SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Dallas County
STP-U-8177(619)--70-25

Effective Date
February 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.

154009a.01 DESCRIPTION.
Includes the furnishing of all material and equipment necessary to complete, in place and operational, traffic control signal(s) as described in the project plans.

A. Submittals

1. Follow the General Provisions (Requirements) and Covenants as well as the additional requirements listed below. All of the following must be submitted within 30 days after awarding of the contract for the project. Verify the method of submittal with the Jurisdiction.
2. Schedule of Unit Prices: Submit a completed schedule of unit prices. Estimates of the work performed on the project will be made by the Jurisdiction and the unit costs will be used to prepare progress payments to the Contractor.
3. Material and Equipment List: Submit a completed list of materials and equipment to the Jurisdiction for written approval before any equipment or materials are ordered.
4. Contractor Certification: Submit the name(s) and contact information of the International Municipal Signal Association (IMSA) Level II Certified Traffic Signal Technician(s) working on the project and a copy of their IMSA certificate.
5. Shop Drawings: Submit shop drawings for traffic signal poles and structures to be furnished on the project. Submit catalog cuts and manufacturer's specifications for all items in the equipment list.

B. Special Requirements

1. The installation of the traffic control signals and appurtenances shall comply with the current edition of the MUTCD as adopted by the Iowa DOT.
2. The Contractor shall be responsible for ONE CALL locates of the fiber cables installed under this project until acceptance of the project by the City.
3. The Contractor shall coordinate with the City for splice connections of the fiber into the existing fiber optic system. The Contractor to supply fiber optic wiring diagram as-built drawings. The Contractor shall maintain accurate quantities of the splices and terminations at each location during the project.

154009a.02 MATERIALS.

A. Underground

1. Handhole:
   a. General:
      i. Cable Hooks: Provide four galvanized steel cable hooks with a minimum diameter of 3/8 inch and a minimum length of 5 inches.

ii. Granular Base: Comply with the following gradations; however, the Engineer may authorize a change in gradation, subject to materials available locally at the time of construction.

Sieve	Percent Passing
2”	100
1 1/2”	80 to 90
1”	15 to 20
3/4”	0 to 0.5

iii. Cover: Include “TRAFFIC SIGNAL” as a message on the cover.

b. Precast Concrete Handhole:
   i. Pipe: Comply with ASTM C 76. Minimum Class III, Wall B (Iowa DOT Class 2000D). Four, 8 inch knockouts (conduit entrance points) equally spaced around the handhole.
   ii. Casting: Gray cast iron and certified according to requirements of AASHTO M 306 for a 16,000 pound proof-load (HS-20).

c. Composite Handhole and Cover: Precast polymer concrete handholes shall be stackable with a minimum depth of 30 inches and an “open” bottom, unless otherwise specified in the plans. Composed of mortar consisting of sand, gravel, and polyester resin reinforced by a woven glass fiber mat or of resin mortar and fiberglass, shall meet or exceed all appropriate ANSI/SCTE 77 tests and requirements. Ensure the cover satisfies loading requirements of ANSI Tier 15. Provide a skid resistant surface on the cover. Provide two 3/8-16 UNC stainless steel hex head bolts with washers.

2. Conduit:
   a. General:
      i. Furnish weatherproof fittings of identical or compatible material to the conduit. Use standard factory elbows, couplings, and other fittings.
      ii. Use a manufactured conduit sealing compound that is readily workable material at temperatures as low as 30°F and will not melt or run at temperatures as high as 300°F.
   b. Steel Conduit and Fittings:
      i. Comply with ANSI C80.1, latest revision.
      ii. Use weatherproof expansion fittings with galvanized, malleable iron, fixed and expansion heads jointed by rigid steel conduit sleeves. As an option, the fixed head may be integral with the sleeve, forming a one piece body of galvanized malleable iron.
      iii. Provide steel bushings.
   c. Plastic Conduit and Fittings:
      i. PVC:
         (a) PVC Schedule 40 plastic conduit and fittings complying with NEMA TC-2 (pipe), NEMA TC-3 (fittings), and UL 651 for Schedule 40 heavy wall type.
         (b) Solvent welded, socket type fittings, except where otherwise specified in the contract documents.
         (c) Threaded adaptors for jointing plastic conduit to rigid metal ducts.
         (d) Provide bell end fittings or bushings.
      ii. HDPE:
         (a) Comply with ASTM F 2160 (conduit) and ASTM D 3350 (HDPE material), SDR 13.5.
         (b) Use orange colored conduit or color as specified in the plans.
         (c) Continuous reel or straight pieces to minimize splicing.
         (d) For dissimilar conduit connections, provide an adhesive compatible with both materials.

3. Wiring and Cable: Provide wire that is plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.
   a. General:
      i. Shall be rated 600 volts minimum.
   b. Power Cable: Comply with Article 4185.12 of the Standard Specifications.
   c. Signal Cable: Comply with IMSA Specifications 19-1 (PVC jacket) or 20-1 (polyethylene jacket) for polyethylene insulated, 600 volt, solid, multi-conductor copper wire, No. 14 AWG.
   d. Tracer Wire: Comply with No. 10 AWG, single conductor, stranded copper, Type thermoplastic high-heat nylon-coated (THHN), with UL approval, and an orange colored jacket.

e. Communications Cable: Comply with IMSA Specifications 39-2 or 40-2 for No. 19 AWG, solid copper conductor, twisted pairs. Use polyethylene insulated, aluminum shielded, complying with REA Specification PE-39 for paired communication cable with electrical shielding.
f. Category 5E (Cat5E) Cable: Provide outdoor use rated cable.
g. Fiber Optic Cable and Accessories:
    i. Furnish fiber optic cable of the mode type, size, and number of fibers specified in the contract documents, and all associated accessories.
    ii. Meet the latest applicable standard specifications by ANSI, Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA).
    iii. ~~Multimode Fiber – Grade Index:~~
        ~~Core Diameter: 62.5 µm ± 1.0 µm~~
        ~~Cladding Diameter: 125.0 µm ± 1.0 µm~~
        ~~Core Concentricity: ± 1%~~
        ~~Max. Attenuation: 3.75 dB/km @ 850 nm~~
    iv. Single-Mode Fiber:

