SPECIAL PROVISIONS

FOR

ITS INFRASTRUCTURE AND FIBER OPTIC CABLE INSTALLATION

Polk County
ITS-080-3(234)127--25-77

Effective Date
December 17, 019

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

150591.01 GENERAL REQUIREMENTS.

A. Description.

1. This part consists of the general provisions necessary when furnishing and installing the ITS Infrastructure as described in the project plans and these special provisions.

2. This project involves supplying and installing conduit, handholes, device poles and footings, device cabinets and footings, tracer wire and pull tape, power supplies and cabling, power terminations, serial communications cable, and fiber optic cable installation deemed necessary for a complete ITS Infrastructure installation designed for use with future proposed ITS device deployments and other uses planned by the Iowa DOT. The Iowa DOT plans to initiate separate contracts to terminate the fiber optic cable and place it in service (light the fiber network). Separate contracts will also be initiated 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.

3. The Contractor shall not take advantage of any apparent error, discrepancy or omission in the plans or specifications. Upon discovery of such an error, discrepancy or omission, the Contractor shall notify the Engineer immediately. The Engineer will then make such corrections or interpretations as necessary to fulfill the intent of the plans and specifications.

4. Materials or work described in words which, so applied, have known technical or trade meaning shall be held to refer to such recognized standards.

5. Figured dimensions on the plans shall be taken as correct but shall be checked by the Contractor before starting construction. Any errors, omissions, or discrepancies shall be brought to the attention of the Engineer and the Engineer's decision thereon shall be final.

Correction of errors or omissions on the drawings or specifications may be made by the Engineer when such correction is necessary for the proper execution of the work.

6. The Contractor for this project shall coordinate work with the Contractor(s) working on the fiber optic cable termination and device deployment projects. The Iowa DOT will assist in the coordination and scheduling of work. The Contractor for this project shall assign a responsible staff member that will work with the Iowa DOT on decisions regarding order of work and scheduling as needed throughout the duration of this project.

B. Related Specifications and Standards.

The work as detailed on the plans for the ITS Infrastructure Installation shall be completed in accordance with the plans, special provisions and all other Contract Documents including the documents listed below. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete project.

- Specifications of the Underwriter's Laboratories, Inc.
- National Electrical Code
- Manual on Uniform Traffic Control Devices

C. Local Requirements.

1. Coordination of Work.

Contractor for this project shall coordinate work with the Contractor(s) working on other Iowa DOT projects in the vicinity as noted in Tab 111-01, Coordinated Operations, on the C-Sheets of the plans. The Contractor shall provide the Engineer any requests to perform work during the dates of special events noted in Tab 102-15 on the C-Sheets of Tied Project (184) a minimum of 5 days prior to the event. The decision of the Engineer regarding a request shall be final.

2. Building Facilities.

All work in or around any building facility shall be coordinated with the Engineer and the Iowa DOT District staff. Provide a minimum of 48 hours notice to the Engineer before performing any work in the immediate vicinity of a building or surrounding parking area.

D. Contractor's Responsibility.

1. Coordination with Utilities.

a. The Contractor is responsible for determining the exact location and elevation of all public utilities in proximity to any construction work and shall conduct all activities to ensure that public utilities are not disturbed or damaged.

b. The Contractor is fully liable for all expenses incurred as a result of failing to obtain required clearances, location of utilities, and any damage to utilities caused by construction.

c. Utility companies whose facilities are shown on the plans or known to be within the construction limits shall be notified by the Contractor of the starting construction date.

2. One Call Locating.

Until final acceptance, the Contractor shall provide all utility locates of the work performed under this contract when requested through One-Call services or by the Engineer. The Contractor shall perform any such locations within 24 hours of receiving notice that such locations are needed.

3. Material and Equipment Storage and Construction Site Access.

a. Contractor shall secure a designated material storage area for this project. Any request to store material in the right-of-way in order to complete the current work activity shall be approved by the Engineer.

b. Construction equipment may be stored within the right-of-way during non-working hours if

it is outside of the roadway clear zone, as far from the traveled way as practical and as approved by the Engineer. No equipment shall be stored at the toe of any roadway slope.

c. No worker vehicles will be allowed to park in, or access a job site directly from an Interstate or Freeway facility. Access to the job site for both workers and materials shall only be via interchanges or intersecting roadways unless otherwise approved by the Engineer. Worker vehicles shall be parked off-site or at a location acceptable to the Engineer

4. Finishing Activities.

Upon completion of the work at each project area, thoroughly clean the site and restore it to a condition at least equal to that existing prior to construction. Project area is defined as the approximate area disturbed during a normal week of work. During and after completion, employ appropriate measures for erosion control, where applicable. Seed and fertilize work areas upon completion of work in accordance with the contract documents.

E. Contractor Submissions.

1. Materials List.

The Engineer shall furnish a list of materials required for the project to each bidder with the proposal. 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, the Contractor shall 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 are installation of conduit, handholes, device poles and footings, device cabinets and footings, and electrical installations.

c. Upon acceptance of the schedule, the Contractor will be expected to 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 the Contractor can commence construction activities.

3. Shop Drawings/Catalog Cuts.

a. Prior to construction and after approval of the Materials List, submit one electronic pdf file of the shop drawings or catalog cuts for the materials to the Iowa DOT for approval.

b. The Engineer shall review the shop drawings/catalog cuts for the purpose of assuring general conformance with the project design concept and contract documents.

c. Provide written notice of any deviations from the requirements of the plans or contract documents.

d. 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. Shop drawings, specification data, and samples for acceptance testing (when requested) shall be submitted to the Iowa DOT for approval and/or selection prior to the placing of orders for any equipment and materials.

b. The Contractor shall order all materials requiring production lead-time greater than 4 weeks within 5 business days of receiving the approved shop drawing(s).

c. The Contractor shall 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.

