

TRAFFIC SIGNALS

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 Division 1 of SUDAS - General Provisions and Covenants, as well as the additional requirements listed below. All of the following must be submitted within 30 days after awarding of the contract for the project. Verify the method of submittal with the 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 Jurisdiction 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 SUBSTITUTIONS

Comply with Division 1 of SUDAS - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 of SUDAS- General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 of SUDAS - General Provisions and Covenants. Traffic signal installation shall be coordinated so to minimize impact to traffic. For replacement projects, existing signals shall remain operational as long as possible. This may require installation of new facilities during non-peak traffic flows, possibly at night. New mast arm installation shall not conflict or block existing active signals.

1.07 SPECIAL REQUIREMENTS

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

1.08 MEASUREMENT AND PAYMENT

A. Traffic Signal:

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

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 installation.

PART 2 - PRODUCTS

2.01 UNDERGROUND

A. Handhole

1. **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

2. Composite Handhole and Cover:

- a. Refer to contract documents for specific product information.
- b. Cover: Include "TRAFFIC SIGNAL" text on lid. Alternate messages may be required as specified in the contract documents.

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. Plastic Conduit and Fittings:

a. PVC:

- 1) PVC Schedule 80 plastic conduit and fittings complying with NEMA TC-2 (pipe), NEMA TC-3 (fittings), and UL 651 for Schedule 80 heavy wall type. Schedule 40 fittings are allowed within concrete encasements.
- 2) Solvent welded, socket type fittings, except where otherwise specified in the contract documents.
- 3) Threaded adaptors for jointing plastic conduit to rigid metal ducts.
- 4) 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 for underground fiber optic cable and red or black conduit for traffic signal cable installation.
- 3) Continuous reel or straight pieces to minimize splicing.
- 4) For dissimilar conduit connections, provide an adhesive compatible with both materials.

3. Steel Conduit and Fittings:

- a. Steel conduit shall not be used on new construction and shall be used only as approved by the Engineer.
- b. Comply with ANSI C80.1.
- c. 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.
- d. Provide steel bushings.

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 Iowa DOT Article 4185.11.

2. Signal Cable: Comply with IMSA Specifications 19-1 (PVC jacket) or 20-1 (polyethylene jacket) for polyethylene insulated, 600 volt, stranded, multi-conductor copper wire, #14 American Wire Gauge (AWG). The number and size of conductors as specified in the contract documents.

3. **Tracer Wire:** Comply with #10 AWG, single conductor, stranded copper, type thermoplastic heat and water resistant, nylon-coated (THWN), with UL approval, and an orange colored jacket.
4. **Category 5E/6 (Cat5E/Cat 6) Cable:** Provide outdoor use rated cable. Cable shall be shielded and gel filled with pure copper conductors.
5. **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. Fiber Distribution Panel: Provide a fiber distribution panel capable of terminating 24 fibers, or as specified in the contract documents. The distribution panel shall be installed within a wall or shelf mountable housing.
 - c. Fiber Optic Connectors:
 - 1) ST type connectors of ceramic ferrule and physical contact end finish to terminate single-mode fibers to equipment.
 - 2) Mechanical connectors not allowed for cable splices.
 - 3) Maximum attenuation per connector: 0.75 dB.
 - d. Fiber Optic Jumpers/Patch Cords: For connections in the cabinet, provide 4 factory assembled jumpers with dielectric strength member, durable outer jacket, and ST to LC connectors. Provide adequate length for connections and 2 feet minimum slack.
 - e. Fiber Optic Pigtail Kits: Provide 24 single mode fiber pigtail kit with ST connectors suitable for termination of the fiber.
 - f. Fiber to Ethernet Switch: Refer to contract documents for specific product information.

D. Footings and Foundations:

1. Use Class C structural concrete complying with Iowa DOT Section 2403.
2. Use uncoated reinforcing steel complying with Iowa DOT Section 4151.

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 #6 AWG bare conductor, copper wire.

2.02 DETECTION

- A. 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. Refer to contract documents for specific product information.
- b. The configuration will consist of four cameras (unless otherwise specified in the plans), mounting assemblies, one to four rack-mounted detector cards or SDLC link, card racks, field video monitor (minimum 9-inch screen), software and all associated equipment required to set up and operate in a field environment.

- c. Provide operations manuals and one service manual with schematics and parts list for out of warranty repairs.
- B. Radar Detection:** Detects vehicles by processing radar data and providing detection outputs to the traffic signal controller.
- 1. Radar Detection Units:**
 - a. Refer to contract documents for specific product information.
 - b. The configuration will consist of four to eight units as specified in the contract documents, mounting assemblies, cabling, software, cabinet equipment, and all equipment necessary for set-up and operation in a field environment.
- C. Video/Radar Hybrid Detection System:** Detects vehicles near the stop bar by processing video images and detects vehicles in advance of the stop bar by processing radar data. The video and radar provide detection outputs to the traffic signal controller.
- 1. Video/Radar Hybrid Detection Units:**
 - a. Refer to contract documents for specific product information.
 - b. The configuration will consist of two to four units as specified in the contract documents, mounting assemblies, cabling, software, cabinet equipment, and all equipment necessary for set-up and operation in a field environment.
- D. Inductive Loop Vehicle Detector:** A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.
- 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.
 - 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 Iowa DOT 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 2,000 micro-henries. Output circuits of the sensor 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.