Typical Core Diameter:	8.3 µm ± 1.0 µm
Cladding Diameter:	125.0 µm ± 1.0 µm
Core Concentricity:	± 1%
Attenuation Uniformity:	No point discontinuity greater than 0.1 um at either 1310 nm or 1550 nm
Max. Attenuation:	0.25 dB/km

    v. Dual layer UV cured acrylate coating applied by the fiber manufacturer, mechanically or chemically strip-able without damage to the fiber.
    vi. Glass reinforced plastic rod central member designed to prevent the buckling of the cable. Cable core interstices filled with water blocking tape to prevent water infiltration.
    vii. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.
    viii. Buffer tubes of dual layer construction with a polycarbonate inner layer and polyester outer layer. Each buffer tube filled with a water-swellable yarn or tape. Buffer tubes stranded around the central member using reverse oscillation or “SZ” stranding process. Gel-free cable and buffer tubes.
    ix. Buffer tubes and fibers meeting TIA/EIA-598A, “Color coding of fiber optic cables.” The single mode cable shall include loose tubes with 12 fibers in each with a total number of tubes matching the number of fibers specified on the plans. ~~The multimode cable shall include one loose tube with 12 fibers.~~ The tube and fiber colors shall follow the industry color code (BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, RS, AQ).
    x. Cable tensile strength provided by a high tensile strength aramid yarn and/or fiberglass.
    xi. All dielectric cables, without armoring, sheathed with medium density polyethylene (1.4 mm minimum nominal jacket thickness). Jacketing material applied directly over the tensile strength members and flooding compound. Jacket or sheath marked in a contrasting color with the manufacturer's name and the words “Optical Cable,” the year of manufacture, and sequential meter or feet marks. The markings shall be repeated every meter. The actual length of the cable shall be within the range plus one percent of the length marked. Additionally, provide a durable weather proof label on the cable jacket showing the actual attenuation of each fiber expressed in dB/km.
    xii. Cable fabricated to withstand a maximum pulling tension of 600 pounds during installation (short term) and 135 pounds upon installation (long term).
    xiii. Shipping, storing, and operating temperature range of the cable: -40°F to +160°F.
    xiv. Each fiber of all fiber optic cable tested by manufacturer at the 100% level for the following tests:
        (a) Proof tested at a minimum load of 50 kpsi
        (b) Each fiber shall be tested for attenuation and the reading shall be part of the cable labeling.
        (c) Meet the appropriate standard Fiber Optic Test Procedure for the following measurements:
            - Fluid Penetration
            - Compound Drip
            - Compressive Loading Resistance

- Cyclic Flexing
- Cyclic Impact
- Tensile Loading and Bending

xv. Make cable ends available for testing. Seal cable ends to prevent moisture impregnation.

xvi. Fiber Distribution Panel: Provide a fiber distribution panel capable of terminating a minimum of 24 fibers, or as specified in the contract documents.

xvii. Fiber Optic Connectors:

~~(a) ST type connectors of ceramic ferrule and physical contact end finish shall be used to terminate multi-mode fibers to equipment.~~

(b) ST type connectors of ceramic ferrule and physical contact end finish shall be used to terminate single-mode fibers to equipment.

(c) ST or mechanical connectors not allowed for cable splices.

(d) Maximum attenuation per connector: 0.75 dB.

xviii. Fiber Optic Jumpers/Patch Cords:

~~(a) Six fibers in each multimode fiber optic cable shall be terminated in the distribution unit with the traffic signal controller cabinet.~~

(b) Duplex pigtail jumpers shall be used to branch traffic signal controller circuits from the distribution panel in the cabinet to controller FO OTR or to other communication equipment.

(c) Length of pigtail jumpers will vary according to distribution panel to NEMA controller FO OTR location. Length of jumper should provide for a minimum of 2 feet total slack between distribution panel and OTR connections.

(d) Controller cabinet pigtail jumpers shall consist of factory-assembled patch cords, each of which shall contain two multimode fibers. Each such fiber shall have an ST compatible, physical contact connector with ceramic ferrule on one end (i.e., a total of four STPC connectors per cord). Each patch cord shall have a dielectric strength member and a durable outer jacket designed to withstand handling.

xix. Fiber Optic Breakout Kits: Provide breakout kits for separation and protection of individual fibers, with buffering tube and jacketing materials suitable for termination of the fiber and fiber optic connector as specified.

xx. Splices/ Splice Enclosures: Fusion splice continuous fiber runs or branch circuit connections in splice enclosures as allowed or specified in the contract documents. Provide environmentally protected outside plant splice enclosures with adequate number of trays to splice all fibers. Maximum attenuation per splice: 0.3 dB.

4. Footings:
   a. Use Class C structural concrete complying with Section 2403 of the Standard Specifications.
   b. Reinforcing steel shall be the type and size as shown on the plans and shall conform to the requirements of Section 2404 of the Standard Specifications.
   c. Use uncoated reinforcing steel complying with Section 4151 of the Standard Specifications.
5. Bonding and Grounding:
   a. Ground Rods: Provide 5/8 inch by 8 foot copper clad, steel ground rod at each pole and controller footing.
   b. Bonding Jumper or Connecting Wire: Provide No. 6 AWG bare conductor, copper wire.

B. Detection

1. Inductive Loop Vehicle Detector: A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.
   a. Cables: All cables must be UL approved.
      i. Tube Loop Detector Cable: Comply with IMSA Specifications 51-5.
      ii. Preformed Loop Detector Cable: As approved by the Engineer.
      iii. Loop Detector Lead-in Cable: Comply with IMSA Specifications 50-2.
   b. Detector Loop Sealant:
      i. Use a rapid cure, high viscosity, liquid epoxy sealant formulated for use in sealing inductive wire loops and leads embedded in pavement. Ensure the cured sealer is unaffected by oils, gasoline, grease, acids, and most alkalis.
      ii. Use a sealant complying with Materials I.M. 491.18.