F. As-Built Documentation.

1. General.

a. As-built record drawings will be the responsibility of, and completed by, an on-site representative of the Engineer. As such, it will be the responsibility of the Engineer's representative 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. It is the responsibility of the Contractor to maintain written records of daily construction progress, areas worked and quantities installed to aid in the completeness of as-constructed documentation by the Engineer's on-site representative.

2. GPS Data Recording Staking Assistance.

a. The Engineer's on-site representative will be responsible for collecting GPS data of all installations including, but not limited to: conduit routing, handholes, device poles, device cabinets, and power supplies. All efforts will be made by the Engineer's on-site representative to coordinate with the Contractor and collect construction progress daily.

b. The Contractor shall be responsible to coordinate and assist the Engineer's on-site representative in this effort by staking, flagging or otherwise locating all installed features until such time that the GPS data can be collected.

150591.02 MATERIALS.

A. General.

Supply only new materials from reputable suppliers and manufacturers approved by the Engineer. 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 UL-approved. Securely store and protect all materials delivered to the project site. Provide appropriate material quantities for testing or verification at no additional cost when requested by the Engineer.

B. Device Cabinets.

1. Pole Mounted ITS Device Cabinets.

a. General.

1) Cabinets shall be dimensioned as identified in the Contract Documents.

2) Cabinets shall be corrosion resistant, NEMA Type 3R compliant, constructed of welded sheet aluminum with a minimum nominal thickness of 1/8 inch.

3) Cabinets shall be complete with all required internal components, fully wired back panel, side mount DIN rails, terminal strips, and stainless steel hardware.

4) Cabinets shall meet the requirements of ASTM B-209 for 5052-H32 aluminum sheet. The aluminum shall be smooth and the exterior shall be left in its unpainted natural color.

5) All exterior seams for cabinet and doors shall be continuously welded.

6) Cabinets shall be equipped with top and bottom mounting brackets and include pole mounting reinforcement/stiffener plates as part of the cabinet design. Mounting brackets shall be fabricated from 0.250 inch thick aluminum, 5052-H32, mill finish

b. Cabinet Doors.

1) The cabinet door shall be sturdy, torsionally rigid, and attached by a continuous heavy-duty stainless steel butt hinge. The door shall substantially cover the full area

of the front of the cabinet and have a stainless steel, pad-lockable handle.

2) The cabinet door shall be provided with a doorstop catch mechanism to hold the door open at three positions; 90 degrees, 120 degrees and 180 degrees. Both the door and doorstop mechanism shall be of sufficient strength to withstand a wind load of five pounds per square foot of door area applied to both inside and outside surfaces.

3) A neoprene gasket shall be provided to act as a permanent and weather resistant seal at the cabinet door facing. The gasket material shall be of a non-absorbent material and shall maintain its resiliency after long-term exposure to the outdoor environment. The gasket shall have a minimum thickness of 1/3 inch. The gasket shall be located in a channel provided for this purpose either on the cabinet or on the door. An "L" bracket is acceptable in lieu of this channel if the gasket is fitted snugly against the bracket to insure a uniformly dust and weather resistant seal around the entire door facing.

4) LED cabinet light shall be provided and operated by door switch.

5) Each cabinet door shall be provided with a high quality, heavy-duty tumbler-type lock. Two, No. 2 keys for each tumbler lock shall be provided for each cabinet. All locks for the project shall be keyed identically to key pattern 9R46142 or as otherwise identified by the Iowa DOT. Keys shall be given to the Iowa DOT. Do not attach keys to the exterior of the cabinet at any time during storage or installation.

6) A heavy-duty clear plastic envelope shall be provided, securely attached to the cabinet door via welded hooks, for stowing cabinet wiring diagrams and equipment manuals. Minimum dimensions shall be 9 inches wide by 12 inches deep.

c. Electrical Components and Wiring for 120 VAC Power Source.

1) One four-position service entrance terminal block with tin plated aluminum connectors, nickel-plated steel screws, and a current rating up to 70 Amps.

2) One 20 Amp single pole breaker (Main).

3) One 15 Amp single pole breaker (Equipment).

4) One 15 Amp single pole breaker (Auxiliary).

5) One 120/240 VAC surge protector with surge current at minimum of 100 KA, nanosecond response time, and an operating temperature of -40°F to +185°F.

6) One auxiliary four-terminal electrical block rated for a maximum 250 VAC RMS maximum voltage and 20 Amps current.

7) One 15 Amp GFCI duplex receptacle Ivory in color.

8) Space for one eight-outlet Power Distribution Unit by others.

9) One seven TAP Ground Bar.

10) One seven TAP Neutral Bar.

11) All miscellaneous wiring, harnesses connectors and attachment hardware.

12) All conductors used in the cabinet wiring shall be No. 14 AWG or larger with a minimum of 19 strands. Conductors shall conform to MIL SPEC MIL-W-168780, Type B or D. The insulation shall have a minimum thickness of 10 MILS. All wiring containing line voltage shall be a minimum size of No. 12 AWG.

d. Electrical Components and Wiring for Other Than120 VAC Power Source.

The device cabinet internal electrical components and wiring shall remain the same as described above for 120 VAC Power Source. Add the following components to accommodate a 240 VAC or 480 VAC power source feed to the device cabinet as indicated on the plans.

1) Provide a NEMA 3R aluminum or stainless steel, 30 Amp, 480 VAC, heavy duty fused disconnect. Mount on exterior side of device cabinet below transformer. Provide 15 Amp time-delay fuses for a 240 VAC power feed or, 10 Amp time-delay fuses for a 480 VAC power feed.

2) Provide a NEMA 3R sealed 3kVA single-phase transformer with 240 x 480 V primary and 120 x 240 V secondary. Mount on exterior side of device cabinet above fused disconnect. Configure primary connections appropriately for connected source voltage. Configure secondary for 120V output to device cabinet.

3) Conduit and fittings between disconnect and transformer, and from transformer into device cabinet shall be rigid aluminum.

