



**SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION**

**Polk County
STBG-SWAP-1945(841)--SG-77**

**Effective Date
February 16, 2021**

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.

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Underground
- B. Detection
- C. Communications
- D. Cabinet and Controller
- E. Poles, Heads, and Signs

1.02 DESCRIPTION OF WORK

This part of the specifications 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.

1.03 SUBMITTALS

Comply with the 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 Engineer.

- A. **Schedule of Unit Prices:** Submit a completed schedule of unit prices. Estimates of the work performed on the project will be made by the Engineer and the unit costs will be used to prepare progress payments to the Contractor.
- B. **Material and Equipment List:** Submit a completed list of materials and equipment to the Engineer for written approval before any equipment or materials are ordered.

- C. **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.
- D. **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.

1.04 SPECIAL REQUIREMENTS

Comply with the current edition of the MUTCD as adopted by the Iowa DOT.

1.05 MEASUREMENT AND PAYMENT

A. Traffic Signalization:

1. **Measurement:** Lump sum item; no measurement will be made.
2. **Payment:** Payment will be at the lump sum price for traffic signalization.

B. Temporary Traffic Signal:

1. **Measurement:** Lump sum item; no measurement will be made.
2. **Payment:** Payment will be at the lump sum price for temporary traffic signal. 50% of the lump sum bid amount will be paid upon completion of the installation and successful initial operation of the signal; the final 50% will be paid upon removal of the temporary traffic signal and cleanup of the site.
3. **Includes:** Lump sum price includes, but is not limited to, furnishing, installing, maintaining, and removing poles; wiring; traffic signal control equipment including pedestrian equipment if specified; all modifications of signal timing due to changes in construction staging; relocation of trailer mounted temporary traffic signal systems; placement in another physical location to address changes in construction staging; and all appurtenances.

1.06 RELATED SPECIFICATIONS AND STANDARDS

Unless otherwise specified in the project plans and special provisions the traffic signal installed under this special provision shall comply with:

- A. Specifications of the Underwriters Laboratories Inc.
- B. National Electrical Code.
- C. MUTCD latest edition.

1.07 LOCAL REQUIREMENTS

The Contractor shall notify and receive approval from the City prior to any operational shutdown of any existing traffic signal installation. Adherence to the City Electrical Code shall be required for service to the Controller.

The Contractor is responsible for locating all equipment installed as part of the project within the City right-of-way until project acceptance. Any damage as a result of failure to locate this equipment shall be the responsibility of the Contractor to replace with no additional cost to the City.

The Contractor shall receive delivery of traffic signal poles and equipment and assumes responsibility for delivery and installation in the field.

Contractor shall provide to the City “as-built” drawings that identify all changes made to the contract plans.

Areas disturbed by construction shall be restored to their original condition at the Contractor’s expense.

PART 2 - PRODUCTS

2.01 UNDERGROUND

A. Handhole:

1. General:

- a. **Cable Hooks:** Provide four galvanized steel cable hooks with a minimum diameter of 3/8 inch and a minimum length of 5 inches.
- b. **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

- c. **Cover:** Include “TRAFFIC SIGNAL” as a message on the cover. Alternate messages may be required as specified in the contract documents.

2. Precast Concrete Handhole:

- a. **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.
- b. **Casting:** Gray cast iron and certified according to requirements of AASHTO M306 for a 16,000 pound proof-load (HS-20).

- 3. **Composite Handhole and Cover:** Composed of mortar consisting of sand, gravel, and polyester resin reinforced by a woven glass fiber mat or of resin mortar and fiberglass. Ensure the handhole and cover withstands a load of 20,000 pounds. Provide a skid resistant surface on the cover. Provide two 3/8-16 UNC stainless steel hex head bolts with washers.

B. Conduit:

1. General:

- a. Furnish weatherproof fittings of identical or compatible material to the conduit. Use standard factory elbows, couplings, and other fittings.
- b. 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.

2. Steel Conduit and Fittings:

- a. Comply with ANSI C80.1.

- b. 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.
- c. Provide steel bushings.

3. Plastic Conduit and Fittings:

a. PVC:

- 1) 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. Solvent welded, socket type fittings, except where otherwise specified in the contract documents.
- 2) Threaded adaptors for jointing plastic conduit to rigid metal ducts.
- 3) Provide bell end fittings or bushings.

b. HDPE:

- 1) Comply with ASTM F 2160 (conduit) and ASTM D 3350 (HDPE material), SDR 13.5.
- 2) Use orange colored conduit.
- 3) Continuous reel or straight pieces to minimize splicing.
- 4) For dissimilar conduit connections, provide an adhesive compatible with both materials.

C. 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.

- 1. **Power Cable:** Comply with [Article 4185.11 of the Standard Specifications](#).
- 2. **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.
- 3. **Tracer Wire:** Comply with No. 10 AWG, single conductor, stranded copper, type thermoplastic heat and water resistant, nylon-coated (THWN), with UL approval, and an orange colored jacket.
- 4. **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.
- 5. **Category 5E (Cat5E) Cable:** Provide outdoor use rated cable.
- 6. **Fiber Optic Cable and Accessories:**
 - a. Furnish fiber optic cable of the mode type, size, and number of fibers specified in the contract documents, and all associated accessories.
 - b. Meet the latest applicable standard specifications by ANSI, Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA).
 - c. Multimode Fiber:
 - Core Diameter: 62.5 $\mu\text{m} \pm 1.0 \mu\text{m}$
 - Cladding Diameter: 125.0 $\mu\text{m} \pm 1.0 \mu\text{m}$
 - Core Concentricity: $\pm 1\%$
 - Max. Attenuation: 3.50 dB/km @ 850 nm
 - d. Single-Mode Fiber:
 - Typical Core Diameter: 8.3 $\mu\text{m} \pm 1.0 \mu\text{m}$

- Cladding Diameter: 125.0 $\mu\text{m} \pm 1.0 \mu\text{m}$
 - Core Concentricity: $\pm 1\%$
 - Attenuation Uniformity: No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm
 - Max. Attenuation: 0.25 dB/km @ 1550 nm, 0.35 dB/km @ 1310 nm
- e. Dual layer UV cured acrylate coating applied by the fiber manufacturer, mechanically or chemically strip-able without damage to the fiber.
 - f. 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. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.
 - g. Buffer tubes of dual layer construction with a polycarbonate inner layer and polyester outer layer. Each buffer tube filled with a water-swellaable yarn or tape. Buffer tubes stranded around the central member using reverse oscillation or "SZ" stranding process. Gel-free cable and buffer tubes.
 - h. Buffer tubes and fibers meeting TIA/EIA-598A, "Color coding of fiber optic cables," with 12 fibers per buffer tube.
 - i. Cable tensile strength provided by a high tensile strength aramid yarn and/or fiber glass.
 - j. 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. Additionally, provide a durable weatherproof label on the cable jacket showing the actual attenuation of each fiber expressed in dB/km.
 - k. Cable fabricated to withstand a maximum pulling tension of 600 pounds during installation (short term) and 135 pounds upon installation (long term).
 - l. Shipping, storing, and operating temperature range of the cable: -40°F to $+158^{\circ}\text{F}$
Installation temperature range of cable: 14°F to $+140^{\circ}\text{F}$.
 - m. Each fiber of all fiber optic cable tested by manufacturer at the 100% level for the following tests:
 - Proof tested at a minimum load of 50 kpsi
 - Attenuation
 - n. 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
 - o. Make cable ends available for testing. Seal cable ends to prevent moisture impregnation.
 - p. Fiber Optic Termination Unit: Contractor shall provide and install a fiber optic termination unit in the proposed cabinet(s). The unit shall be a rack mount, drawer type enclosure that is dust and moisture repellent. The unit shall provide easy front access with removable rear tray for easy rear access and shall have a maximum dimension of 3.5 inches (H) by 18.5 inches (W) by 11.25 inches (D). The size of the unit shall be adequate for the number of fibers, proper winding area, and splices. The unit shall provide for cable entry from the side and be capable of accommodating up to 48 connections. All fibers entering the traffic signal controller cabinet shall be terminated in the fiber optic termination unit within the traffic controller cabinet.
 - q. Fiber Optic Connectors: Only SC or LC type connectors of ceramic ferrule and

Physical Contact end finish shall be used to terminate fibers to equipment. SC, LC or mechanical connectors shall not be used to splice cables. All multimode fibers shall be terminated with ST connectors. All single mode fibers shall be terminated with LC connectors. Maximum attenuation per connector shall be 0.75 dB. Fiber Optic Jumpers/Patch Cords: For connections in the cabinet, provide factory-assembled duplex pigtail jumpers with dielectric strength member, durable outer jacket and ST or SC compatible connectors. Provide adequate length for connections and 2 feet minimum slack.