c. Sensor (Amplifier) Unit:
    i. Use a sensor unit that is solid state, digital, providing detection channel(s) with an inductance range of 0 to 2,000 micro-henries. Output circuits of the sensor unit will be provided by relays. Vehicle presence will result in a continuous call indication.
    ii. Provide a sensor unit with the following qualities:
        (a) Sensitivity adjustment to allow as a minimum the selection of high, medium, or low sensitivity.
        (b) Be capable of providing reliable detection of all licensed motor vehicles.
        (c) Provide an indicator light for visual indication of each vehicle detection.
        (d) Will not require external equipment for tuning or adjustment.
        (e) Provide operation in the pulse mode or presence mode. Ensure mode switch is readily accessible.
        (f) Provide a self tuning system that is activated automatically with each application of power. Provide automatic and continuous fine tuning to correct for environmental drift of loop impedance.
        (g) Provide for fail-safe operation (continuous call) in the event of detector loop failure.
        (h) Ensure each detector channel will respond to a frequency shift in an increasing or decreasing value as occurs with temperature shifts in the pavement without requiring a locked call.
        (i) Use detector units with delay and extension timing. The delay feature is selected and adjusted externally on the sensor unit housing. Digitally derived timing is selectable in 1 second increments from 0 to 30 seconds. Ensure delay timing inhibits detector output until presence has been maintained for the time selected. Restart delay timer at each new detection.
        (j) Use a sensor unit capable of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors.

2. Pedestrian Push Button Detectors:
    a. Assembly:
        i. Ensure the entire assembly is weather tight, secure against electrical shock, withstands continuous hard usage.
        ii. Provide a removable contact assembly mounted in a die cast aluminum case.
        iii. Ensure contacts are normally open with no current flowing except at the moment of actuation.
        iv. Ensure the contacts are entirely insulated from the housing and operating button with terminals for making connections.
        v. Provide housing with one outlet for 1/2 inch pipe.
    b. Operating Button:
        i. Shall be piezo driven solid state switch type with audible confirmation tone.
        ii. Ensure the button does not protrude out from the case.
        iii. Supply ADA compliant operating button.
    c. Signs: Furnish signs complying with MUTCD.

C. Communications

1. Traffic Monitoring System: Provide as specified in the contract documents including, video camera in dome, dome mounting bracket and hardware, camera controller, cabling from camera to controller cabinet, and all accessories and hardware necessary for a complete and operational system. The PTZ camera shall be an AXIS ~~Q6032e~~ Q6054-E Weather Resistant Dome Network Camera.
    a. Pan/tilt/zoom (PTZ) color camera with automatic conversion to monochrome during low light levels, auto focus, auto-iris control, electronic image stabilization, privacy masking and high resolution 1/4 inch CCD imager. Minimum optical zoom: 35X. Minimum digital zoom: 12X.
    b. Camera system provided in a NEMA 4X or IP66 certified rugged weather-resistant package.
    c. Shall be IP addressable and come with internet-based camera interface controls.
    d. Provide all required lightning protection for electronics control, power, and coax video outputs.
    e. Operating temperature range: -40ºF to 122°F.
    f. Electronic Image Stabilization up to 12dB suppression

g. Maximum cable length as specified by camera manufacturer.
h. Provide full 360 degree endless pan and 220 degree tilt under PTZ control.
i. Dome electronics capable of programming a minimum of 100 preset views and nine preprogrammed pattern sequences of preset views. All views selectable by the central office computer or a remote control device.
j. Provide encoder and decoder devices as needed to transmit video over existing or proposed communication systems at 30 frames per second.
k. Provide all necessary rack support devices for video viewing and PTZ control.
l. Provide ability to control PTZ and view video remotely.

D. Cabinet and Controller

1. NEMA Controller, Cabinet, and Auxiliary Equipment: Comply with the latest edition of NEMA TS1 or TS2 standards.
   a. Controller:
      i. Controller shall be a Siemens M50 series with fiber optic communication capability, including a smart malfunction management unit (MMU).
      ii. Solid state modular design with digital timing and capable of accommodating at least eight phases.
      iii. Fully prompted, front panel keyboard with menu driven programmability.
      iv. Local time base scheduler including automatic accommodation for daylight savings time.
      v. Local coordination control.
      vi. Local preemption control with at least four programmable internal preemption sequences.
      vii. Current software and documentation.
      viii. Data retained in a memory medium that does not require battery backup.
   b. Cabinet:
      i. Unpainted aluminum cabinet according to NEMA standards.
      ii. Aluminum cabinet riser with same dimensions as cabinet, 18 inch height and matching finish on the signal cabinet, as specified in the contract documents.
      iii. Police door with auto/flash switch and on/off power switch for signal heads only. Controller to remain in full operation regardless of switch positions.
      iv. Maintenance panel on inside of the main door containing the following test switches.
         (a) Controller power switch.
         (b) Detector test switches.
         (c) Stop time switch.
         (d) Signal flash switch.
      v. Heavy-duty clear plastic envelope attached to inside wall of cabinet or cabinet door, for cabinet wiring diagrams, 12 inches by 18 inches minimum.
      vi. GFI electrical outlet and lamps in accessible location near the front of the cabinet. GFI outlet fused separately from main AC circuit breaker. Two LED cabinet lamps connected and fused with GFI outlet.
      vii. Back panel positions to accommodate phasing and expansibility specified in the contract documents.
      viii. Power protection devices including AC power circuit breakers, radio interference suppressors, and lightning and surge protectors.
         (a) AC field service single pole, nonadjustable, magnetic breaker rated for 117 VAC operation, NEC approved.
         (b) Radio interference suppressors (RIS) as required to minimize interference in all broadcast transmission and aircraft frequency bands.
         (c) Lightning arrestor/surge protector capable of withstanding repeated (minimum of 25) 30,000 ampere surges.
      ix. Neatly train wiring throughout the cabinet and riser. Bundle and attach wiring to interior panels using nonconductive clamps or tie-wraps.
   c. Auxiliary Equipment: Conflict monitor/malfunction management unit, flasher, load switches, terminals and facilities, and miscellaneous equipment and materials according to NEMA standards.
      i. All fiber optic cable shall be suitably identified inside the cabinet.

ii. Included as incidental to Auxiliary Equipment, is any and all jumpers/pigtail cables, splice trays/enclosures, termination panels to accommodate the number of terminations per plan, fiber optic connectors, and fiber breakout kits