4) Conductors used to connect the disconnect to the transformer and connect the transformer to the internal service entrance terminal block shall be minimum #12 AWG type THWN or XHHW stranded copper.

e. Ventilation.

1) Vents.

a) Furnish cabinets containing a suitably designed rain tight vent or vents that:

- Are equipped with suitable screens or dust filters, and
- Allow the release of excessive heat and/or any explosive gases, which may enter the cabinet.

b) Ensure when filters are utilized, positive retainment is provided on all sides to prevent warpage and entry of foreign matter around the edges.

c) The filters shall be dry type, easily removed and replaced, and standard dimensions commercially available.

2) Vent Fan.

Meet the following requirements:

a) A thermostatically controlled vent fan is furnished to provide air circulation within the cabinet.

b) The thermostat controlling the fan is manually adjustable to turn on between 90°F and 150°F with a differential of not more than 10°F between automatic turn on and turn off.

c) The fan is located with respect to the vent holes to direct the bulk of the airflow over the internal components within the cabinet.

d) Ventilation fan shall be fused separately and wired after the main AC+ circuit breaker.

f. Grounding.

1) The cabinet internal ground shall consist of one or more ground bus bars permanently affixed to the cabinet and connected to the grounding electrode.

2) Use bare stranded No. 6 AWG copper wire between bus bars and between the bus-bar and grounding electrode.

3) Each copper ground bus bar shall have a minimum of 20 connector points. Each connector point shall be capable of securing at least one No. 6 AWG conductor.

4) AC neutral and equipment ground wiring shall return to bus bars.

2. Pedestal Mounted ITS Device Cabinets.

a. General.

1) Device cabinet shall be constructed for ground mounting and have an open bottom.

2) Cabinets shall be dimensioned as identified in the Contract Documents.

3) Cabinets shall be corrosion resistant, NEMA Type 3R compliant, constructed of welded sheet aluminum with a minimum nominal thickness of 1/8 inch.

4) Cabinets shall be complete with all required internal components, fully wired back panel, side mount DIN rails, terminal strips, and stainless steel hardware.

5) Cabinets shall meet the requirements of ASTM B-209 for 5052-H32 aluminum sheet. The aluminum shall be smooth and the exterior shall be left in its unpainted natural color.

6) All exterior seams for cabinet and doors shall be continuously welded.

b. Cabinet Doors.

1) The cabinet door shall be sturdy, torsionally rigid, and attached by a continuous heavy-duty stainless steel butt hinge. The door shall substantially cover the full area of the front of the cabinet and have a stainless steel, pad-lockable handle.

2) The cabinet door shall be provided with a doorstop catch mechanism to hold the door open at three positions; 90 degrees, 120 degrees and 180 degrees. Both the door and doorstop mechanism shall be of sufficient strength to withstand a wind load of five pounds per square foot of door area applied to both inside and outside surfaces.

3) A neoprene gasket shall be provided to act as a permanent and weather resistant seal at the cabinet door facing. The gasket material shall be of a non-absorbent material and shall maintain its resiliency after long-term exposure to the outdoor environment.

The gasket shall have a minimum thickness of 1/3 inch. The gasket shall be located in a channel provided for this purpose either on the cabinet or on the door. An "L" bracket is acceptable in lieu of this channel if the gasket is fitted snugly against the bracket to insure a uniformly dust and weather resistant seal around the entire door facing.

4) LED cabinet light shall be provided and operated by door switch.

5) Each cabinet door shall be provided with a high quality, heavy-duty tumbler-type lock. Two, No. 2 keys for each tumbler lock shall be provided for each cabinet. All locks for the project shall be keyed identically to key pattern 9R46142 or as otherwise identified by the Iowa DOT. Keys shall be given to the Iowa DOT. Do not attach keys to the exterior of the cabinet at any time during storage or installation.

6) A heavy-duty clear plastic envelope shall be provided, securely attached to the cabinet door via welded hooks, for stowing cabinet wiring diagrams and equipment manuals. Minimum dimensions shall be 9 inches wide by 12 inches deep.

c. Electrical Components and Wiring for 120 VAC Power Source.

Provide cabinets equipped and configured with internal power components as shown in the plans and listed below.

1) One four-position service entrance terminal block with tin plated aluminum connectors, nickel-plated steel screws, and a current rating up to 70 Amps.

2) One 20 Amp single pole breaker (Main).

3) One 15 Amp single pole breaker (Equipment).

4) One 15 Amp single pole breaker (Auxiliary).

5) One 120/240 VAC surge protector with surge current at minimum of 100 KA, nanosecond response time, and an operating temperature of -40°F to +185°F.

6) One auxiliary four-terminal electrical block rated for a maximum 250 VAC RMS maximum voltage and 20 Amps current.

7) Space for one eight-outlet Power Distribution Unit by others.

8) One 15 Amp GFCI duplex receptacle Ivory in color.

9) One seven TAP Ground Bar.

10) One seven TAP Neutral Bar.

11) All miscellaneous wiring, harnesses connectors and attachment hardware.

12) All conductors used on the cabinet wiring shall be No. 14 AWG or larger with a minimum of 19 strands. Conductors shall conform to MIL SPEC MIL-W-168780, Type B or D. The insulation shall have a minimum thickness of 10 MILS. All wiring containing line voltage shall be a minimum size of No. 12 AWG.

d. Electrical Components and Wiring for Other Than 120 VAC Power Source.

The device cabinet internal electrical components and wiring shall remain the same as described above for 120 VAC Power Source. Add the following components to accommodate a 240 VAC or 480 VAC power source feed to the device cabinet as indicated on the plans.

1) Provide a NEMA 3R aluminum or stainless steel, 30 Amp, 480 VAC, heavy duty fused disconnect. Mount on exterior side of device cabinet below transformer. Provide 15 Amp time-delay fuses for a 240 VAC power feed or, 10 Amp time-delay fuses for a 480 VAC power feed.