- r. **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.
- s. **Splices/ Splice Enclosures:** Fiber optic cable runs shall be continuous without splice between controller cabinets, unless otherwise specified. Ends of continuous fiber cable runs and/or traffic signal controller branch circuit points will be fusion spliced in an outside plant splice enclosure located in handholes as shown on plans. Enclosure shall accept a minimum of six cables and provide adequate number of trays to splice all fibers. All fiber cables shall enter the enclosure at one end. Enclosure shall be watertight and re-enterable using gel-compressed cable connections and a re-enterable gasket. Maximum attenuation per splice: 0.3dB.

D. Footings and Foundations:

1. Use Class C structural concrete complying with [Section 2403 of the Standard Specifications](#).
2. Use uncoated reinforcing steel complying with [Section 4151 of the Standard Specifications](#).

E. Bonding and Grounding:

1. **Ground Rods:** Provide 5/8 inch by 8 foot copper clad, steel ground rod.
2. **Bonding Jumper or Connecting Wire:** Provide No. 6 AWG bare conductor, copper wire.

2.02 DETECTION

A. 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. All loops detectors in new pavement shall be preformed. No saw-cut loops will be accepted in new pavement.

1. **Cables:** All cables must be UL approved.
 - a. **Tube Loop Detector Cable:** Comply with IMSA Specifications 51-5.
 - b. **Preformed Loop Detector Cable:** As approved by the Engineer.
 - c. **Loop Detector Lead-in Cable:** Comply with IMSA Specifications 50-2. Detector lead-in cable shall be No. 14 AWG.
2. **Detector Loop Sealant:**
 - a. 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.
 - b. Use a sealant complying with [Materials I.M. 491.18](#).
3. **Sensor (Amplifier) Unit:**

- a. Use a sensor unit that is solid state, digital, providing detection channel(s) with an inductance range of 0 to 2000 micro-henries. Output circuits of the sensor unit will be provided by relays. Vehicle presence will result in a continuous call indication.
- b. Provide a sensor unit with the following qualities:
 - 1) Sensitivity adjustment to allow as a minimum the selection of high, medium, or low sensitivity.
 - 2) Be capable of providing reliable detection of all licensed motor vehicles.
 - 3) Provide an indicator light for visual indication of each vehicle detection.
 - 4) Will not require external equipment for tuning or adjustment.
 - 5) Provide operation in the pulse mode or presence mode. Ensure mode switch is readily accessible.
 - 6) 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.
 - 7) Provide for fail-safe operation (continuous call) in the event of detector loop failure.
 - 8) 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.
 - 9) 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.
 - 10) 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.

B. Pedestrian Push Button Detectors:

1. Assembly:

- a. Ensure the entire assembly is weather tight, secure against electrical shock, withstands continuous hard usage.
- b. Provide a removable contact assembly mounted in a die cast aluminum case.
- c. Ensure contacts are normally open with no current flowing except at the moment of actuation.
- d. Ensure the contacts are entirely insulated from the housing and operating button with terminals for making connections.
- e. Provide housing with one outlet for 1/2 inch pipe.

2. Accessible Pedestrian Signals (APS) Push Button Stations:

- a. **Housing:** Die cast aluminum, weather tight, secure against electrical shock and withstands continuous hard usage.
- b. **Audible and Vibrotactile Features:** Audible walk indication tone, vibrotactile arrow, and locator tone complying with MUTCD.
- c. **Voice Messages:** As specified in the contract documents and per MUTCD.
- d. **Speaker:** Weatherproof with automatic volume adjustment to 5 dBA over ambient sound. Maximum volume 100 dB at 3 feet.
- e. **Push Button:** Nonrusting metal alloy, ADA compliant, 2 inch diameter with tactile arrow and 3 pounds maximum operational force.
- f. **Switch:** Solid state rated at 20 million operations minimum.
- g. **Program and Audio File Updates:** USB or Ethernet.
- h. **Operating Temperature:** -30 to + 165°F.

3. Solid State Pedestrian Push Buttons (non-APS):

- a. **Housing:** Die cast aluminum, weather tight, secure against electrical shock and withstands continuous hard usage.
 - b. **Push Button:** Nonrusting metal alloy, ADA compliant, 2 inch diameter with 3 pounds maximum operational force.
 - c. **Switch:** Solid state rated at 20 million operations minimum.
 - d. **Operating Temperature:** -30°F to + 165°F.
4. **Signs:** Furnish signs complying with MUTCD.
5. **Construction:** Pedestrian pushbuttons shall be of the push type without levers, handles, or toggle switches. Each pushbutton shall consist of a solid state electronic switch with no moving plunger or moving electrical contacts. The case shall have one outlet for a 1/2 inch pipe. The operating button shall be made of stainless steel and shall be of sturdy design. This button shall not protrude out from the case. The entire assembly shall be weather tight, secure against electrical shock and of such construction as to withstand continuous hard usage. The contact shall be normally open and no current flowing except at the moment of actuation. The pushbuttons supplied shall be ADA accessible pushbutton assembly with momentary LED indicator. The pushbutton casing shall be black in color, with a raised directional arrow.
6. **Construction:** When APS pushbuttons are specified in the plans they shall meet the following specification. Pushbutton assembly shall be black in color, have an integrated R10-3 sign and ADA compliant pushbutton with raised directional arrow. The pushbutton shall provide confirmation through latching LED light, sound and tactile bounce. Pushbutton shall provide both sounds and message options during the WALK interval as well as vibration, sounds during the clearance interval, adjustable volume locator tone during the DON'T WALK interval, direction of travel messages, and special messages determined by the user. The pushbuttons shall have a control unit that mounts in the controller cabinet to operate all pushbuttons for the intersection. All wiring and components to create a functional system are included in the unit price for this item.
- C. **Video Detection Camera System:** Detects vehicles by processing video images and providing detection outputs to the traffic signal controller.
1. **Video Detection System and Processors:**
- a. Processor to be card rack mounted or located within camera. Compatible with NEMA TS-1, TS-2, and Type 170 controllers and cabinets.
 - b. Must be capable of the following:
 - 1) Shadow rejection without special hardware.
 - 2) Non-impaired operation under light intensity changes.
 - 3) Maintained operation during various weather conditions (e.g. rain, fog, snow).
 - 4) Anti-vibration, 5% rejection based on image change.
 - 5) Ability to select direction of flow parameters.
 - 6) Ability to properly detect directionally.
 - 7) Operate in presence mode with less than 4% error.
 - c. Provide user-defined detection zone programming via a graphical user interface (GUI) and any necessary equipment for future programming. Store detection zones in non-volatile memory.
 - d. Comply with NEMA TS-1 and TS-2 environmental and physical standards with an operating temperature of -34°C to +60°C, and 0% to 95% relative humidity.
 - e. Ensure a factory certified representative from the supplier provides on-site VDS programming and testing.
2. **Video Cameras:**
- a. Provide a charge-coupled device (CCD) image sensor with variable focus color or

black and white lens providing a minimum of 4 degrees to at least a 40 degree horizontal field of view.

- b. Equipped with internal thermostatically controlled heater and external sunshield.
- c. Meet NEMA-4 or NEMA-6P environmental standards.
- d. Use camera cable(s) meeting the manufacturer's recommendations. Provide a continuous run, without splices, from the camera to the controller cabinet.

D. Microwave Vehicle Detectors: Detects all vehicles moving within the field of detection at speeds from 2 to 80 mph.

1. Must be capable of the following:
 - a. Minimum detection range from 3 feet to 200 feet for all vehicles.
 - b. Pattern spread of the detection field no more than 16 degrees.
 - c. Self-tuning and capable of continuous operation over a temperature range of -35°F to 165°F.
 - d. Side-fire mount or overhead mount.
 - e. Detecting directional traffic and the direction user selectable.
2. Microprocessor based using Doppler microwave at an operating frequency of 10.525 GHz.
3. FCC certification and tested to the applicable FCC specifications.
4. Enclosure constructed of aluminum or stainless steel and water resistant.
5. All user operated controls and adjustments must be clearly marked and easily accessible.
6. Relay detection output to the controller with a minimum 5 amp rating and designed to place a constant call to the controller in the event of any failure.
7. Easily accessible indicator showing activation of detection relay.
8. Required wiring as recommended by the manufacturer.
9. Provide mounting hardware for the type of mounting specified in the contract documents and power supply equipment as recommended by the manufacturer.

2.03 COMMUNICATIONS

A. 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.

1. 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: 25X. Minimum digital zoom: 12X.
2. Camera system provided in a NEMA 4X or IP66 certified rugged weather-resistant package.
3. Provide all required lightning protection for electronics control, power, and coax video outputs.
4. Operating temperature range: -40°C to +50°C.

5. Maximum cable length as specified by camera manufacturer.
6. Provide full 360 degree endless pan and 220 degree tilt under PTZ control.
7. Dome electronics capable of programming a minimum of 64 preset views and nine preprogrammed pattern sequences of preset views. All views selectable by the central office computer or a remote control device.
8. Provide encoder and decoder devices as needed to transmit video over existing or proposed communication systems at 30 frames per second.
9. Provide all necessary rack support devices for video viewing and PTZ control.
10. Provide ability to control PTZ and view video remotely.