2. Uninterruptible Power Supply Battery Backup System: Monitors 120VAC input from the electric utility source and automatically switches to/from a system consisting of batteries and electronics.
   a. Outdoor Hardened Battery Backup System
      i. Supply a "rack-mounted" UPS unit, including a front panel with indicators and control switches.
      ii. The system shall include, but not be limited to the following: Inverter/charger, four batteries, battery heater mats, a charge management system, a separate automatic and manually operated bypass switch and all necessary hardware and interconnect wiring.
      iii. Designed to provide a minimum of 4 hours of normal operation.
   b. Use cabinet equipment that is plug connected and shelf mounted.
      i. Designed to cover a temperature range from -30°F to +165°F and include a surge suppressor.
      ii. Enclosure/Cabinet
      iii. System should be mounted in a cabinet connected to the side of the traffic controller cabinet.
      iv. The enclosure will house the batteries, UPS and bypass switches.
      v. The cabinet must meet the requirements for NEMA 3R enclosures.
      vi. Dimensions of the enclosure shall not exceed 50 inches height by 17 inches wide by 17 inches deep.
      vii. The UPS enclosure must not interfere with the opening of the traffic cabinet door.
      viii. The complete enclosure and door must be made from 0.125 inch think aluminum. All external seams must be continuously welded. The door must have a double flange for weather sealing purposes.
      ix. A ventilation fan must be mounted in the air baffle at the top of the cabinet with an air outlet built into the overhang. The bottom of the door must be louvered to allow airflow. The fan must be thermostatically controlled. A removable dust filter must be located behind the vent.
      x. The enclosure shall be a natural aluminum finish.
   c. Batteries
      i. The individual batteries shall be voltage rating type 12V and have an amp-hour rating of 100 amp-hour minimum.
      ii. Batteries shall be easily replaced and commercially available.
      iii. Batteries shall be deep discharge, sealed prismatic lead-calcuim based GEL/VRLA Gelled Electrolyte/Valve Regulated Lead Acid, and designed for standby operations.
3. Emergency Vehicle Preemption System:
   a. Shall be manufactured by TOMAR with a 2140 OSP card and 2090-ST detectors.
   b. Provide as specified in the contract documents including, preemption detector, mounting bracket and hardware, cabling from detector to controller cabinet, OSP card, and all accessories and hardware necessary for a complete and operational system.

E. Poles, Heads, and Signs

1. Vehicle Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.
   a. Housing:
      i. Individual signal sections made of a durable polycarbonate. The black color to be an integral part of the materials composition.
      ii. Self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together.
      iii. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
      iv. Doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of noncorrosive material. Doors are to be easily removed and reinstalled without use of special tools.
   b. Optical System: Designed to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens.

c. Lenses: 12 inch diameter polycarbonate. Do not use glass lenses.
d. Visors:
    i. Standard Installation:
        (a) Each signal lens is to have a visor with the bottom 25% open.
        (b) Minimum 0.1 inch in thickness and black in color.
        (c) Fits tightly against the housing door with no filtration of light between the visor and door.
        (d) Minimum length of 9 1/2 inches. Ensure the visor angle is slightly downward.
e. Terminal Block:
    i. Three-section signal equipped with a six position terminal block.
    ii. Four- and five-section signal equipped with an eight position terminal block.
f. Backplate:
    i. Manufactured one-piece, durable, black plastic capable of withstanding a 100 mph wind.
    ii. Provides 5 inches of black field around the assembly.
g. Mounting Hardware:
    i. Fixed: 1 1/2 inch aluminum pipe and fittings, natural aluminum finish for galvanized poles or match the pole color. Secure to pole with a minimum 5/8 inch wide stainless steel banding material.
    ii. Universally Adjustable: Rigid mounted, consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes.
h. LED Modules: Comply with current ITE standards.

2. Pedestrian Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.
    a. Housing:
        i. Made of a durable polycarbonate. Black color to be an integral part of the materials composition.
        ii. Self-contained unit capable of separate mounting or inclusion in a signal face containing one or more signal sections rigidly and securely fastened together.
        iii. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
        iv. Doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of noncorrosive material. Doors are to be easily removed and reinstalled without use of special tools.
    b. Visor:
        i. Tunnel type visor, black in color, attached to the housing door by stainless steel screws.
        ii. Fit tightly against the housing door to prevent any filtration of light between the door and the visor.
        iii. Ensure the visor angle is slightly downward.
    c. LED Module:
        i. Provide a LED unit(s) for the filled upraised hand symbol, walking person symbol, and countdown timer.
        ii. Ensure immediate blank out of the countdown timer display upon recognizing a shortened “Walk” or a shortened "Flashing Don't Walk" interval.

3. Traffic Signal Poles and Mast Arms:
    a. General:
        i. Mast arm length and vertical pole height as specified in the contract documents.
        ii. Ensure the mast arms, poles, and supporting bases are galvanized inside and out according to ASTM A 123.
        iii. Poles, mast arms and hardware shall be colored RAL 7043 by IADOT approved methods.
        ~~iii~~ iv. Continuous tapered, round, steel poles of the transformer base type. Fabricated from low carbon (maximum carbon 0.30%) steel of U.S. standard gauge.
        ~~iv~~ v. When a transformer base is not specified, provide a 6 inch by 16 inch handhole in the pole shaft for cable access. Provide a cover for the handhole. Secure the cover to the base with simple tools. Hardware to be corrosion resistant.
        ~~v~~ vi. Ensure minimum yield strength of 48,000 psi after manufacture. Supply base and flange plates of structural steel complying with AASHTO M 183 (ASTM A 36) and cast steel complying with ASTM A 27, Grade 65-35 or better.

~~vi~~ vii. Where a combination street lighting/signal pole is specified in the contract documents, the luminaire arm is to be mounted in the same vertical plane as the signal arm unless otherwise specified. Use a single member tapered type arm for the luminaire arm type. Equip the pole with a minimum 4 inch by 6 inch handhole and cover located opposite the signal mast arm.

~~vii~~ viii. If allowed by the Engineer, poles and mast arms may be fabricated by welding two sections together, resulting in a smooth joint and factory welded as follows:

(a) Ensure a minimum of 60% penetration for plates 3/8 inch and less in thickness for longitudinal butt welds, except within one foot of a transverse butt-welded joint. Ensure a minimum of 80% penetration for plates over 3/8 inch in thickness.

(b) Ensure 100% penetration for longitudinal butt welds on poles and arms within one foot of a transverse butt-welded joint.