2) Provide a NEMA 3R sealed 3kVA single-phase transformer with 240 x 480 V primary and 120 x 240 V secondary. Mount on exterior side of device cabinet above fused disconnect. Configure primary connections appropriately for connected source voltage. Configure secondary for 120V output to device cabinet.

3) Conduit and fittings between disconnect and transformer, and from transformer into device cabinet shall be rigid aluminum.

4) Conductors used to connect the disconnect to the transformer and connect the transformer to the internal service entrance terminal block shall be minimum #12 AWG type THWN or XHHW stranded copper.

e. Ventilation.

1) Vents.

a) Furnish cabinets containing a suitably designed rain tight vent or vents that:
- Are equipped with suitable screens or dust filters, and
- Allow the release of excessive heat and/or any explosive gases, which may enter the cabinet.

b) Ensure when filters are utilized, positive retainment is provided on all sides to prevent warpage and entry of foreign matter around the edges.

c) The filters shall be dry type, easily removed and replaced, and standard dimensions commercially available.

2) Vent Fan.

Meet the following requirements:
- A thermostatically controlled vent fan is furnished to provide air circulation within the cabinet.
- The thermostat controlling the fan is manually adjustable to turn on between 90°F and 150°F with a differential of not more than 10°F between automatic turn on and turn off.
- The fan is located with respect to the vent holes to direct the bulk of the airflow over the internal components within the cabinet.
- Ventilation fan shall be fused separately and wired after the main AC+ circuit breaker.

f. Grounding.

1) The cabinet internal ground shall consist of one or more ground bus bars permanently affixed to the cabinet and connected to the grounding electrode.

2) Use bare stranded No. 6 AWG copper wire between bus bars and between the bus-bar and grounding electrode.

3) Each copper ground bus bar shall have a minimum of 20 connector points. Each connector point shall be capable of securing at least one No. 6 AWG conductor.

4) AC neutral and equipment ground wiring shall return to bus bars.

g. Pedestal.

1) Supply cabinet pedestals, clean-cut in design and appearance to match cabinet.

2) Cabinet pedestals shall be dimensioned as identified in the Contract Documents.

3) Cabinet pedestals shall be corrosion resistant, NEMA Type 3R compliant, constructed of welded sheet aluminum with a minimum nominal thickness of 1/8 inch.

4) Cabinet pedestals shall be complete with all stainless steel hardware.

5) Cabinet pedestals shall meet the requirements of ASTM B-209 for 5052-H32 aluminum sheet. The aluminum shall be smooth and the exterior shall be left in its unpainted natural color.

6) All exterior seams for cabinet pedestals shall be continuously welded. All edges shall be filed to a radius of 1/32 inch minimum.

C. Cabinet Footings.

All concrete shall meet the requirements of Section 2403 of the Standard Specifications. Use Class C concrete for cabinet footings and all other non-paving concrete construction.

D. Power Installed Foundation.

1. All device pole footings shall be power installed foundations.

2. All materials shall meet the requirements listed in the design details of the plans sheets.

E. 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 0.024 inches per foot of length of box when installed and subject to an ASTM C-857 TIER 22 load.
f. Handholes shall meet ANSI/SCTE 77 standards and be verified by a registered third party and stamped by a registered Professional Engineer.
g. Handhole lid strength shall be tested to 22,500 pounds (Tier 15).
h. Handhole lids shall be labeled as indicated in the plans or as directed by the Engineer.
i. The Engineer shall provide approval prior to use of any handholes satisfying the contract documents requirements for structural, physical, and chemical properties.

2. Test Stations.
a. Supply Rhino part TVTI60OB5 or approved equivalent test stations at all Type Fiber Vault handholes unless noted/excluded otherwise on the plans.
b. Test Stations shall be 60-inch triangular flexible orange plastic marker with five separate access terminals and set screw to hold terminal concealment cap on.
c. Place custom warning decals on all sides, the Engineer shall provide prior approval of decals.

F. Conduit.

1. Galvanized Rigid Steel Conduit.
a. Galvanized Rigid Steel conduit (GRS) shall be galvanized steel meeting the requirements of ANSI Standard Specification C80.1.
b. All applicable requirements stated in Articles 2523.03, N and 4185.10 of the Standard Specifications shall be met.

2. Polyvinyl Chloride Conduit.
Polyvinyl chloride (PVC) conduit shall be GRAY rigid (e.g. Schedule 40) polyvinyl chloride meeting the requirements of NEMA TC-2, Type 2, and applicable UL Standards.

3. High Density Polyethylene conduit.
a. High Density Polyethylene (HDPE) conduit shall be smooth wall ORANGE
b. HDPE shall be SDR 13.5 minimum and meet or exceed ASTM D3035/F2160/NEMA TC-7 EPEC-B standards.
c. HDPE shall be manufactured from thermoplastic polymer conforming to the minimum standard of PE334470E/C as defined in ASTM D3350.
d. Sequential foot markings should be printed on HDPE.
e. A custom message of stated material specifications that product meets shall be printed a minimum of every 10 feet on conduit.
f. Conduit shall be UL 651 listed.

G. Poles.
Furnish all work, apparatus, and materials to construct and install the device poles designed to mount future ITS equipment to as required for the planned ITS system. Specific poles are required to have lowering device equipment to facilitate access. These poles are only required at the locations clearly specified in the plan sheets.

1. General.
a. All poles shall be tapered steel poles, 45 feet in length (excluding the transformer base).
b. Poles shall satisfy the Buy America requirements of Article 1107.06 of the Standard

Specifications.

c. The poles shall be designed to satisfy deflection requirements.

d. The poles shall be provided with two handholes with removable covers. The handhole openings shall be reinforced with a minimum 0.432 inch wide hot rolled steel rim. The first handhole shall be located 1.5 feet above the base plate (measured from bottom lip of handhole) and have minimum outside dimensions of 6 inches by 10 inches. The second handhole shall be oriented directly above the first handhole but located 40 feet above the baseplate (measured from bottom lip of handhole) and have minimum outside dimensions of 3 inches by 5 inches.

e. Ensure each pole has an approved grounding provision for use during installation and that it is accessible and will function as intended after the galvanization process. Ensure the grounding lug is readily accessible through the handhole and from the bottom of the pole shaft.

f. Poles shall include a removable end cap at the top of the pole with a J-hook cable support above the upper handhole.

g. Ensure the poles and base plates are hot dip galvanized inside and out according to ASTM A123.

h. Unless otherwise noted in this specification, materials shall meet the applicable minimum requirements of Section 4185 of the Standard Specifications.