B. Fiber Optic Hub Cabinet: As specified in the contract documents.

C. Wireless Interconnect Network: Provides two-way data communication between the on-street master controller and local traffic signal controllers.

1. Data Transceiver:

- a. Utilize a license-free spread spectrum radio frequency (902-928 MHZ) with frequency hopping technology.
- b. Completely programmable by software. Furnish software to the Jurisdiction.
- c. Built-in diagnostics capabilities.
- d. Configurable as master, slave, or repeater with store and forward capability.
- e. Maintains user selectable power output levels between 0.1 and 1 watt.
- f. Operates with input voltages between 6 VDC and 30 VDC.
- g. RS-232 interface with 115.2 kbps capability.
- h. Operating temperature of -40°C to +75°C.
- i. Receiver sensitivity of -108 to -110 dBm at 10^{-6} BER.
- j. Protected from power surges.
- k. Rack or shelf mounted in controller cabinet and connections for antenna, power, and controller.

2. Antenna:

- a. Capable of transmitting and receiving data between intersections.
- b. Mount near the top of the signal pole nearest the controller cabinet or as specified in the contract documents. Provide engineer-approved mounting hardware.
- c. Connect to transceiver via appropriate cable from pole to signal cabinet in same conduit as traffic signal cable. Conceal cable within a watertight connection at antenna.

2.04 CABINET AND CONTROLLER

A. Controller, Cabinet, and Auxiliary Equipment

1. Controller: This part consists of the equipment requirements necessary for furnishing a 2070 Advanced Traffic Controller (ATC) system with a 1C CPU module and vendor matching traffic signal Controller Local Software (CLS) as described in the project plans and these special provisions.

- a. **Related Specifications and Standards:** Unless otherwise specified in the project plans and special provisions the 2070 ATC system furnished and installed under this specification shall comply with:
 - A. California Department of Transportation (Caltrans) TEES 2009 with Errata

- B. Caltrans Qualified Products List
- C. Institute of Transportation Engineers (ITE) ATC Standard 5.2b
- D. NTCIP Base Standards
- E. National Electrical Code.
- F. MUTCD latest edition.

b. General Specifications:

- A. Equipment Certification:
 1. The Contractor shall furnish the Engineer with a certification from the equipment manufacturer or supplier stating that the equipment furnished under this specification complies with all provisions of this specification. With prior approval of the Engineer, minor exceptions to this specification may be allowed, provided these exceptions are detailed on the certification.
- B. Warranty:
 1. All 2070 ATC controllers and auxiliary equipment furnished under this specification shall be provided with a standard industry warranty. Any parts found to be defective shall, upon concurrence of the defect by the manufacturer, be replaced free of charge.
- C. Delivery and Coordination:
 1. A minimum of one week prior to the scheduled "turn-on", the Contractor or supplier shall deliver the necessary components to the Traffic Signal Shop located at 1551 E Martin Luther King Jr Parkway. It is the responsibility of the deliverer to call ahead to schedule delivery.
 2. The City of Des Moines will install the 1C CPU module and verify the specified software and timings. Should any controllers be found faulty at the shop, the person/company who delivered the equipment will be contacted. The Signal Shop is not responsible for trouble shooting this equipment nor is any part of this process intended to replace "burn-in" responsibility of the manufacturer.
 3. The Contractor/Supplier is responsible for picking up the controller(s) from the Signal Shop and is solely responsible for bringing the controller(s) to full operation at the intersection(s). No assistance will be provided by the Signal crew once the software is working correctly and the signal timings have been verified in the Signal Shop. Having a knowledgeable representative at the project site(s) when the controller(s) is ready to be turned on is paramount to the safety and efficiency of this operation.

c. Controller Chassis:

- A. The ATC Controller Chassis shall comply with TEES 2009 with latest Errata and be listed on Caltrans Qualified Products List. The product shall be McCain 2070LX or City of Des Moines Project Manager approved equal.
- B. Controller Chassis shall be equipped with Linux Operating System with serial motherboard.
- C. ATC Controller Chassis Microprocessors shall be Freescale Power QUICC II Pro.
- D. ATC Controller Chassis shall include the following memory:
 1. 16MB Flash memory
 2. 128MB DDR RAM (expandable)
 3. 2MB Non-volatile SRAM
- E. ATC Controller Chassis shall include Backup Real-Time Clock (RTC).
- F. ATC Controller Chassis shall include the following Communication Interfaces:
 1. Two SDLC ports
 2. Four asynchronous Serial ports
 3. ENET 1: 100 Base-T Ethernet switch, one uplink port, and three additional port

4. ENET 2: 100 Base-T Ethernet port dedicated for local communications
 5. Two USB ports
 - G. ATC Controller Chassis shall include a Front Panel Interface with:
 1. One Display: 8 lines by 40 characters
 2. One Keyboard: 3 by 4 navigation and 4 by 4 data entry keypads
 - H. ATC Controller Chassis shall include the following Cabinet Interfaces:
 1. Rear Connections: TEES C1S, C11S, C12S
 - I. ATC Controller Chassis dimensions shall be 7 inches H by 19 inches W by 13 inches D and shall be EIA rack mount compatible.
 - J. ATC Controller Chassis power requirements shall be: 89 VAC to 135 VAC, 60 Hz (± 3 Hz).
 - K. ATC Controller Chassis shall be capable of operating in the following environment:
 1. Temperature: -37°C to $+74^{\circ}\text{C}$
 2. Humidity: 0 to 95% (non-condensing)
- d. Controller Modules:** 2070 ATC System shall be furnished with the 2070 ATC Controller Modules listed within this section.
- A. ATC Controller Modules shall comply with TEES 2009 form factor for 2070 components.
 - B. ATC Controller Modules shall be capable of operating in the following environment:
 1. Temperature: -37°C to $+74^{\circ}\text{C}$
 2. Humidity: 0 to 95% (non-condensing)
 - C. I/O Module shall be 2070-2E for Caltrans 170/2070 cabinets. I/O Module shall comply with TEES 2009 with latest Errata and be on Caltrans Qualified Products List.
 - D. Front Panel Display shall be 2070-3B small font LCD panel module with 8 lines by 40 characters, 3 by 4 navigation keypad, 4 by 4 data entry keypad.
 - E. Power Supply Module shall be 2070-4A. Power Supply Module shall comply with TEES 2009 with latest Errata and be on Caltrans Qualified Products List.
- e. Controller Local Software (CLS):** 2070 ATC 1C CPU module and CLS shall be furnished by the City. The City of Des Moines has established a procurement contract for the McCain 1C CPU module with McCain Omni EX software (version 1.11.3 or approved alternate). The 1C CPU module and software will include the following functions/features:
- F. Phases
 1. 16 volume/density vehicle phases
 2. 16 pedestrian phases
 3. Four rings
 4. Automatic barrier calculation based on compatible phases
 5. Variable phase sequence
 6. Exclusive pedestrian-phase operation
 7. Alternate timing for special vehicles, bicycles or pedestrians
 8. Advanced and delayed walk
 9. Texas diamond operation
 10. 32 output channels
 11. Four unique sets of phase timing and options selectable by pattern
 - G. Overlaps
 1. 16 vehicle overlaps
 2. 16 pedestrian overlaps
 3. Negative (excluded) vehicle and pedestrian phases
 4. Delayed start of green
 5. Flashing yellow or red arrow overlaps
 6. Detector call phases and locking
 7. Four unique sets of overlap configurations selectable by pattern

- H. Coordination
 - 1. 250 free or coordinated patterns
 - 2. Automatic or manual permissive
 - 3. Fixed or floating force off
 - 4. Reference beginning or end of green
 - 5. Change virtually all operational parameters by pattern
 - 6. 16 phase sequence selection by pattern
- I. Cabinet Inputs and Outputs
 - 1. Support all cabinet types
 - 2. Individually assignable input and output functions (I/O mapping)
 - 3. Internal multi-input Boolean logic gates with delay, extend and latch, and flashing output features
 - 4. 16 generic alarm inputs
 - 5. 16 special functions
 - 6. External pattern selection
 - 7. Pulsing preempt and transit priority input discrimination
- J. Detection
 - 1. 128 local/system detectors
 - 2. Single or dual detector speed calculation
 - 3. Phase assignments configurable per detector, multiple phases per detector
 - 4. Direct detector actuation for vehicle and pedestrian overlaps
 - 5. All NTCIP detector options
 - 6. Delay and extend timing
 - 7. Alternate passage, minimum green and pedestrian timing detection
 - 8. Vol/Occ configurable per detector
 - 9. Detector failure monitoring configurable by time-of-day
 - 10. Connect directly to video detection
- K. Communications
 - 1. Support all industry standard communication
 - 2. Fully NTCIP 1201 and 1202 compliant (mandatory and optional objects)
 - 3. NTCIP MIB and block objects for all vendor-specific parameters
 - 4. Data validation during download
 - 5. Network time client and/or server
 - 6. GPS, WWV, NMEA, and NTP time synchronization
 - 7. California AB3418E with master function for time and pattern broadcast
 - 8. USB for database upload/download, firmware upgrades, log retrieval
 - 9. Peer to peer sharing of I/O between intersections
 - 10. Web browser support
 - 11. Connected vehicle SPaT interface
- L. Preemption
 - 1. Eight preemption sequences
 - 2. Each sequence configurable for railroad or emergency vehicle operation
 - 3. Definable priority and linking
 - 4. User configurable overlap enable/disable during all preempt intervals
 - 5. Flashing and limited service options
 - 6. User assignable status options
- M. Transit Priority
 - 1. Estimated time of arrival
 - 2. 16 priority strategies in four sets, selectable by pattern
 - 3. Options to support any type of vehicle detection
 - 4. Configurable headway and preempt lockout times
 - 5. Queue jump