(c) Ensure 100% penetration, achieved by back-up ring or bar, for transverse butt welds for connecting.

(d) Examine 100% of transverse butt welds and 100% penetration longitudinal butt welds by ultrasonic inspection according to the requirements of AWS D1.1- 80.AH.

(e) Comply with ANSI/AWS D1.1 except as modified by Iowa DOT Article 2408.03, B.

~~viii~~ ix. Provide non-shrink grout (complying with Materials I.M. 491.13) or a rodent guard (complying with Materials I.M. 443.01) for placement between the pole base and the foundation.

b. Pole Design:

i. Comply with AASHTO 2013 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals~~, 1994~~.

ii. ~~Designed to support the loading necessary for all traffic control equipment. Capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure.~~ Use a 90 mph basic wind speed with a 50 year mean recurrence interval for strength design. Use Category II for fatigue design. Apply only natural wind gust loads (i.e., do not apply galloping loads, vortex shedding loads, or truck-induced gust loads) for fatigue design.

iii. Install vibration mitigation devices on all traffic signal pole mast arms over 60 feet in length as shown in the standard details.

c. Hardware:

i. Equipped with all necessary hardware and anchor bolts to provide for a complete installation without additional parts.

ii. Anchor bolts complying with ASTM F 1554 Grade 105, hot dip galvanized and threaded a minimum of 6 inches at one end and have a 4 inch long, 90 degree bend at the other end.

iii. Washers complying with ASTM F 436.

iv. Heavy hex nuts complying with ASTM A 563.

v. All hardware made of steel, hot dipped galvanized complying with ASTM F 2329, or ASTM B 695, Class 50, Type I, or electrodeposited coated of the same coating thickness and designed for this purpose.

4. Traffic Signal Pedestal Poles:

a. General:

i. Poles, bases and hardware shall be colored RAL 7043 by IADOT approved methods.

~~a~~ b. Materials:

ii. Pedestal: The height from the bottom of the base to the top of the shaft as specified in the contract documents.

iii. Pedestal Shaft: Schedule 80 with satin brush or spun finish aluminum tubing. Top of the shaft outer diameter to be 4 1/2 inches and provided with a pole cap. Supply base collar for poles with shaft lengths greater than 10 feet.

iv. Pedestal Base: Cast aluminum, square in shape, with a handhole.

(a) Handhole: Minimum of 6 inches by 6 inches and equipped with a cast aluminum cover that can be securely fastened to the base with the use of simple tools.

(b) Base: Minimum weight of 20 pounds with a four bolt pattern uniformly spaced on a 12 1/2 inch diameter bolt circle. Meet or exceed AASHTO breakaway requirements.

~~b~~ c. Anchor Bolts: Four 3/4 inch by 15 inch steel, hot dip galvanized anchor bolts with right angle bend at the bottom end, complete with all hardware required for installation.

5. Pedestrian Push Button Post:

a. Material:

i. Post: Standard weight (Schedule 40) pipe complying with ASTM F 1083, galvanized inside and out; 2 1/2 inches in diameter.
ii. Cap: Waterproof cap complying with ASTM F 626.
iii. Anchor Bolts: Four 1/2 inch by 24 inch steel, hot dip galvanized anchor bolts complete with all hardware required for installation.
iv. Non-shrink Grout: Comply with Materials I.M. 491.13 or a rodent guard (complying with Materials I.M. 443.01) for placement between the post base and the foundation.
v. Base Plate: Provide a 5 inch square, 1/2 inch thick galvanized steel base plate with a 4 1/2 inch bolt circle.
vi. Poles, bases and hardware shall be colored RAL 7043 by IADOT approved methods.

6. Traffic Signs:
   a. Comply with Section 4186 of the Standard Specifications.
   b. Use a universally adjustable mast arm mounted sign bracket.
   c. Comply with MUTCD and the contract documents for the street name sign dimensions and sheeting. Street name lettering shall be Series C with 12 inch uppercase and lowercase letters.

154009a.03 CONSTRUCTION.

A. Underground

1. Handhole:
   a. Locations:
      i. Do not construct in ditch bottoms, low areas where ponding of water may occur, or where they will be subject to normal vehicular traffic.
      ii. With Engineer approval, additional handholes may be placed, at no additional cost to the Contracting Authority, to facilitate the work.
   b. Excavation: Excavate as necessary to accommodate the handhole and granular base.
   c. Granular Base: Install 8 inch thick granular base extending a minimum of 6 inches beyond the outside walls of the handhole.
   d. Placement:
      i. In paved areas, install the handhole at an elevation so the casting is level and flush with the pavement. In unpaved areas, install the handhole approximately 1 inch above the final grade.
      ii. Verify ring placement. Invert rings when installed in paved areas.
   e. Conduit:
      i. Remove knockouts as necessary to facilitate conduit entrance.
      ii. Extend conduit into the handhole, through a knockout, approximately 2 inches beyond the inside wall. Conduit to slope down and away from the handhole.
      iii. Place non-shrink grout (complying with Materials I.M. 491.13) in the opening of the knockout area after placement of conduit.
   f. Cable Hooks: Install cable hooks centered between the knockouts and the top of the handhole.
   g. Backfill: Place suitable backfill material according to Section 2552 of the Standard Specifications.
   h. Casting: Place the casting on the handhole. Ensure the final elevation meets the handhole placement requirements.
2. Conduit:
   a. General:
      i. Place conduit to a minimum depth of 30 inches and a maximum depth of 60 inches below the gutterline. When conduit is placed behind the curb, place to a minimum depth of 24 inches and a maximum depth of 48 inches below top of curb.
      ii. Change direction at handholes or by bending, such that the conduit will not be damaged or its internal diameter changed. Ensure bends are uniform in curvature and the inside radius of curvature of any bend is no less than six times the internal diameter of the conduit.
      iii. On the exposed ends of conduit, place bell-end fittings on PVC or HDPE conduit and bushings on steel conduit prior to installing cable. Extend all conduits a minimum of 2 inches and a maximum of 4 inches above the finished surface of any footing or structural base.

iv. When it is necessary to cut and thread steel conduit, do not allow exposed threads. Ensure conduits and fittings are free from burrs and rough places. Clean, swab, and ream conduit runs before cables are installed. Use nipples to eliminate cutting and threading where short lengths of conduit are required. Coat damaged galvanized finish on conduit with zinc rich paint. Use only galvanized steel fittings with steel conduit.
v. Pack conduit ends with a conduit sealing compound.

b. Trenched Installation:
i. Place backfill in layers not to exceed 12 inches in depth with each layer thoroughly compacted before the next layer is placed. Ensure backfill material is free of cinders, broken concrete, or other hard or abrasive materials.
ii. Remove all surplus material from the public right-of-way as soon as possible.

c. Trenchless Installation:
i. When placing conduit under pavements, use the trenchless installation methods described in Section 2553 of the Standard Specification.
ii. If trenchless methods that compact soils in the bore path are used, provide sufficient cover to prevent heaving of overlying paved surfaces.
iii. Do not allow pits for boring to be closer than 2 feet to the back of curb, unless otherwise specified in the contract documents.