2. Pole Design Calculations and Fabrication Specifications.

a. All poles shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2013.

b. The device loadings specified in this document shall be used in all AASHTO design calculations and pole deflection evaluations and the poles shall be capable of withstanding winds up to 90 mph with a 1.14 gust factor without failure utilizing the device loadings specified. Calculations and detailed drawings shall be submitted demonstrating compliance with the AASHTO specification.

c. All materials and products shall be manufactured in the United States of America, and comply with ASTM or AASHTO specifications. Mill certifications shall be supplied as proof of compliance with the specifications. The Fabricator shall be certified under Category I, "Conventional Steel Structures" as set forth by the American Institute of Steel Construction Quality Certification Program. Proof of this certification will be required to ensure that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality pole structures. All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) D1.1 Structural Welding Code. Tackers and welders shall be qualified in accordance with the code. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt- welded pole and arm splices shall be ultrasonically or radiographically inspected.

d. All poles shall be designed to support the specified camera, sensor and device cabinet and shall be stiffened or otherwise manufactured to meet allowable deflection criteria contained herein. Pole design shall assume the following loadings. All mounting heights are measured from the base of foundation to bottom of equipment.

Radio Communication Equipment and Mounting Bracket
Weight: 10 pounds
Surface Area: 3 square feet
Mounting Height: 44 feet

Camera and Mounting Bracket
Weight: 12 pounds
Surface Area: 1.5 square feet
Mounting Height: 40 feet

Roadway Sensor
Weight: 4.2 pounds
Surface Area: 1.5 square feet
Mounting Height: 25 feet

Device Cabinet
Weight: 600 pounds
Surface Area: 6 square feet
Mounting Height: 5 feet

Camera Lowering Device
Weight: 130 pounds
Surface Area: 3.0 square feet
Mounting Height: 44 feet

e. The pole top deflection shall not exceed 1 inch in a 30 mph (non-gust) wind. Close consideration must be given to the effective projected area of the equipment along with the weight when designing the pole to meet the specified deflection performance criteria. The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base, at 5-foot pole intervals/segments and at any other critical pole section. At each of these locations, the following information shall be given:

1) The pole's diameter, thickness, section modulus, moment of inertia, and cross sectional area.

2) The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each pole segment.

3) The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio (CSR).

4) The pole's angular and linear deflection.

f. All pole shafts shall have a minimum yield strength of 55 ksi and conform to ASTM A595 Grade A or ASTM A572 Grade 55. The shaft shall have a constant linear taper and contain only one longitudinal seam weld. Circumferential welded tube butt splices and laminated tubes are not permitted. Longitudinal seam welds within 6 inches of base plate welds shall be complete penetration welds.

g. Base plates shall conform to ASTM A36. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar.

h. Anchor Bolts.

1) Anchor bolts shall conform to the requirements of ASTM F1554 Grade 105 S4, be full- length galvanized according to ASTM F2329 (with zinc bath temperature limited to 850oF) or ASTM B695 Class 55 Type 1, and be Unified Coarse Thread Series with Class 2A tolerance. The use of J Bolt anchors is not allowed as anchor bolts shall be straight rods with a nut or a nut and a plate on the bottom threaded end of each rod. Each anchor bolt shall be supplied with three hex nuts and two flat washers. The nuts shall be heavy hex and meet the requirements of ASTM A563 Grade DH or ASTM A194 Grade 2H. Washers shall meet the requirements of ASTM F436. Nuts and washers shall be galvanized according to the requirements of ASTM F2329 (with zinc bath temperature limited to 850oF) or ASTM B 695 Class 55 Type I.

2) Substitution of ASTM A194 Grade 2H nuts for ASTM A563 Grade DH nuts may be requested if availability of ASTM A563 Grade DH is limited due to the “Buy America” requirements.

3) Galvanizing of anchor bolts, nuts and washers according to ASTM F2329 or ASTM B695 Class 55 Type 1 is allowable. However, per Article 4187.01, C, 3, d of the Standard Specifications, the entire anchor bolt assembly is to be galvanized by the same zinc-coating process.

3. **Transformer Base.**
   - **a.** Steel with top and bottom plates conforming to ASTM A36 and walls conforming to ASTM A595 Grade A with a minimum yield strength of 55 ksi.
   - **b.** Transformer base shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2013.
   - **c.** Transformer bases need to be designed to be structurally adequate to support the pole loadings.
   - **d.** Equipped with a weatherproof access door with door opening area of no less than 100 square inches.

4. **Submittal.**
   - **a.** Submittal shall include all structural calculations and be accompanied by a shop drawing that at a minimum illustrates a schematic of the proposed pole and transformer base with a summary of the design criteria, material data, pole data and details of handholes, pole top, pole base and pole orientation.
   - **b.** Design calculations shall be sealed by a registered Professional Engineer from the State of Iowa.

H. Wire and Cable.

1. **RS-485 Serial Communication Cable.**
   - **a.** 3-conductor, twisted, shielded pair for use on RS-485 serial communication applications.
   - **b.** Cable shall be rated for wet-location installation in underground conduit.
   - **c.** Conductors shall be minimum No. 24 AWG insulated. Shielding shall be over-all aluminum foil with No. 24 AWG drain wire.
   - **d.** Project application length of run: 0 to 2000 feet maximum.
   - **e.** Acceptable Manufacturers: Belden, Berk-Tek, or Approved equivalent.