6. Intelligent phase time adjustment based on expected vehicle arrival
 7. Remotely actuation or enable/disable of priority strategies
 8. Support for user configurable special logic and advanced operations
 9. Programmable logic for advanced TSP applications
- N. Time-of-Day Scheduler
1. 64 schedule
 2. 64 day plans
 3. 48 events
 4. 128 actions
 5. Operational parameters changeable by time-of-day
- O. Logs
1. High resolution logging
 2. Extensive event log for management and diagnostic purposes
 3. Cycle-based measures of effectiveness
 4. Detector volume, occupancy and speed
 5. Speed trap data
 6. NTCIP global reporting conformance group for user-defined event logging
 7. User access logs

Any modifications to this specification or production shall be reviewed and approved by the City of Des Moines Project Manager.

2. Cabinet:

- a. When specified, the Model 332A or Model 332D Cabinet furnished for the project shall meet the requirements of Chapter 11 "Specifications for Cabinet Model 332A," and the Model 336 Cabinet shall meet the requirements of "Specifications for Cabinet Model 336" dated February 1982, except that the color specified in Section 1, paragraph 3 shall be changed to silver. Molex Flash Blocks shall be provided for all eight vehicle phases to program either red or yellow flashing indications. A detector input panel shall be provided on the rear left side of the cabinet. Cabinet locks shall Corbin Type 2 locks. An aluminum cabinet shall be furnished. The aluminum surface shall have an anodic coating applied. The anodic coating and anodic coating process shall meet the requirements of Section 2.4.1 and 2.4.2 of the "Traffic Signal Control Equipment Specifications," California Business, Transportation and Housing Agency, Department of Transportation, January 1989. Alternative aluminum surface treatments, which produce an equivalent uniformly textured surface, may be substituted as approved by the Engineer.
- b. Aluminum cabinet riser with same dimensions as cabinet and 12 to 18 inch height, as specified in the contract documents.
- c. Police door with auto/flash switch, manual/stop time switch, and on/off power switch for signal heads only. Controller to remain in full operation regardless of switch positions.
- d. Maintenance panel on inside of the main door containing the following test switches.
 - 1) Controller power switch.
 - 2) Detector test switches.
 - 3) Stop time switch.
 - 4) Signal flash switch.
- e. Heavy-duty clear plastic envelope attached to inside wall of cabinet or cabinet door, for cabinet wiring diagrams, 12 inches by 18 inches minimum.
- f. GFI electrical outlet and lamp in accessible location near the front of the cabinet. GFI outlet fused separately from main AC circuit breaker. Fluorescent or LED cabinet lamp connected and fused with GFI outlet. Each cabinet shall include LED lighting fixtures mounted inside the front and back portion of the cabinet. These fixtures shall include a protective cover and shall operate by a normal power UL listed ballast. Two door actuated switches shall be installed to turn on the cabinet light when the door is open, front door front light back door back light. Each switch

- should work each individual light.
- g. Back panel positions to accommodate phasing and expansibility specified in the contract documents.
 - h. Each cabinet shall be provided with devices to protect the control equipment from surges and over voltages. This shall include incoming power lines, the Input File, the Output File, and communication lines. Each inductive loop detector input wire shall be protected with a 30V MOV with (30 Joule Rating) P/n ERZ-C20 KE 470 or equal. The output of all load switch outputs shall be protected with a 150V MOV (80 Joule Rating). P/n ERZ-C20 DK 241U or equal. The MOVs shall be connected from the AC positive field terminal to the chassis ground. For the 332A or 332D cabinet, appropriate input surge protection shall be mounted on the Lower Input Termination Panel (LIP). The power distribution assembly (PDA#2) of each controller cabinet shall include a surge protection unit on the AC Service Input. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effect of lightning transient voltages applied to the AC line. The protection device shall be a two stage series parallel device. It shall include the following features and functions: AC field service single pole, nonadjustable, magnetic breaker rated for 117 VAC operation, NEC approved.
 - A. Maximum AC line voltage: 140 VAC.
 - B. Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to 1/2 the peak: 20,000 Amperes.
 - C. The protector shall be provided with the following terminals:
 1. Main line (AC line first stage terminal).
 2. Main Neutral (AC Neutral input terminal).
 3. Equipment Line Out (AC Line second stage output terminal, 10 Amps.).
 4. Equipment Neutral Out (Neutral terminal to protected equipment).
 5. GND (Earth connection).
 6. The Main AC line in and the Equipment Line out terminals shall be separated by a 200 Microhenry (minimum) inductor rated to handle 10 Amp AC Service. The first stage clamp shall be between Main Line and Ground terminals.
 7. The second stage clamp shall be between Equipment Line out and Equipment Neutral.
 8. The protector for the first and second stage clamp must have a MOV or similar solid state device rated at 20 KA and be of a completely solid stage design (i.e., no gas discharge between tubes allowed).
 9. The Main Neutral and Equipment Neutral Out shall be connected together internally and shall have an MOV similar solid state device or gas discharge tubes rated at 20 KA between Main Neutral and Ground terminals.
 10. Peak clamp voltage: 350 Volts at 20 KA (Voltage measured between Equipment Line Out and Equipment Neutral Out terminals. Current applied between Main Line and Ground Terminals with Ground and Main Neutral terminals externally tied together.). Voltage shall never exceed 350 volts.
 11. The Protector shall be epoxy encapsulated in a flame retardant material.
 12. Continuous service current, 10 Amps at 120 VAC RMS.
 13. The Equipment Line Out shall provide power to the Type 170 and to the 24 V power supply.
 14. Provide communications line protector with a mounting connector for incoming and outgoing communication line.
 - i. Neatly train wiring throughout the cabinet and riser. Bundle and attach wiring to interior panels using nonconductive clamps or tie-wraps.

- j. Cabinets shall be furnished with all necessary auxiliary control equipment to properly operate twelve signal phases and six pedestrian phases, which includes conflict monitor unit, isolation modules, detector sensing units as specified on contract documents, and load switch packs.
 - k. Cabinets shall include 14 inch aluminum riser.
- 3. Auxiliary Equipment:** Contractor shall provide/install/integrate conflict monitor/malfunction management unit, flasher, load switches, terminals and facilities, and miscellaneous equipment and materials as necessary to provide for a complete and operational traffic signal system. Specific notes include:
- a. **Loop Detector Amplifier:** All loop detector amplifier units furnished for this project shall be Model 222, Two-Channel Loop Detector Sensor Units with audible feature meeting the requirements of Chapter 4 with the following exceptions:
 - A. Digital design capable of normal operation when operated with a grounded loop.
 - B. Shall comply with all performance requirements when connected to an inductance of from 50 to 1500 microhenries.
 - C. Each detector channel shall respond to an absolute inductance change (Delta L) rather than as a percentage of the total inductance (Delta L/L).
 - D. Unit must have optically isolated outputs.
 - b. **Switch Pack:** Each vehicular and each pedestrian phase shall be provided with a separate switch pack.
 - c. **Isolator:** A Model 242 Two-Channel Isolator shall be provided to introduce stop timing to the controller from the conflict monitor and the manual flash switch.
 - d. **Conflict Monitor:** The Model 2010ECLip (w/ Ethernet Port) Monitor Unit shall be provided. The conflict monitor provided shall have broad fault coverage, full intersection display, event logging and RMS voltage reporting. It shall include support for flashing yellow arrow operation. The monitor shall include an Ethernet port for communication with a personal computer or traffic management center. Downloadable information shall include monitor status, event logs, and five signal sequence history logs, which are stored in the monitor's nonvolatile memory.
 - e. **Power Supply:** A "PDA-2" Power Distribution Assembly shall be provided.
 - f. **Shelf:** A standard print shelf drawer shall be provided and installed above the input file.
- 4. Locate Boxes:** An outdoor-rated, single gang box to house communications / interconnect tracer wire shall be installed on the exterior of the controller cabinet. The location on the cabinet shall be determined by the project engineer. The locate box shall be constructed of die-cast aluminum with a die-cast zinc weatherproof cover and self-closing lid. The box shall be 2 3/4 inches x 4 1/2 inches x 2 5/8 inches D. A 12 inch long ground wire shall be attached to a lug within the box.
- B. 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.
- 1. Include a maintenance bypass switch to allow operation of the traffic signal system while repairs are made to the battery backup system.
 - 2. Designed to provide a minimum of 4 hours of normal operation.
 - 3. Use cabinet equipment that is plug connected and shelf mounted.
 - 4. Designed to cover a temperature range from -30°F to +165°F and include a surge

suppressor.