3. Wiring and Cable:
a. Where practical, follow color codes so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green. Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables. Label home runs for cables as follows: northwest corner is red, southeast corner is blue, northeast corner is green, and southwest corner is orange.
b. Install continuous runs of vehicle and pedestrian signal cables from the vehicle or pedestrian signal head to the handhole compartment of the signal pole base. Install continuous runs of vehicle and pedestrian signal cables from the handhole compartment of the signal pole base to the terminal compartment in the controller cabinet. Do not splice signal cables in underground handholes.
c. Install continuous runs for video detection and emergency vehicle preemption cables from the unit to the controller cabinet.
d. Install continuous runs of power lead-in cables from the service point to the meter socket and from the meter socket to the controller cabinet.
e. Install continuous detector cable from each detector loop to the first handhole adjacent to the loop. Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables. Install continuous homerun cable from the splice made in the first handhole to the terminal compartment in the controller cabinet. Attach the drain wire of the shielded cable to the ground in the controller cabinet.
f. Provide a minimum of 4 feet of additional cable at each handhole and loosely coil the extra cable on the handhole cable hooks. Provide a minimum of 2 feet of additional cable at each signal pole (measured from the handhole compartment in the pole to the end of the cable). Provide a minimum of 10 feet of additional cable at each controller base.
g. Pull cables through conduit using a cable grip designed to provide a firm hold upon the exterior covering of the cable or cables, and minimize dragging on the ground or pavement.
h. Install a tracer wire in all conduits with the exception of conduits between detector loops and handholes. Use a silicon-filled wire nut to splice the tracer wire in each handhole and at the controller to form a continuous run.
i. Fiber Optic Cable and Accessories:
i. General.
(a) Cable end shall be secured inside the controller cabinet so that no load is applied to the exposed fiber strands.
(b) Minimum bend radius for static storage shall not be less than ten times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.
(c) The minimum bend radius during installation shall not be less fifteen times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.
(d) Slack shall be left in each handhole at the top of any conduit riser, junction box, and controller. This slack cable requirement may be deleted where existing handholes

or through points lack sufficient area to maintain the minimum bend requirements. Where slack has been deleted, extra slack equal to the amount that would have been distributed in the through points shall be equally divided between the two controller cabinets and shall be in addition to the slack mandated at the cabinets. Slack in each handhole type shall be provided as designated on the plans. Slack cable shall be coiled and the coils bound at three points around the coil perimeter and supported in their static storage position.

ii. Use a suitable cable feeder guide between the cable reel and the face of the conduit to protect the cable and guide the cable directly into the conduit off the reel. During the installation, carefully inspect cable jacket for defects. If defects are found, notify the Engineer prior to any additional cable being installed. Take care when pulling the cable to ensure the cable does not become kinked, crushed, twisted, snapped, etc.

iii. Attach a pulling eye to the cable and use to pull the cable through the conduit. Use a pulling swivel to preclude twisting of the cable. Lubricate cable prior to entering the conduit with a lubricant recommended by the manufacturer. Use dynamometer or break away pulling swing to ensure the pulling tension does not exceed the specified force of 600 pounds or the cable manufacturer's recommendations, whichever is less. The mechanical stress on the cable shall not allow the cable to twist, stretch, become crushed, or forced around sharp turns that exceed the bend radius or scar or damage the jacket. Manually assist the pulling of the cable at each pull point.

iv. Do not pull cable through any intermediate junction box, handhole, pull box, pole base, or any other opening in the conduit unless specified in the contract documents. The necessary length of cable to be installed shall be pulled from handhole or controller cabinet to the immediate next downstream handhole or cabinet. Carefully store the remaining length of cable to be installed in the next conduit run(s) in a manner that is not hazardous to pedestrian or vehicular traffic, yet ensures that no damage to the cable occurs. Storage methods are subject to Engineer approval.

v. At each handhole, visibly mark or tag cable, “CITY SM~~/MM~~”

vi. Secure cables inside controller cabinet so that no load is applied to exposed fiber strands.

vii. Ensure the radius of the bend for static storage is no less than 10 times the outside diameter of the cable, or as recommended by the manufacturer. Ensure the radius of the bend during installation is no less than 15 times the outside diameter of the cable, or as recommended by the manufacturer.

viii. Provide cable slack in each handhole, junction box, and cabinet as specified:

Traffic Cabinet	50 feet
Type 1 Handhole	50 feet
Type 3 Handhole (tub)	100 feet

ix. Where handholes or junction boxes lack sufficient area for cable storage or bend radius requirements, provide equivalent additional slack in adjacent facilities. Coil and bind slack cable at three points around the cable perimeter and support in its static storage position.

x. Install fiber optic accessories according to the manufacturer’s recommendations and as specified in the contract documents.

j. Fiber Optic Cable Field Testing:

i. General

(a) Each fiber furnished and installed as part of the project shall be tested, both on-the-reel prior to installation and after installation using a high-resolution optical time domain reflectometer (OTDR).