2. **Tracer Wire.**
   Single conductor, stranded copper, Type THHN, No. 12 AWG with UL approval and green colored jacket.

3. **Pull Tape.**
   Sequentially numbered with a minimum proper tensile strength of 2670 N

4. **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.

I. Fiber Optic Cable.

1. **General.**
   - **a.** 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.
   - **b.** All fiber-optic cable for installation on this project shall be provided by the Contractor.
   - **c.** The Contractor shall provide the Engineer the manufacturer's production test provided with the spool.
   - **d.** The Contractor shall provide the Iowa DOT with documentation of wasted cable.
   - **e.** 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.
   - **f.** The cable core shall be water blocked with dry water blocking materials to improve

access and handling of individual tubes.

g. 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.

h. 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.

i. 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.

j. The optical fiber shall be manufactured by Corning, OFS or Draka.

k. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

l. The jacket or sheath shall be free of holes, splits, and blisters.

m. 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.

n. The maximum pulling tension shall be 600 pounds during installation (short term) and 200 pounds installed (long term).

o. 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 – 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.

3. Single-Mode, Fiber-Optic OSP Cable – Single Armored Loose Tube.

a. Fiber-optic, single-mode, graded loose tube Armored cable constructed with industry standard 2.5 mm buffer tubes stranded around a central strength member.

b. Single-mode, dispersion-unshifted fiber meeting ITUT G.652D requirements.

c. Armored cables shall have an armor layer applied directly over the water swellable tape and cable core. The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied around the outside of the water swellable tape and cable core with an overlapping seam with the corrugation in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be sheathed with MDPE. The minimum nominal jacket thickness shall be 1.3 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

150591.03 CONSTRUCTION.

A. General.

The Contractor shall expect some reasonable variation in location of the facilities shown due to unforeseen conflicts, changes in proposed work, installation difficulties, or other circumstances. The Engineer shall authorize any changes in location in writing before performing the installation. No additional compensation shall be provided for additional work associated with or resulting from unauthorized changes to the contract documents.

B. 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 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. Orientate 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 controller cabinet with a sealing compound that meets the following requirements:

1) Readily workable, soft plastic

2) Workable at temperatures as low as 30°F, and

3) Does not melt or run at temperatures as high as 300°F.

d. Do not install the controller cabinet on preplaced caulking material on the concrete base or place caulking material around the base of the cabinet after installation.

C. Cabinet Footings.

a. General.

a. Install cabinet footings in accordance with the contract documents and the manufacturer's recommendations.

b. All cabinet footings shall include a full depth 4 feet concrete maintenance pad area that is cast and reinforced as a single unit with the cabinet footing.

c. Prepare and submit for Engineer approval, design plans and details for all cabinet footings at no additional cost to the Engineer. Such plans and details shall be sealed by a professional engineer licensed in the State of Iowa.

d. Contact the Engineer a minimum of 1 week in advance to arrange a field review prior to placing the cabinet footing.

e. Notify the Engineer immediately if an obstruction conflicts with a footing. The Engineer is responsible for relocating or determining another effective means of supporting the structure to eliminate the conflict. Payment shall not be made for re-work or extra work as the result of an unauthorized relocation of a footing.

b. Installation Details.

a. Construct all footings as located by the Engineer. Securely rest all footings on firm undisturbed ground and set level and to the proper elevation.

b. Form the upper portion of all concrete footings and for all instances where the excavation is irregular in shape to provide the proper dimensions. Forming materials shall be level and braced to avoid displacement, warping, or deflection from the specified pattern during construction and curing.

c. Install and secure anchor bolts, conduits, and reinforcement before concrete placement. Use a rigid template to position anchor bolts in accordance with the appropriate pattern. The center of the template and the center of the concrete base shall coincide unless otherwise directed by the Engineer.

d. Install a sufficient number of conduits sized as indicated in the contract documents. All conduits shall be located as indicated in the contract documents.

e. Place all concrete within 90 minutes of batching and consolidate using a high-frequency

vibrator during construction.

f. Modification of a footing after construction is not allowed.

g. Cover all anchor bolts to protect them against damage and to protect the public from possible injury until erecting poles.

h. Allow a minimum of 7 calendar days curing of concrete footings before setting cabinets.

c. Improper Construction.

Remove and reconstruct, at no additional cost to the Engineer, all footings improperly constructed or with improperly installed anchor bolts, conduit, or any other footing components as determined 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 1 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 is responsible for relocating or determining another effective means of supporting the structure to eliminate the conflict. Payment shall 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.

d. Modification of a footing after construction is not allowed.

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. Handholes.

1. Install the type and size of handholes at the locations indicated in the contract documents.

2. Construct all Type Fiber Vault handholes as located by the Engineer.

3. Set handholes flush with the surface when constructing in a sidewalk or driveway. Set handholes approximately 1 inch above the finished surface of the surrounding ground when constructing in an earth embankment or non-paved surface.

4. Install course aggregate bedding to a depth of 1 foot below the handhole.

5. Conduit shall enter the handhole from the bottom and extend conduit ends between 4 and 6 inches above the aggregate bedding.

6. Side penetrations of the handholes are not permitted.

7. Terminate each tracer wire run in test stations at Handhole Type Fiber Vault locations.

8. Install ground rods at all Type Fiber Vault handholes as indicated in the contract documents.

9. Plug all open conduit ends within the handhole in a manner acceptable to the Engineer.

10. Rodent proof all handholes to the satisfaction of the Engineer.

F. Conduit.

1. General.

a. Follow all general guidelines covering the construction of buried conduit.

b. Install conduit by plowing, jacking, pushing, boring, structure attachment 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, pole, 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 documents 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. Thread and cap with standard pipe caps all rigid steel conduit ends until installing wiring. Per Article 2523.03, N of the Standard Specifications replace caps with approved conduit bushing during and after wire installation.

k. Seal all conduit openings using an approved sealing compound (duct seal) at all conduit openings at the junction boxes handholes, poles, cabinets, and building entrances.