C. Emergency Vehicle Preemption System: As specified in the contract documents.

D. Ethernet Switch: The Contractor shall coordinate the installation of an Ethernet switch with the City. The City shall provide the following:

- a. Configured Ethernet Switch
- b. Small Form Factor Pluggables (SFPs)

The Contractor shall provide the following:

- a. Jumpers
- b. All other equipment necessary to install and integrate Ethernet switch into the traffic signal cabinet.

The Contractor shall coordinate with the City Traffic Signal Shop at the onset of the project.

2.05 POES, HEADS, AND SIGNS

A. Vehicle Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.

1. **Housing:** Each section shall be complete with a one-piece, hinged door with watertight gaskets and two stainless steel locking devices. All screws, latching bolts, and hinge pins shall be stainless steel to prohibit rust and corrosion. All sections of the vehicle signal head housings shall be of the black in color including the visor and door. The black color shall be permanently molded into the components.
2. **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.
3. **Lenses:** 12 inch diameter polycarbonate. Do not use glass lenses.
4. **Visors:**
 - a. **Standard Installation:**
 - 1) Each signal lens is to have a visor with the bottom 25% open.
 - 2) Minimum 0.1 inch in thickness and black in color.
 - 3) Fits tightly against the housing door with no filtration of light between the visor and door.
 - 4) Minimum length of 9 1/2 inches. Ensure the visor angle is slightly downward.
 - b. **Optically Programmed Sections:** Make sure the optical unit and visor are designed as a whole to eliminate the return of outside rays entering the unit from above the horizontal.
5. **Terminal Block:**
 - a. Three-section signal equipped with a six position terminal block.
 - b. Four- and five-section signal equipped with an eight position terminal block.
6. **Backplate:**
 - a. Manufactured one-piece, durable, black plastic capable of withstanding a 100 mph wind.
 - b. Provides 5 inches of black field around the assembly.
7. **Mounting Hardware:**
 - a. **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.
 - b. **Universally Adjustable:** The traffic signal mounting bracket shall universally adjustable. Rigid mounted, consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes. The mounting assembly shall be of a cable type.

8. LED Modules: Comply with current ITE standards.

B. Pedestrian Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.

- 1. Housing:** The purpose of this specification is to describe minimum acceptable design and operating requirements for pedestrian traffic signal heads including all fittings and brackets, as specified on the plans.
 - a. All pedestrian signal heads shall be light emitting diode (LED).
 - b. The signal head shall be designed so that all components are readily accessible from the front by opening the signal door.
 - c. The housing shall be one piece, 16 inch by 16 inch (nominal) in size. The housing case shall include four integrally-cast, hinged lug pairs; two at the top and two at the bottom of each case. The case, when properly mated to other pedestrian signal components and mounting hardware, shall provide a dustproof and weatherproof enclosure and shall provide for easy access to and replacement of all components.
 - d. The door frame shall be one piece, complete with two hinged lugs cast at the bottom and two latch slots cast at the top of each door. The door shall be attached to the case by means of two, type 304 stainless steel spring pins.
 - e. All screws, latching bolts, and hinge pins shall be stainless steel to prohibit rust and corrosion.
 - f. The countdown pedestrian indicator unit shall fit in a traditional 16 inch by 16 inch pedestrian signal head housing.
 - g. All pedestrian signal heads shall be mounted using a clamshell-style mounting bracket.
- 2. Visor:**
 - a. Tunnel type visor attached to the housing door by stainless steel screws.
 - b. Fit tightly against the housing door to prevent any filtration of light between the door and the visor.
 - c. Ensure the visor angle is slightly downward.
- 3. LED Module:**
 - a. Provide a LED unit(s) for the filled upraised hand symbol, walking person symbol, and countdown timer.
 - b. Ensure immediate blank out of the countdown timer display upon recognizing a shortened "Walk" or a shortened "Flashing Don't Walk" interval.

C. Traffic Signal Poles and Mast Arms:

- 1. General:**
 - a. Use mast arm length and vertical pole height as specified in the contract documents.
 - b. Ensure the mast arms, poles, and supporting bases are galvanized on both interior and exterior surfaces according to ASTM A 123, or is specified on the plans, per the Pole Finish Section 2.05, C, 4.
 - c. Use continuously tapered, round, steel poles of the transformer base type. Fabricate poles from low carbon (maximum carbon 0.30%) steel of U.S. standard gauge.
 - d. 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. Use corrosion resistant hardware.
 - e. Ensure minimum yield strength of 48,000 psi after manufacture. Supply base and flange plates of structural steel complying with ASTM A 36 and cast steel complying with ASTM A 27, Grade 65-35 or better.
 - f. Where a combination street lighting/signal pole is specified in the contract

documents, ensure the luminaire arm is mounted in the same vertical plane as the signal arm unless otherwise specified. Use a luminaire arm of the single member tapered type. Fabricate the pole with a minimum 4 inch by 6 inch handhole and cover located opposite the signal mast arm.

- g. If allowed by the Engineer, poles and mast arms may be fabricated by shop welding two sections together, resulting in a smooth joint as follows:
 - 1) Ensure a minimum of 60% penetration for longitudinal butt welds in plates 3/8 inch and less in thickness, except within 1 foot of a transverse butt-welded joint. Ensure a minimum of 80% penetration for longitudinal butt welds in plates over 3/8 inch in thickness.
 - 2) Ensure 100% penetration for longitudinal butt welds in poles and arms within 1 foot of a transverse butt-welded joint.
 - 3) Ensure 100% penetration for transverse butt welds by using a back-up ring or bar to connect the sections.
 - 4) Examine the full length of all transverse butt welds and 100% penetration longitudinal butt welds by ultrasonic inspection according to the requirements of ANSI/AWS D1.1.
 - 5) Comply with ANSI/AWS D1.1 except as modified by [Article 2408.03](#), B of the Standard Specifications.
 - h. 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.
 - i. All mast-arms shall have a 4% rise when in-place and fully loaded.
 - j. Mast arms shall be continuous to 50 feet in length. Vertical pole configuration shall provide for two-piece combination pole with internal tapped plate connection to allow for addition or removal of luminaire pole extension. Poles shall be vertical under normal load.
- 2. Pole Design:** Comply with AASHTO 2013 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. 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. Install vibration mitigation devices on all traffic signal pole mast arms over 60 feet in length as shown on the figures.

The contractor shall provide designs for all concrete bases where mast arms are longer than 70 feet or when it is called for on the plans. The cost for the design shall be considered as part of the cost of the mast arm pole. This design would then be used as a substitute for footing design as shown on the signal detail sheet of the plans. The use of the ground rod and the number of conduits as indicated on the signal detail sheet of the plans shall remain the same.

- 3. Hardware:**
- a. **General:**
 - 1) Equip poles and mast arms with all necessary hardware and anchor bolts to provide for a complete installation without additional parts.
 - 2) Furnish each anchor bolt with one leveling nut, one anchoring nut, and one jam nut (if required) on the exposed end and one of the following on the embedded end: nut, nut and plate, or nut and anchor bolt assembly ring plate. Use anchor bolts, nuts, and washers that comply with [Materials I.M. 453.08](#).
 - b. **Anchor Bolts:**
 - 1) Use straight full-length galvanized bolts.
 - 2) Comply with ASTM F 1554, Grade 105, S4 (-20°F).
 - 3) Threads are to comply with ANSI/ASME B1.1 for UNC thread series, Class 2A tolerance.

- 4) The end of each anchor bolt intended to project from the concrete is to be color coded to identify the grade.
 - 5) Do not bend or weld anchor bolts.
 - c. **Nuts:**
 - 1) Comply with ASTM A 563, Grade DH or ASTM A 194, Grade 2H.
 - 2) Use heavy hex.
 - 3) Use ANSI/ASME B1.1 for UNC thread series, Class 2B tolerance.
 - 4) Nuts may be over-tapped according to the allowance requirements of ASTM A 563.
 - d. **Washers:** Comply with ASTM F 436 Type 1.
 - e. **Galvanizing:** Galvanize entire anchor bolt assembly consisting of anchor bolts, nuts, and washers (and plates or anchor bolt assembly ring plate, if used) according to the requirements of ASTM B 695, Class 55 Type 1 or ASTM F 2329 with zinc bath temperature limited to 850°F. Galvanize entire assembly by the same zinc-coating process, with no mixed processes in a lot of fastener assemblies.
4. **Pole Finish:** This section specifies requirements for certain items on the project; including signal poles, signal pole mast arms, light poles, light pole mast arms, and luminaires, as specified on the plans.
- a. **Quality Control:** The galvanizing, wet paint process, powder coating, and/or finish painting facilities shall be owned and operated by the pole manufacturer to ensure a quality coating system.
 - b. **Packaging:** Prior to shipment, small poles shall be wrapped in 0.188 inch thick Ultraviolet-inhibiting plastic backed foam. Larger poles shall be cradled in a 1.0 inch rubberized foam base.
 - c. **Field Repair Procedures:** Where factory applied finishes/coatings have become damaged or abraded due to handling, transport, installation, welding or other circumstances, they shall be repaired by the field painting crew or miscellaneous metal contractor. All damaged areas shall be thoroughly wire brushed. All dirt, oil, grease, or other contaminants shall be removed in accordance with SSPC-SP1 and SP5. Touch-up paint supplied by the galvanizer or steel fabricator, identical in color and composition to that used in the plant, shall be applied to all prepared surfaces to a dry film thickness of at least 4.0 mils.
 - d. **Method of Measurement and Basis of Payment:** Combination/Top Finishing/Coating shall be considered incidental to the price bid per each pole and shall be considered incidental to the lump sum bid for the traffic signal system.