(b) Single mode measurements shall be conducted at the 1550 ± 30 nanometer wavelength. ~~Multi-mode measurements shall be conducted at 1300 ±30 nanometer wavelength.~~

(c) The Contractor shall record the identification, location, length, and attenuation measurements of each tested fiber and shall furnish all test reports to the Engineer prior to installation of the cables. All cable readings/measurements shall be compared to the maximum allowable deviations in the cable specification and the levels of acceptance recommended by the manufacturer in their printed documentation. Any cable having measurements outside the allowable range shall be replaced and shall not be acceptable for installation on this project.

ii. On-reel Testing:
(a) Prior to the installation, the Contractor shall perform on-site, on-reel testing. This testing shall be for both attenuation and continuity.
(b) The testing shall be performed using an OTDR by means of a pigtail splice. All test results shall be within ± 3% of factory-supplied attenuation measurements.
(c) Testing shall be done in one direction only.
(d) Except for the access to and the test preparation of any one end of the newly furnished cable to be tested, the Contractor shall preserve the cable in its originally-shipped condition. If any fiber of the cable fails the on-reel attenuation test, the cable shall be rejected and shall not be used on this project. The rejected cable shall be replaced at the Contractor's expense.

iii. Cable Segment Testing.
(a) As each cable segment is terminated, the Contractor shall perform an end-to-end attenuation (power loss) test of each terminated fiber of each FO cable. This testing shall be performed using hand-held optical test sets and shall be tabulated and be included in the documentation package to be provided to the Engineer at the conclusion of the project.
(b) Overall loss for each link shall not exceed the cumulative specified maximum losses of the components. For example, at 850 nm, a one kilometer link with two splices and a connector on each end shall not exceed 4.9 dB:

1.0 km x 3.5 dB/km: 3.5 dB
0.2 dB per splice x 2: 0.4 dB
0.5 dB per connector x 2: 1.0 dB
Maximum allowable loss: 4.9 Db

(c) The cable segment shall be rejected for use on this project if any terminated fiber of the cable segment fails the attenuation test. Rejected cables shall be repaired or replaced by the Contractor at the Contractor's expense. The Contractor shall retest all fibers of any repaired or replaced cable segment. The Contractor shall submit complete documentation of the cable segment attenuation tests. Such documentation shall be submitted in either hardcopy (written) form or in Engineer-approved electronic format on diskette.

iv. Final System Testing:
(a) After the complete fiber optic system is installed and terminated, but excluding the capping of unused fibers, an OTDR reading shall be performed on all cables to insure that each section is in compliance with the issued specification.
(b) A hard copy of OTDR signature traces for all fibers for all sections shall be provided to the Engineer. Fibers which have been terminated shall be indicated in the report. In addition to the OTDR test report, the Contractor shall provide the test results of an Attenuation Test for the installed fibers using the insertion loss test procedure and the Transmitter/Receiver Power Level Test and the Continuity Test.

4. Footings:
a. Excavation: Excavate to the size, shape, and depth specified in the contract documents. Ensure the bottom of all foundations rest securely on firm undisturbed soil. Minimize over excavation to ensure support and stability of the foundation.
b. Footing: Provide a means for holding all of the following elements rigidly in place while the concrete is being placed.
i. Forms:
(a) Set the forms level or sloped to meet the adjacent paved areas.
(b) When adjacent to paved areas, shape the top 11 inches of the footing to be square and flush with the surrounding paved area. Provide preformed expansion material between the footing and paved areas.
(c) When installed in an unpaved area, set the top of the footing 2 inches above the surface of the ground.
ii. Reinforcing Steel: Install reinforcing steel.
iii. Conduit: Install conduit.
iv. Anchor Bolts:
(a) Set anchor bolts using a template constructed to accommodate the specified elevation, orientation, and spacing according to the pole and controller manufacturer's requirements.

(b) Center the pole anchor bolts within the concrete footing.
(c) Protect the anchor bolts until poles are erected.
(d) Orient controller footing with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the Engineer.

v. Concrete:
(a) Place concrete to form a monolithic foundation. Consolidate concrete by vibration methods.
(b) Finish the top of the base level and round the top edges with an edging tool having a radius of 1/2 inch. Provide a rubbed surface finish on the exposed surface of the footing.
(c) Allow the footings to cure a minimum of 4 days prior to erecting the poles and 7 days prior to installing the mast arms. Times may be shortened if supported by strength test results.

c. Backfill: Place suitable backfill material according to Section 2552 of the Standard Specificaions.

5. Bonding and Grounding:
a. Ensure the traffic signal installation is grounded as required by the National Electric Safety Code.
b. Install a ground rod at each signal pole and controller footing.
c. Use PVC conduit within the footing to accommodate the connection between the top of the footing and the ground rod.
d. Bond poles to ground rods with copper wire. Connect ground wires to ground rods with approved mechanical connectors.
e. Bond rigid steel conduit ends in handholes with copper wire and approved fittings.

B. Detection

1. Detector Loop Cable Installation:
a. Coordinate the location of the detector loop with the Engineer. Obtain the Engineer's approval prior to cutting the pavement.
b. Saw to ensure proper depth and alignment of the slot. Make a 2 inch deep clean, straight, well-defined 3/8 inch wide saw cut without damage to adjacent areas. Overlap the saw cuts where the detector loop changes direction to provide full depth at all corners. Do not use right angle or corners less than 90 degrees.
c. Before installing the detector loop cable, check the saw cuts for the presence of jagged edges or protrusions and remove if present. Clean and dry the saw cuts to remove cutting dust, grit, oil, moisture, or other contaminants. Clean by flushing with a stream of water under pressure. Use oil-free compressed air to dry the saw cuts.
d. Install detector loop cable without damage. Place three turns of the detector loop cable into the saw cut. Seal the ends of the tubing at the time of placement to prevent entrance of moisture.
e. Ensure the detector loop cables are in the bottom of the saw cut. Place detector loop sealant within the saw cut area. Comply with the manufacturer's instructions for mixing and using the detector loop sealant.
f. Install preformed loop detector according to the manufacturer's recommendations.
g. Identify each detector loop cable in the handhole by phase and location. Wind loops that are physically adjacent in an individual lane or adjacent lanes with opposite rotation (i.e. No. 1 clockwise, No. 2 counter-clockwise, No. 3 clockwise, etc.). Rotation reversal can be accomplished by reversing leads at the handhole.
h. Twist, with at least five turns per foot, all lengths of loop wires and tubing that are not embedded in the pavement.
i. Identify all detector loop lead-in cables with appropriate detector numbers.
j. Use a detector loop cable splice kit for the electrical splice between the detector loop cable and the detector loop lead-in cable to the controller.
i. Ensure splice kit provides a watertight protective covering for the spliced wire, the shielding on the detector loop lead-in cable, and the end of the tubing containing the detector loop cable.
ii. Use a manufactured electrical splice kit approved by the Engineer.
k. Test all loops and document by using the following procedures:

i. Determine the insulation resistance of the loop wire using a "megger" with 500V applied to either loop wire to earth ground. The resistance is to be greater than 100 megohms.
ii. Determine the inductance of the loop using a loop inductance meter.