E. 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.

2. Accessible Pedestrian Signals (APS) Push Buttons:

- 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.
- i. **Signs:** MUTCD signs R 10-3e (9" x 15") on all APS units.
- j. **Braille Message:** Include on all APS pushbuttons.
- k. **Audio Files:** Provide a copy of custom audio files to the City on USB drive or CD.
- l. Refer to contract documents for specific product information.

- m. Refer to contract documents for APS order form for specified Braille message for informational signs and specified voice messages for push buttons.

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 to + 165°F.
- e. **Signs:** MUTCD sign R 10-3e (9" x 15") with all solid state pushbuttons.
- f. Refer to contract documents for specific product information.

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) Dome Camera:

- a. High definition (HD) video resolution.
- b. Refer to contract documents for specific product information.

2.04 CABINETS AND CONTROLLER

- A. **NEMA Controller, Cabinet:** Comply with the latest edition of NEMA TS2 standards.

1. Controller and Multi-Malfunction Unit (MMU):

- a. City shall furnish traffic signal controller with 55 pin A-connector and SDLC connector.
- b. City shall furnish MMU.

2. Signal Cabinet:

a. General Requirements:

- 1) Cabinet shall be NEMA TS-2 Type 1.
- 2) Base mount controller cabinets shall be NEMA P size with 8 phase-16 load switch back panel and 15" cabinet riser.
- 3) Cabinet shall have a TS-2 detector rack with BIU, 16 vehicle detector inputs and 4 preemption inputs.
- 4) Cabinet shall be supplied with all necessary components for a fully operational traffic signal including network components. All components shall comply with any relevant NEMA standards.
- 5) Transfer switch: Reliance C30A1L, or approved equal, transfer switch installed and prewired on signal cabinet, right side near top.

b. Cabinet Construction:

- 1) The controller and all associated equipment shall be housed in weatherproof metal cabinet of clean-cut design and appearance.

- 2) Cabinet, riser, and all mounting attachments shall be natural, brushed aluminum.
- 3) Cabinet lifting eyes shall be installed on cabinet.
- 4) A hinged door shall be provided permitting complete access to the interior of cabinet. When closed, the door shall fit closely to gasket material, making the cabinet weather and dust resistant. The door shall be provided with a strong lock and #2 key.
- 5) Provide a stop and catch arrangement for the door. Door shall be able to be stopped at open angles of 90 degrees and 180 degrees, ± 10 degrees.
- 6) Provide a police door in the cabinet door with a skeleton key lock. Police panel shall have signal/off switch, flash/normal switch, auto/manual control switch and pluggable manual pushbutton. Label all switches.
- 7) Provide a service panel on inside of cabinet door with controller on/off, flash/normal, stop time on/off/normal and flash/normal switch. Label all switches.
- 8) Provide 2 – 10" deep mounting shelves. Top shelf is for network switch and power supply (left side), detector rack with power supply (right side). Provide brackets under top shelf for 1 RU 19-inch rack device. Bottom shelf is for monitor, controller, pedestrian detector unit and MMU. Provide slide out print drawer/laptop table with bottom shelf.
- 9) Screws used for mounting shelves or other mounting purposes shall not protrude beyond the outside wall of the cabinet.
- 10) Provide a GFCI service outlet located in an accessible place. Outlet to be powered by a separate circuit from service pedestal.
- 11) Provide LED lighting controlled by a door-actuated switch to illuminate all parts of the cabinet interior during nighttime hours.
- 12) Provide a wall-mounted fiber enclosure in the top left side of the cabinet. It shall be easily removed by loosening 4 mounting screws. Enclosure shall be Panduit FWME4.
- 13) Provide a thermostatically controlled fan unit with a minimum rating of 100 cfm to provide forced air ventilation through the cabinet. The fan unit shall be mounted to the inside top of the cabinet and shall be easily removed and replaced without having to dismantle any part of the cabinet or exhaust duct system. The thermostat controlling the fan shall be adjustable. The electrical circuit controlling the fan shall be able to be de-energized for fan replacement without affecting the signal operation. The fan shall intake air through filtered vents located near the bottom of the cabinet or cabinet door and exhaust it through a weather-proof, screened duct located near the top of the cabinet. 12" X 16" pleated cloth type filters shall be used to cover the air intakes into the cabinet. Filters shall be easily removed and replaced.

c. Cabinet Connecting Cables, Wiring and Panels:

- 1) Provide TS-2 type 2 A connector, 55 pin.
- 2) Provide SDLC cable for detection controller unit. Include jack for future SDLC cable.
- 3) Provide circuit breakers for all overload protection instead of fuses.
- 4) Provide eight AC receptacles in cabinet for network or detection devices, no GFCI feature.
- 5) Provide surge suppression and line filter in power inlet panel.
- 6) Provide clear plastic cover over power inlet panel.