2. Installation Clearances.

Depth of all bores shall be a minimum of 48 inches unless otherwise specified in the plans.

a. Unless otherwise indicated, install all conduit at rail crossings at a minimum of 15 feet below base of rail or 15 feet below natural ground line, whichever is greater.

b. Maintain the minimum depth throughout the length of all conduit installations.

c. Maintain a minimum of 2 feet of separation when underground conduits parallel an existing facility.

3. Conduit Splicing.

a. All mechanically joined conduit splices shall use compression couplings designed for underground placement and blown-in fiber installation.

b. Electrofusion joining of HDPE conduit will be allowed provided that method used does not create a ridge on the inside of the conduit that may impact future fiber installation.

c. Butt fusion welding and solvent welding of conduits will not be allowed.

d. All conduit splices shall be watertight to 200 psi.

e. Conduit splicing is incidental to the connected items of work.

4. Facilities Protection.

a. The contractor is responsible for protecting and maintaining 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. Exposed Installations.

a. Use hot-dipped galvanized rigid steel conduit (GRS) for all exposed or aboveground areas along the project. Watertight flexible steel conduit and fittings will be allowed for cabinet connections when approved by the Engineer.

b. Support exposed conduit and place steel conduit hangers at intervals indicated in the contract documents, NEC, and as directed by the Engineer.

c. Accomplish attachments to bridges or structures using approved galvanized beam clamps and hangers.

d. Install approved expansion joints at all bridge structure joints.

e. Install approved restrainer brackets at each expansion joint and at mid-points of expansion joints.

f. Alterations to specific attachment methods or fastener designs are subject to approval of the Engineer before installation and any additional costs are incidental to the work performed.

6. Galvanized Rigid Steel Conduit Bends and Connections.

a. Perform bending in a manner that does not injure or change the internal diameter of the conduit, with a uniform curvature, and a minimum inside radius of 12 inches.

b. Accomplish change in direction of steel conduit by bending or installing a junction box.

c. Cut and thread steel conduit to eliminate exposed threads after completing connections. Tighten all couplings until the adjoining conduit ends meet to allow a continuous inner surface throughout the entire length of the conduit run.

d. Remove all burrs and roughened surfaces from conduits and fittings.

e. Ream, clean, and swab all conduit runs before installation.

f. Use nipples to eliminate cutting and threading short lengths of conduit.

g. Paint damaged galvanized finishing on conduits, poles, structures, or other galvanized surfaces using a zinc-rich paint acceptable to the Engineer.

h. Use only galvanized steel fittings with rigid steel conduit.

7. 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 exceed4 inches in loose thickness. Use a suitably sized mechanical tamper for all areas inaccessible to rollers. Operate pneumatic or other mechanical tampers in accordance with the manufacturer's recommendations.

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.

i. 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.

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

9. 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 Engineer.

10. 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.

11. 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 borehole 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.

G. Poles.

1. General.

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.

3. Camera Lowering System.

a. The camera-lowering device manufacturer shall have a minimum of 3 years of experience in the successful manufacturing of camera lowering systems and upon request will identify a minimum of three completed projects where the purposed system has been installed and successfully utilized for at least 1 year.

b. The lowering device manufacturer shall furnish a factory representative to assist with the assembly and testing of the first lowering system onto the pole assembly. The manufacturer shall furnish to the Iowa DOT acceptable documentation regarding the installation, operation, maintenance requirements, and safety features of the lowering device.

c. The lowering device shall be integrated with/mounted to a device pole meeting the design criteria and specifications as described above in this section.

d. Acceptable Lowering Device Manufacturer: MG Squared, No Substitutions.

H. Wire and Cable.

1. General.

a. All installations and connections shall comply with the contract documents and all generally accepted codes and standards.

b. Install cable connectors in accordance with Standard Road Plan RM-40 and the contract documents at the base of all breakaway poles, cabinets, or other installations for all non-low voltage installations unless otherwise directed by the Engineer. All costs associated with these connectors are incidental to the cost of the connected items of work.

c. The Engineer shall resolve all conflicts.

2. RS-485 Serial Communication Cable.

a. Install and test for continuity in all conduit installations as indicated on the contract documents.

b. Cable shall be installed continuously from device cabinet through the conduit/raceway system to sensor device location. Intermediate splicing of cable shall not be allowed.

3. Tracer Wire.

a. Install, splice, and test for continuity in all conduit installations as indicated on the contract documents.

b. Splice tracer wires in the Fiber Vault handhole, cabinet, and pole bases to form a continuous network using UL tested for wet location splice kits.

c. Terminate each tracer wire run at Type Fiber Vault handholes in test stations.
d. Maintain the continuity of the tracer wire through Type III pulling handholes.

4. Pull Tape.
Install in all conduits.

5. 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 Iowa DOT.

I. Fiber Optic Cable.

1. General.
a. Remove fiber optic cable from the reel in a manner acceptable to the Manufacturer and Engineer.
b. Install fiber optic cable in existing conduit systems or over lashed on aerial messenger cable system as indicated in the contract documents.
c. Direct bury of fiber optic cable is not allowed.
d. Do not twist or bend the fiber optic cable in excess of the limits recommended by the manufacturer.
e. 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.
f. Protect at all times all proposed cables, cable ends, and any exposed portions of fiber optic cable from damage including water intrusion.
g. 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.