2. Pedestrian Push Button Detectors:
   a. Install according to the manufacturer's recommendations.
   b. Seal the wire entrance into the pedestrian push button assembly.

C. Communications

1. Traffic Monitoring System: Install according to the manufacturer's recommendations and as specified in the contract documents, as well as the following:
   a. Position camera dome on the pole as directed by the Engineer.
   b. Test installed system under the supervision of the Engineer, and certify as fully functional.

D. Cabinet and Controller

1. Controller, Cabinet, and Auxiliary Equipment:
   a. Install according to the manufacturer's recommendations and as specified in the contract documents.
   b. Install on pre-placed caulking material on the concrete base. After the cabinet is installed in place, place caulking material around the base of the cabinet.
   c. This installation includes any and all jumpers/pigtail cables, splice trays/enclosures, termination panels to accommodate the number of terminations per plan, fiber optic connectors, and fiber breakout kits.
2. Controller: Install according to the manufacturer's recommendations and as specified in the contract documents.
3. Battery Backup System: Install new corrosion resistant materials according to the manufacturer's recommendations and as specified in the contract documents.
   a. Enclosure/Cabinet: The enclosure will be mounted to the traffic controller cabinet with six hex head bolts, ¼ inch by 20 inches. All holes will be field drilled by the contractor to accommodate the specific situation. A grommet must be supplied to protect the cable in a field drilled 1.5 inch to 2 inch hold for cable connection to the traffic controller. The contractor will supply all mounting hardware, bolts, washers, nuts, gaskets, bushings, grommets, caulking, etc., necessary to install the cabinet in a safe and weatherproof manner.
4. Emergency Vehicle Preemption System: Install according to the manufacturer's recommendations and as specified in the contract documents.

E. Poles, Heads, and Signs

1. Vehicle and Pedestrian Traffic Signal Heads:
   a. Inspect each signal head assembly while still on the ground for the following:
      i. Physical defects
      ii. Visor type
      iii. LED wattage
      iv. Lens orientation
      v. Wiring connections
   b. Attach signal head mounting hardware according to the manufacturer's recommendations. Apply anti-seize compound to all mechanical fasteners.
   c. Adjust each signal head both vertically and horizontally to approximate a uniform grade of all like signal heads.
   d. During the course of construction and until the signals are placed in operation, cover signal faces or turn away from approaching traffic. When ready for operation, plumb and aim the heads.
2. Traffic Signal and Pedestal Poles and Pedestrian Push Button Posts:
   a. Erect all poles and posts vertically under normal load.
   b. Securely bolt the bases to the cast-in-place concrete foundations.
      i. Mast Arm Poles: Provide footing type (A through F) as specified in the contract documents. Level by using two nuts on each anchor bolt or according to the manufacturer's recommendations.
      ii. Pedestal Poles: Level by using metal shims and one nut on each anchor bolt or according to the manufacturer's recommendations.

iii. Pedestrian Push Button Posts: Weld the post to the base plate using a minimum 3/16 inch weld. Level by using two nuts on each bolt.

c. After leveling the poles, use non-shrink grout or a rodent guard between the pole base and the foundation. When non-shrink grout is used, neatly finish exposed edges of grout to present a pleasing appearance, and place a weep hole in the grout.
d. Apply anti-seize compound to all mechanical fasteners on pole access doors.
e. Install pedestrian push button post caps with tamper-proof set screws per manufacturer's direction or by driving the cap a minimum of 1/2 inch onto the post.

3. Traffic Signs: Install signs using universally adjustable sign brackets banded to the pole. Apply anti-seize compound to all mechanical fasteners.

F. Surface Restoration

1. Replace or reconstruct features removed as a part of the work, such as sidewalks, driveways, curbs, roadway pavement, unpaved areas, or any other items. This is incidental to the lump sum bid items.
2. Complete restoration as directed by the Engineer.

G. Testing

1. Notify the Engineer 48 hours in advance of the time and date the signal or signal system will be ready for turn on. Do not turn on the signal or signal system without authorization of the Engineer.
2. Ensure a representative from the manufacturer and/or supplier of signal controller or other authorized person is at the project site when the signal controllers are ready to be turned on to provide technical assistance including, as a minimum, programming of all necessary input data.
3. All required signal timing data will be provided by the Engineer.
4. A test period of 30 calendar days will start upon confirmation from the Engineer that the signal or signal system is operating consistent with the project requirements. Any failure or malfunction of the equipment furnished by the Contractor, occurring during the test period will be corrected by the Contractor at no additional cost to the Contracting Authority. Upon confirmation by the Engineer that any failure or malfunction has been corrected, a new test period of 30 calendar days will start, exclusive of minor malfunctions such as lamp burnouts. Repeat this procedure until the signal equipment has operated satisfactorily for 30 consecutive calendar days.
5. After signal turn on and prior to completion of the 30 calendar day test period, respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

H. Documentation

1. Provide file documentation packages with each signal system, consisting of the following:
   a. Complete cabinet wiring diagram.
   b. Complete physical description of the equipment.
   c. Controller printout or equal documentation of initial controller settings installed in the field or in the office.
   d. Product manuals for all cabinet equipment.
   e. Standard industry warranties on equipment supplied.
   f. Documentation of field cable labeling scheme.
   g. Diagram of phasing and detector locations.
   h. One set of as-built construction plans indicating changes from the original contract documents.
2. Supply two complete sets of documentation. One set to be placed in the controller cabinet and the other set (less construction plan) to be delivered to the Engineer.

154009a.04 METHOD OF MEASUREMENT.

Lump sum item; no measurement will be made.

154009a.05 BASIS OF PAYMENT.

The Traffic Signalization will be paid for at the lump sum bid item price, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete signal installation and for all equipment, tools, labor, and incidentals necessary to complete the work.