electronic files of the OLTS and OTDR traces. Use test equipment or alternate to EXFO FTB-500 OTDR meter, and Fluke DTX-CLT OLTS meter.
- All test equipment shall be factory certified within the last year. The Contractor shall provide copies of the certification 10 days prior to testing.
- Test results will be recorded on a form similar to the Testing Plan shown in the plans. The form will be 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. The Contractor shall submit test results in a format approved by the Engineer. Completed test forms on each fiber shall be handed over to the Engineer. Contractor shall also 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
  - Operator name
  - Date and Time
  - Setup and test parameters including wavelength, pulse width, range, scale and ambient temperature.
  - Test results for OTDR test in both directions for total fiber trace, splice loss/gain (dB), connector loss (dB), all events greater than .05 dB, measured length from cable markings and total length from OTDR.
  - Test results for attenuation test including measured cable length (cable marking), total length (from OTDR test), number of splices (from as-built) and total link end-to-end attenuation in each direction and the bidirectional average.
- OTDR testing shall use launch and receiving cables minimum 3280 feet or greater than the dead zone for the OTDR used for this test.
- All fiber connectors shall be cleaned and checked for dirt, scratches or chips before installed in adapters and testing. All dust covers shall be installed after testing is complete.
- The Contractor shall test all fibers installed prior to the fiber cut-over to the existing fiber network and connect to the existing devices. The test results shall be submitted to the Engineer for approval prior to the fiber cut-over.
- The Contractor shall verify prior to submittal to the Engineer for approval that all test results satisfy the requirements of the Contract Documents.
- The Contractor shall provide the Engineer a minimum of 4 weeks to review the test results.
  - All test results submitted to the Engineer by the Contractor are subject to reduced compensation if the test results are identified as Out of Specifications (OOS) detailed below:
  - The fiber optic cable shall have a maximum attenuation of 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm when measured with an OLTS. Fiber test results submitted to the Engineer that exceed the max attenuation loss specification will be identified as OOS and shall result in reduced compensation of $150.00 for each OOS trace.
  - Each connector shall 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 0.50 dB in a single direction or an average bi-directional loss of 0.25 dB will be identified as OOS and shall result in reduced compensation of $150.00 for each OOS trace.
  - Each splice shall have an averaged loss value of 0.08 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 0.08 dB will be identified as OOS and shall result in reduced compensation of $150.00 for each OOS trace.
- In the event of OOS, the Engineer will reject the test and notify the Contractor to retest. The Contractor shall remove malfunctioning units, replace with new units, and retest meeting the requirements specified above. The Contractor shall submit the test results for the Engineer's approval.
- The Contractor shall not begin the fiber cut-over without the approval of the fiber test results and the fiber cut-over plan from the Engineer and all parties involved. The fiber cut-over shall be performed within the allowable working hours specified in the contract documents.

150333.05 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

No measurement will be made for this work. See sheet N.27 for Bill of Material and quantity estimates. Payment for this work is include in the contract lump sum price for Traffic Signal Fiber Optics.

Table 1: Equipment and Materials Submittal List

Description	Manufacturer	Catalog Number
OTDR Meter		
OLTS Meter		
Fusion Splicer		
24 SM Fiber		
12 SM Fiber		
Tracer Wire		
Fiber Optic Splice Closure		
Adapter Panels		
Duct Seal		
Splice Trays		
Duplex Jumpers		
Connectors and Pigtails		
Single Panel Housing		