2. Cable Installation.
a. All fiber optic cable shall be installed in ducts or conduits.
b. 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.
c. Dynamometers and breakaway pulling swings shall be used to ensure that the pulling line tension does not exceed 600 pounds.
d. 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.
e. Cables shall not be forced around sharp corners and precautions shall be taken during installation to prevent the cable from being kinked or crushed.
f. 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.
g. Pulling of the cable shall be hand assisted.
h. DOT approved installation methods include Pulling, High Air Speed Blowing, Air-Assist, Push/Pull Installation, and Air Blown Cable. Installation must comply with all manufacturers' recommendations for cable installation including pulling tensions and bending radii.
i. 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 and shall reject the cable if deemed unacceptable.
j. The 96-fiber cable shall be installed in a continuous run without splices between the following locations:
- From Fiber Vault HH3A on Sheet N.3 at Station 73+05, 105 RT to Handhole HH9C

on Sheet N.9 at Station 1548+04, 36 LT.
- From Handhole HH9C on Sheet N.9 at Station 1548+04, 36 LT to Handhole HH16C on Sheet N.16 at Station 650+40, 687 LT.

k. The 144-fiber cable shall be installed in a continuous run without splices between the following locations:
- From Handhole HH9C on Sheet N.9 at Station 1548+04, 36 LT to Handhole XHH18D on Sheet N.18 at Station 54+10, 140 LT.

l. No splices shall be allowed unless indicated by the plans or approved by the Engineer.

m. Seal all conduit openings using an approved sealing compound (duct seal) at all conduit openings at the junction boxes handholes, poles, cabinets, and building entrances after cable installation.

3. Facilities Protection.

a. In the event it is suspected that cable damage has occurred 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.

b. 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.

c. 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.

d. 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.

4. Slack Coils.

a. Sufficient slack shall be left at each end of the cable to allow proper cable splicing and termination. The minimum slack amount shall be as indicated in the plans.

b. Storage of slack cable in cabinets and handholes shall be neatly coiled. The slack coils shall be bound at a minimum of three points around the coil perimeter. 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.

c. 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.

5. Cable Identification.

a. Place tags on all fiber optic cable identifying the owner and direction of the cable.

b. 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. For fiber installations with joint Department of Transportation/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.

J. Fiber-Optic Cable Acceptance Testing.

1. Visually inspect fiber optic cable prior to installation. Report any defects to Engineer.

2. Post installation, 100% of the new cables' fiber count shall be tested with an Optical Time Domain Reflectometer (OTDR) at 1310 nm and 1550 nm to verify attenuation and continuity of strands for the entire length of the cable. Performing the OTDR test in one direction only on each fiber shall be permitted.

3. The contractor shall perform all tests in the presence of the Engineer and provide the Engineer with two copies of any software required for viewing electronic files of the OTDR

traces.

4. 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 max attenuation loss specification will be identified as Out Of Specification (OOS).

5. The Contractor shall 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.

6. All test equipment shall be factory certified within the last year. The Contractor shall provide copies of the certification 10 days prior to testing.

7. Test results will be recorded 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. 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:
   a. Cable and fiber identification (as approved by Iowa DOT)
   b. Operator name
   c. Date and Time
   d. Setup and test parameters including wavelength, pulse width, range, scale and ambient temperature.

8. OTDR testing shall use launch and receiving cables minimum 1000 meters or greater than the dead zone for the OTDR used for this test.

150591.04 METHOD OF MEASUREMENT.

A. Device Cabinets.
Measurement for device cabinets shall be paid for at the contract unit price per each for the pay items Device Cabinet, Pole Mount and Device Cabinet, Pedestal Mount.

B. Cabinet Footings.
Measurement for cabinet footings shall be paid for at the contract unit price per each for the pay item Device Cabinet Footing.

C. Power Installed Foundation.
Measurement for power-installed foundations shall be paid for at the contract unit price per each for the pay item Power Installed Foundation.

D. Handholes.
Measurement for all handholes shall be paid for at the contract unit price per each for the pay items Handhole, ITS Type I; Handhole, Type III; and Handhole, Type Fiber Vault.

E. Conduit.
Measurement for all conduit shall be paid for at the contract unit price per linear foot for the pay items 2 Inch Conduit, Trenched/Plowed; 2 Inch Conduit, Bored; and 2 Inch Conduit, Rigid Steel.

F. Poles.
Measurement for all steel poles shall be paid for at the contract unit price per each for the pay items ITS Steel Pole and ITS Steel Pole with Lowering Device.

G. Wire and Cable.
Measurement for all wire and cable shall be paid for at the contract unit price per linear foot for the respective pay item.

H. Fiber Optic Cable.
Measurement for all fiber optic cable, messenger cable and guy wire shall be paid for at the contract unit price per linear foot for the pay items and Fiber Optic Cable, 12 SM; Fiber Optic Cable, 96 SM; and Fiber Optic Cable, 144 SM.

I. Fiber-Optic Cable Acceptance Testing.
Measurement for fiber optic acceptance testing shall be paid for at the lump sum contract unit price bid for the pay item Fiber Optic Cable Acceptance Testing.

150591.04 BASIS OF PAYMENT.

A. Device Cabinets.
Payment is full compensation for:

1. The furnishing and installation of all pole mounted and pedestal 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. Cabinet Footings.
Payment is full compensation for:

1. The furnishing and installation of all cabinet footings,

2. Including all surface excavations, repair or restoration of any nearby areas, concrete, steel reinforcement, and anchors, and

3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

C. Power Installed Foundation.
Payment is full compensation for:

1. The furnishing and installation of all power installed foundations,

2. Including all surface excavations, repair or restoration of any nearby areas, bolts, and bolt mounting assemblies for connection to poles or other structures, and

3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

D. 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 Fiber Vault locations, and

4. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

E. 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, and

4. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

F. Poles.
Payment is full compensation for:

1. The furnishing and installation of all poles and accessories,

2. Including fitting the appropriate bolt pattern to the power installed foundation base plate, 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.

G. 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 wires or cables, and

3. Furnishing all materials, labor, equipment, and other incidental items necessary to meet the requirements of the contract documents.

H. Fiber Optic Cable.
Payment is full compensation for:

1. The furnishing and installation of all cables and wires 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.

I. Fiber-Optic Cable Acceptance Testing.
Payment is full compensation for:

1. The furnishing of all test equipment

2. Furnishing labor, tools, testing equipment, consumable items, and incidentals necessary to complete all acceptance testing satisfying the requirements of the contract documents.