D. Traffic Signal Pedestal Poles:

1. **Materials:**
 - a. **Pedestal:** The height from the bottom of the base to the top of the shaft as specified in the contract documents.
 - b. **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.
 - c. **Pedestal Base:** Cast aluminum, square in shape, with a handhole.
 - 1) **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.
 - 2) **Base:** Minimum weight of 20 pounds with a four bolt pattern uniformly spaced on a 13 3/4 inch diameter bolt circle. Meet or exceed AASHTO breakaway requirements.
2. **Anchor Bolts:** Four 3/4 inch by 15 inch steel, hot dip galvanized anchor bolts complying with ASTM F 1554, Grade 36, with right angle bend at the bottom end,

complete with all hardware required for installation.

E. Pedestrian Push Button Post:

1. Material:

- a. **Post:** Standard weight (Schedule 40) pipe complying with ASTM F 1083, galvanized inside and out; 2 1/2 inches in diameter.
- b. **Cap:** Waterproof cap complying with ASTM F 626.
- c. **Anchor Bolts:** Four 1/2 inch by 24 inch steel, hot dip galvanized anchor bolts complete with all hardware required for installation.
- d. **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.
- e. **Base Plate:** Provide a 5 inch square, 1/2 inch thick galvanized steel base plate with a 4 1/2 inch bolt circle.

F. Traffic Signs:

1. Comply with [Section 4186 of the Standard Specifications](#).
2. **Sign Mounting Brackets:** All signs shall be supplied with a sign bracket. The traffic sign bracket shall be an articulated serrated bracket assembly that includes top, middle, and bottom sign mounting brackets and provides a rigid-mount for the traffic sign. All necessary hardware for a complete installation on a mast arm shall be included. The mounting assembly shall be of a cable type. Approval of other bracket supports shall be based on specifications and/or test data about their physical properties and performance properties.

All pedestrian pushbutton signs shall be mounted to the signal pole using stainless steel bolts. Bolts shall be 5/16 inch flanged with plastic washer. Holes shall be drilled and tapped.
3. Comply with MUTCD and the contract documents for the street name sign dimensions, letter height and font, and sheeting.
4. **Traffic Sign Blanks:** All sign blanks shall be aluminum alloy 6061-T6 conversion coated with Alodine 1200. 5052-H38 alloy is an acceptable alternative.
 - a. All blanks shall be 0.08 inches thick with the following exceptions:
 - 1) If either the length or width dimension of a sign is 36 inches or greater, the blank shall be 0.125 inches thick.
 - 2) Overhead mounted street name signs shall be 0.125 inches thick.
 - b. Blanks shall be finished free of any surface or edge burrs, cut marks, or other irregularities.
 - c. Standard signs shall be pre-drilled with standard hardware holes (0.375 inch diameter) and have no burrs or excess material retained in or around the hole. Holes placement and radii shall conform to the Standard Highway Signs Manual, current edition.
 - d. A diagram showing the location of holes for specialty signs will be provided at the time of order.
 - e. Street name signs shall not be pre-drilled.
5. **Traffic Sign Faces:** The background sheeting used on all signs, with the exception of pedestrian pushbutton signs, shall be 3M DG3 material. Any other applied material, including legends, letters, numbers, or borders, again with the exception of pedestrian pushbutton signs, shall also be 3M DG3 material. Pedestrian pushbutton signs shall be 3M Engineer Grade Prismatic reflective sheeting.

This material shall have a standard warranty to be free from any defects for a period of not less than 7 years from the date of manufacture. A copy of the standard warranty shall be provided as a part of the bid package.

6. Street Name Signs:

- a. All street name signs shall be single-sided
- b. The length of the street name sign shall be in 6 inch increments and will vary based on the legend.
- c. Lettering shall be white and the background shall be blue or green "EC" film. The background color will be specified at the time of order.
- d. Lettering shall be Series B as outlined in the Standard Highway Signs Manual.
- e. All 12 inch or larger signs shall have a white border as shown in the attached detail.
- f. Letter size and spacing shall conform to the MUTCD and the attached details. In cases where descending lower-case letters (g, j, p, q, and y) cannot be accommodated on the specified blank, the next larger blank size shall be used..
- g. Twelve inch or larger street name signs shall be made of 3M Diamond Grade DG3 reflective sheeting. Eight inch street name signs shall be made of 3M High Intensity Prismatic reflective sheeting.

- 7. Completed Signs:** Sign faces shall be firmly attached to the aluminum sign blanks, with no air bubbles, wrinkles, creases, tears or other surface blemishes. The faces shall be neatly trimmed to match the edge of the sign blank. The sign faces shall be properly positioned to provide a uniform border around all sides of the sign.

The signs shall be handled carefully and packaged to prevent any damage to the sign faces. Any sign faces which are damaged at the time of delivery will be rejected and returned to the manufacturer. Undamaged replacement signs shall then be promptly sent, at no extra cost to the City of Des Moines.

2.06 STREETLIGHTING

- A. Luminaires:** When specified for on the plans, Contractor shall supply and install luminaires and the luminaires shall be Autobahn Series wattage equivalent as shown in the plans.
- 100 watt equivalent = ATB0 20BLEDE53 MVOLT R2
 - 150 watt equivalent = ATB0 20BLEDE10 MVOLT R2
 - 250 watt equivalent = ATB2 40BLEDE10 MVOLT R2
- B. Disconnect:** Contractor shall provide and install a disconnect breaker in the signal cabinet for the streetlighting. The disconnect shall be a QOU120 or approved equal.

PART 3 - EXECUTION

3.01 UNDERGROUND

A. Handhole:

- 1. Locations:**
 - a. Do not construct in ditch bottoms, low areas where ponding of water may occur, or where they will be subject to normal vehicular traffic.
 - b. With Engineer approval, additional handholes may be placed, at no additional cost to the Contracting Authority, to facilitate the work.
- 2. Excavation:** Excavate as necessary to accommodate the handhole and granular base.
- 3. Granular Base:** Install 8 inch thick granular base extending a minimum of 6 inches

beyond the outside walls of the handhole.

4. Placement:

- a. 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.
- b. Verify ring placement. Invert rings when installed in paved areas.

5. Conduit:

- a. Remove knockouts as necessary to facilitate conduit entrance.
- b. Extend conduit into the handhole, through a knockout, approximately 2 inches beyond the inside wall. Conduit to slope down and away from the handhole.
- c. Place non-shrink grout (complying with [Materials I.M. 491.13](#)) in the opening of the knockout area after placement of conduit.

6. Cable Hooks: Install cable hooks centered between the knockouts and the top of the handhole.

7. Casting: Place the casting on the handhole. Ensure the final elevation meets the handhole placement requirements.

B. Conduit:

1. General:

- a. Conduit buried in open trenches shall be placed a minimum of 36 inch deep and a minimum of 2 feet from the back of curb unless otherwise directed by the Engineer. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 48 inches below the finished pavement surface or as directed by the Engineer.
- b. 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.
- c. 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 foundation, footing, or structural base.
- d. 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.
- e. Pack conduit ends with a conduit sealing compound.
- f. When underground conduits parallel an existing facility, maintain at least 1 foot of separation.
- g. All conduit will be proofed by the Contractor upon completion to verify continuity and integrity of the duct.
- h. Each conduit shall include one pull tape and tracer.
- i. The Contractor is responsible for locating all new conduits until project acceptance.

2. Trenched Installation:

- a. 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.

- b. Remove all surplus material from the public right-of-way as soon as possible.

3. Trenchless Installation:

- a. If trenchless methods that compact soils in the bore path are used, provide sufficient cover to prevent heaving of overlying paved surfaces.
- b. Do not allow pits for boring to be closer than 2 feet to the back of curb, unless otherwise specified in the contract documents.

C. Wiring and Cable:

1. 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.
2. Each vehicle and pedestrian signal head shall have a separate cable from the signal head to the pole base. A 7-conductor cable shall be used for all four or five section vehicle heads. A 5-conductor cable shall be used for all three section vehicle heads unless otherwise specified in the plans. All signal head cables shall be spliced in the pole base and/or signal cabinet, unless specified otherwise on the plans. Within the cabinet, all signal cables shall be labeled as to their direction of origin. All splices in the handhole compartment of a signal pole shall be made using silicone filled, screw-on wire connectors. Wires shall be twisted before the connector is added. Cable connections in signal heads and controller cabinets shall be made at the terminal blocks provided for that purpose, without using crimp-on connectors.
3. Install continuous runs for video detection and emergency vehicle preemption cables from the unit to the controller cabinet.
4. The Contractor shall coil 50 feet of power service cable at the base of the secondary service pole. The Contractor is responsible for coordinating power service locations with MidAmerican Energy at the onset of the project, prior to conduit/cable installation. The Contractor is responsible for the cost of the secondary service riser installed by MidAmerican Energy and all associated power service connection costs and fees until acceptance of the project. Meter to be installed onto side of the traffic signal controller cabinet; the meter socket to be a 200A with by-pass.
5. 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.
6. 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.
7. 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.
8. A continuous orange tracer wire (1c No. 10) shall be included from each quadrant to the

controller cabinet. A separate orange tracer wire (1c No. 10) shall be included in all conduits with all fiber optic communication cable. A yellow tracer wire shall be used in conduits with only streetlight circuits. Tracer wire for the signal system shall terminate on a terminal block with connection points in the controller cabinet and shall be labeled with the quadrant of origin. Tracer wire for the communication/fiber system shall terminate in the locate box and list direction. The Contractor shall install, splice, and test the tracer wire for continuity. Every tracer wire run shall be grounded at one end.

9. Fiber Optic Cable and Accessories:

- a.** 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.
- b.** 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. Do 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.
- c.** 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. Install cable by pulling 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.
- d.** At each handhole or through point and at the cabinet, the cable shall be visibly and durably marked or tagged with the type of cable (single mode or multi-mode), the fiber count, and "FIBER OPTIC CABLE, CITY OF DES MOINES". Additionally, each cable shall be marked with the adjacent intersection of origin and destination. In cases where cables are spliced in a splice enclosure only the intersection of origin is needed.

Example:

FIBER OPTIC CABLE, CITY OF DES MOINES
48 FIBER – SM
EAST – 63 rd & HICKMAN WEST – WESTOVER & HICKMAN

- e.** Secure cables inside controller cabinet so that no load is applied to exposed fiber strands.
- f.** 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.
- g.** Slack shall be left in each handhole, at the top of any conduit riser, in each junction

box, in each controller cabinet, and at each equipment rack or other point of termination. Slack in handholes shall be 100 feet in Type III and Type IV handholes, 50 feet in Type I and Type II handholes, and 10 feet in 18 inch handholes. 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.

- h.** Install fiber optic accessories according to the manufacturer's recommendations and as specified in the contract documents.
- i.** All fibers, unless stated otherwise in the plans, shall be terminated in the fiber optic termination unit. The enclosure shall be mounted on an EIA 19 inch rack in an area that does not interfere with the normal maintenance of the cabinet electronics. The field cable shall be secured to the enclosure in a manner that does not degrade the fiber optic cable but insures a firm and secure mount. Sufficient lengths of every loose fiber shall be coiled within the enclosure to provide spare distance and reach the fiber interface panel. Spiral wrap each individual fiber in the fan out kit. Each fiber shall be labeled on the bulkhead by direction and intersection of origin

Example:

A – North –
 B – South – 63rd & Univ.
 C – East – MH & Hick.
 D - West

- 10. Fiber Optic Cable Field Testing:** Provide for each fiber both on-reel testing prior to installation and final testing after installation using a high-resolution optical time domain reflectometer (OTDR). Conduct measurements for single-mode fibers at 1310 ± 30 nanometer wavelength. Conduct measurements for multimode fibers at 850 ± 30 nanometer wavelength. Record the identification, location, length, and attenuation measurements of each fiber, and furnish test reports to the Engineer. Replace any cable that fails testing, at no additional cost to the Contracting Authority.
 - a.** On-reel Testing: Perform testing for attenuation and continuity using OTDR and a pigtail splice. Complete testing in one direction only. Acceptable test results will be within $\pm 3\%$ of factory-supplied attenuation measurements. Except for access to and test preparation of one end of the newly furnished cable, preserve the cable in its originally-shipped condition. Furnish test reports to the Engineer prior to installation.
 - b.** Cable Segment Testing: Perform an end-to-end attenuation test of each terminated fiber of each fiber optic cable. Perform testing using hand-held optical test sets. Include test results in documentation package provided to the Engineer at the conclusion of the project. Acceptable test results will not exceed the cumulative specified losses of the components. For example, at 850 nanometers, a one kilometer multimode fiber link with two splices and a connector on each end will not exceed 5.6 dB:

1.0 km x 3.5 dB/km:	3.5 dB
0.3 dB per splice x 2:	0.6 dB
0.75 dB per connector x 2:	<u>1.5 dB</u>
Maximum allowable loss:	5.6 dB

Repair or replace any cable segment that fails testing. Retest any repaired or replaced cable. Submit complete documentation of test results to the Engineer (hard copy or electronically).

- c. **Final System Testing:** After complete fiber optic system is installed and terminated, but prior to capping unused fibers, perform OTDR readings on all cables to ensure that each section is in compliance with the specifications. Provide copies of OTDR trace signatures for all fibers for all cable sections to the Engineer. Also provide test results for attenuation test for the installed fibers using the insertion loss procedure and the transmitter/receiver power level test and the continuity test.
11. The Contractor shall also provide and install all wiring and luminaires as shown in the plans. The Contractor shall connect the cables in the pole to the intersection lighting cable using fused connectors. Breakaway, fused connectors shall be used for all connections.

D. Footings and Foundations:

1. **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.
2. **Foundation:** Provide a means for holding all of the following elements rigidly in place while the concrete is being placed.
 - a. **Forms:**
 - 1) Set the forms level or sloped to meet the adjacent paved areas.
 - 2) When adjacent to paved areas, shape the top 11 inches of the foundation to be square and flush with the surrounding paved area. Provide preformed expansion material between the foundation and paved areas.
 - 3) When installed in an unpaved area, shape the top 11 inches of the foundation to be square and set the top of the foundation 2 inches above the surface of the ground.
 - 4) The Contractor shall be responsible for the proper elevation, offset, and level of each foundation.
 - b. **Reinforcing Steel:** Install reinforcing steel.
 - c. **Conduit:** Install conduit.
 - d. **Anchor Bolts:**
 - 1) Set anchor bolts using a template constructed to accommodate the specified elevation, orientation, and spacing according to the pole and controller manufacturer's requirements.
 - 2) Center the pole anchor bolts within the concrete foundation.
 - 3) Protect the anchor bolts until poles are erected.
 - 4) 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.
 - e. **Concrete:**
 - 1) Place concrete to form a monolithic foundation. Consolidate concrete by vibration methods.
 - 2) 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 or foundation
 - 3) Allow the foundation 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.

3. **Modifications:** When installing a conduit bend in an existing base the conduit size shall be equivalent to the conduit in the ground. The steel in the base shall not be cut or damaged and the concrete shall be broken away in the shape of a "U" with an approximate depth of at least 12 inches below the depth of the surrounding ground surface. Enough concrete shall be removed so the conduit will be inside the anchor bolts of the foundation. The conduit shall be placed in the "U" with concrete added in the "U" and finished to match the base.

E. Bonding and Grounding:

1. Ensure the traffic signal installation is grounded as required by the National Electric Safety Code.
2. Install a ground rod at each signal pole foundation and controller footing.
3. Use PVC conduit within the foundation or footing to accommodate the connection between the top of the concrete and the ground rod.
4. Bond poles to ground rods with copper wire. Connect ground wires to ground rods with approved mechanical connectors.
5. Bond rigid steel conduit ends in handholes with copper wire and approved fittings.
6. Metal conduit, service equipment, anchor bolts, metal poles, pedestals, controller cabinets, interconnect cable shields, and all other electrical equipment shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. The grounding conductor shall be a No. 6 AWG copper, non-insulated wire. The ground wire shall be installed in all conduits with the exception of the 1 inch conduit between the detector loops and the handhole, and any conduit containing only detector lead-in cable or fiber.
7. Grounding shall be accomplished by bonding the grounding circuits to copper clad metal, driven electrodes. The electrodes shall be driven vertically until the top of the rod is minimum of 4 inches below grade. Bonding to the ground rod shall be made by means of suitable screw type positive ground rod clamps. The controller cabinet ground shall measure 10 ohms or less.
8. Grounding to existing water lines will not be permitted.
9. Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or to 1 inch, or longer, brass or bronze bolt installed in the lower portion of the shaft.
10. The service meter and socket shall be bonded to a ground electrode by use of a ground clamp and a No. 6 AWG copper wire.
11. Bonding of metallic conduit in concrete pull boxes and manholes shall be by means of galvanized grounding bushings and bonding jumpers. Where there is a change, at a pull box or manhole, from non-metallic conduit to metallic conduit, the grounding wire in the non-metallic conduit shall be bonded to the metallic conduit. Saddle clamps are not acceptable.
12. Existing ungrounded metal poles on which cabinets are mounted shall be grounded by means of a driven ground rod.
13. The interconnect cable shield shall be bonded to the controller ground buss at one

controller termination point for each interconnect run.

3.02 DETECTION

A. Detector Loop Cable Installation:

1. Coordinate the location of the detector loop with the Engineer. Obtain the Engineer's approval prior to cutting the pavement.
2. 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.
3. 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.
4. Install detector loop cable without damage. Place three turns of the detector loop cable into the saw cut, unless otherwise specified in the plans. Seal the ends of the tubing at the time of placement to prevent entrance of moisture.
5. 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.
6. Install preformed loop detector according to the manufacturer's recommendations.
7. 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.
8. Twist, with at least five turns per foot, all lengths of loop wires and tubing that are not embedded in the pavement.
9. Identify all detector loop lead-in cables with appropriate detector numbers.
10. 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.
 - a. 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.
 - b. Use a manufactured electrical splice kit approved by the Engineer.
11. Test all loops and document by using the following procedures:
 - a. 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.
 - b. Determine the inductance of the loop using a loop inductance meter.

B. Pedestrian Push Button Detectors:

1. Install according to the manufacturer's recommendations.

2. Seal the wire entrance into the pedestrian push button assembly.

C. Video Detection Camera System: Install according to the manufacturer's recommendations and as specified in the contract documents.

3.03 COMMUNICATIONS

A. Traffic Monitoring System: Install according to the manufacturer's recommendations and as specified in the contract documents, as well as the following:

1. Position camera dome on the pole as directed by the Engineer.
2. Test installed system under the supervision of the Engineer, and certify as fully-functional.

B. Fiber Optic Hub Cabinet: Install according to the manufacturer's recommendations and as specified in the contract documents.

3.04 CABINET AND CONTROLLER

A. Controller, Cabinet, and Auxiliary Equipment:

1. Install according to the manufacturer's recommendations and as specified in the contract documents.
2. 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.
3. The aluminum rack edge shall be labeled for each detector amplifier, load switch, and isolator.
4. The cabinet shall be oriented 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 project engineer.

B. Controller: Install according to the manufacturer's recommendations and as specified in the contract documents.

C. UPS Battery Backup System: Install according to the manufacturer's recommendations and as specified in the contract documents.

D. Emergency Vehicle Preemption System: Install according to the manufacturer's recommendations and as specified in the contract documents.

3.05 POLES, HEADS, AND SIGNS

A. Vehicle and Pedestrian Traffic Signal Heads:

1. Inspect each signal head assembly while still on the ground for the following:
 - a. Physical defects
 - b. Visor type
 - c. LED wattage
 - d. Lens orientation
 - e. Wiring connections
2. Attach signal head mounting hardware according to the manufacturer's

recommendations. Apply anti-seize compound to all mechanical fasteners.

3. Adjust each signal head both vertically and horizontally to approximate a uniform grade of all like signal heads.
4. 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.
5. All mast-arm mounted traffic signal heads shall have backplates. Universally adjustable brackets and cable banding shall be used to mount all pole-mounted and mast arm-mounted overhead signals. All overhead displays located on each mast arm shall have each red indication set at approximately the same elevation, unless otherwise directed by the Engineer. All optically limited signal heads shall be properly masked to limit their field of view as directed by the Engineer.

B. Traffic Signal and Pedestal Poles and Pedestrian Push Button Posts:

1. Erect all poles and posts vertically under normal load.
2. Securely bolt the bases to the cast-in-place concrete foundations using the following procedures. Perform this work only on days with winds less than 15 mph. Tighten all of the nuts in the presence of the inspector. Once the tightening procedure is started, complete on all of the base plate nuts without pause or delay.
 - a. Use properly sized wrenches or sockets, or both, designed for tightening nuts or bolts, or both, to avoid rounding or other damage to the nuts. Do not use adjustable end or pipe wrenches.
 - b. Ensure base plates, anchor rods, and nuts are free of all dirt or debris.
 - c. Apply stick wax or bees wax to the threads and bearing surfaces of the anchor bolt, nuts, and washers.
 - d. Tighten top nuts so they fully contact the base plate. Tighten leveling nuts to snug tight condition. Snug tight is defined as the full effort of one person on a wrench with a length equal to 14 times the bolt diameter but not less than 18 inches. Apply full effort as close to the end of the wrench as possible. Perform tightening by leaning back and using entire body weight to pull firmly on the end of the wrench until the nut stops rotating. Perform a minimum of two separate passes of tightening. Sequence tightening in each pass so that the nut on the opposite side, to the extent possible, is subsequently tightened until all of the nuts in that pass have been tightened.
 - e. Tighten top nuts to snug tight as described for the leveling nuts.
 - f. Match-mark the top nuts and base plate using paint, crayon, or other approved means to provide a reference for determining the relative rotation of the nut and base plate during tightening. Further tighten the top nuts tightened in two passes, as listed in Table 8010.01, using a striking or hydraulic wrench. Follow a sequence of tightening in each pass so that the nut on the opposite side, to the extent possible, is subsequently tightened until all nuts in that pass have been turned. Do not allow the leveling nut to rotate during the top nut tightening.
 - g. Lubricate the jam nuts, place, and tighten to snug tight.

Table 8010.01: Bolt Tightening

Anchor Bolt Size	First Pass	Second Pass	Total Rotation
Less than or equal to 1 1/2 inch diameter	1/6 turn	1/6 turn	1/3 turn
Greater than 1 1/2 inch diameter	1/12 turn	1/12 turn	1/6 turn

3. A torque wrench should be used to verify that a torque at least equal to the computed verification torque, T_v , according to paragraph 6.9 of FHWA *Guidelines for the Installation, Inspection, Maintenance, and Repair of Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, is required to additionally tighten the top nuts. An inability to achieve this torque should be interpreted to indicate that the threads have stripped and should be reported to the Engineer.
 4. 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.
 5. Apply anti-seize compound to all mechanical fasteners on pole access doors.
 6. 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.
- C. Traffic Signs:** Install signs using universally adjustable sign brackets banded to the pole. Apply anti-seize compound to all mechanical fasteners.

3.05 TEMPORARY TRAFFIC SIGNAL

Construct according to the configuration specified in the contract documents. Remove the temporary traffic signal as directed by the Engineer.

3.06 SURFACE RESTORATION

Replace or reconstruct features removed as a part of the work, such as sidewalks, driveways, curbs, roadway pavement, unpaved areas, or any other items.

3.07 TESTING

- A. 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.
- B. 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.
- C. All required signal timing data will be provided by the Engineer.
- D. 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.
- E. 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.

3.08 DOCUMENTATION

- A. Provide file documentation packages with each signal system, consisting of the following:

1. Complete cabinet wiring diagram.
 2. Complete physical description of the equipment.
 3. Controller printout or equal documentation of initial controller settings installed in the field or in the office.
 4. Product manuals for all cabinet equipment.
 5. Standard industry warranties on equipment supplied.
 6. Documentation of field cable labeling scheme.
 7. Diagram of phasing and detector locations.
 8. One set of as-built construction plans indicating changes from the original contract documents.
- B. 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

3.10 PAINTING

- A. If the painted surface of any equipment is damaged in shipping or installation; such equipment shall be retouched or repainted in a manner satisfactory to the Engineer.

PART 4 – ADDITIONAL BIDDING ATTACHMENTS

4.01 SCHEDULE OF UNIT PRICES

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	PRECAST CONCRETE HANDHOLE, TYPE IV	15	EA	\$ _____	\$ _____
2	FIBER OPTIC CABLE - SM 12	10,909	LF	\$ _____	\$ _____
3	TRACER - 1c #10	8,158	LF	\$ _____	\$ _____
4	PULL TAPE	8,158	LF	\$ _____	\$ _____
5	2" PVC (SCH 80), PUSHED	9,572	LF	\$ _____	\$ _____
6	FIBER TERMINATION IN SIGNAL CABINET PER SPECIFICATIONS	1	LS	\$ _____	\$ _____
TOTAL LUMP SUM TO FURNISH AND INSTALL TRAFFIC SIGNAL INTERCONNECT					\$ _____

Approved:

City Traffic Engineer

Date

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	PRECAST CONCRETE HANDHOLE, TYPE I	1	EA	\$ _____	\$ _____
2	LOOP DETECTOR - 8x20'	5	EA	\$ _____	\$ _____
3	CABLE - 2c #14 SHIELDED DETECTOR LEAD-IN CABLE	200	LF	\$ _____	\$ _____
4	TRACER - 1c #10	200	LF	\$ _____	\$ _____
5	GROUND - 1c #6	200	LF	\$ _____	\$ _____
6	PULL TAPE	200	LF	\$ _____	\$ _____
7	2" PVC (SCH 80), TRENCHED	200	LF	\$ _____	\$ _____
TOTAL LUMP SUM TO FURNISH AND INSTALL TRAFFIC SIGNALIZATION					\$ _____