- d. **Cabinet Warranty:** The equipment furnished shall be new, of the latest model fabricated in first-class workmanlike manner from good quality material. The manufacturer shall replace free of charge to the purchaser any part that fails in any manner by reason of defective material or workmanship within a period of 18 months from date of shipment from the supplier's factory, but not to exceed one year from the date of operation after installation.
 - e. **Cabinet Documentation:** Provide two printed sets and electronic format (PDF) of the following diagrams and documentation:
 - 1) Complete schematic diagram, accurate and current for unit supplied.
 - 2) Complete physical description of unit.
 - 3) Complete installation procedure for unit.
 - 4) Specifications and assembly procedure for any attached or associated equipment required for operation.
 - 5) Warranty and guarantee on unit, if any.
 - 6) Any relevant manuals.
- B. Service Cabinet and Back-To-Back Battery Back-Up System:** Provide a combination battery backup/electrical service with meter and lighting controller.
- 1. **General Requirements:**
 - a. Provide metered disconnect for traffic signal.
 - b. Provide metered disconnect for street lighting.
 - c. Provide dedicated conduits that connect the unit with the adjacent handholes and traffic signal controller cabinet as specified in the plans.
 - d. The service pedestal shall be part of the continuously grounded traffic signal system.
 - e. Provide two 2-pole lighting circuits, controlled by photocell.
 - 2. **Cabinet Construction:**
 - a. Fabrication from 1/8-inch anodized or natural brushed aluminum.
 - b. Small and low profile with no exposed fasteners.
 - c. Durable all welded construction.
 - d. Vandal proof doors with hasp stress rated to 2000 lbs.
 - e. Factory wired and tested before shipment.
 - f. UL approved copper cable busing and control wiring.
 - g. Meets EUSERC requirements.
 - h. Metered circuits up to 100 Amps.
 - i. Dual Cabinets external dimensions: 20.5 inches wide x 50 inches high x 19.25 inches deep, excluding door handles.
 - j. Internal parts fabricated from 14 gauge cold rolled steel.
 - k. Welded construction with welding materials specifically designed for the material used.
 - l. Stainless steel fasteners, latches, and hardware and continuous piano style hinges.
 - m. No exposed nuts, bolts, screws, rivets, or other fasteners on the exterior.
 - n. Removable back pan mounted on four welded 1/4 inch studs.
 - o. Fully framed side hinged outer doors with swagged close tolerance sides for flush fit with top drip lip and closed cell neoprene flange compressed gaskets.

- p. Base mounting detail identical to existing cabinets for emergency replacement.
- 3. Dead front Safety Door:**
- a. Hinged dead front panel with 1/4 turn latch and knurled knobs for distribution and control panel.
 - b. Hinged dead front door on the same side as the front door minimum opening of 120 degrees.
 - c. GFCI service outlet mounted in dead front panel.
- 4. Power Distribution Panel:**
- a. Main breakers shall be 1 pole, 2 pole, 3 pole as appropriate for the installation, and in accordance with the local utility.
 - b. Provide circuit breakers for the following: battery backup, signal A (after backup), signal B (after backup), 2-pole lighting A, 2-pole lighting B, service outlets and control circuit.
 - c. Industrial grade circuit breakers. No plug-in circuit breakers.
 - d. Install all branch circuit breakers in a vertical position with handle up for 'On', handle down for 'Off'.
 - e. U.L. approved copper THHN cable busing, fully rated.
- 5. Battery Back-Up System:**
- a. Vandal-resistant construction.
 - b. 1400 VA, 950 Watts, Industry Standard run time 3 hours - all LED Intersection.
 - c. T0ypical Intersection (700 watts) run time 2 hours, with 6-8 hours of selected flash.
 - d. Inverter Tilt-out housing for easy maintenance.
 - e. No tools required for inverter 110 contact connections and simple slide-in installation with weight not to exceed 28 pounds.
 - f. Full power bypass and isolation switches.
 - g. Transient voltage protection.
 - h. Power analyzer with triple redundant bypass.
 - i. Conditioned power.
 - j. Power conflict monitor with isolation and transfer module.
 - k. Watchdog timer with redundant 5 ms delay and hard transfer to utility power.
 - l. Low battery and on battery relay outputs.
 - m. Ethernet port for local or remote monitoring.
 - n. Intelligent battery management system with microprocessor controlled smart battery charger, automatic self-test, cell guard for longer life and faster recharge times.
 - o. 24V 18AH batteries AGM/VRLA (absorbed glass mat/valve regulated lead acid), compact, lightweight and not to exceed 25 pounds.
 - p. Seismically rated fixed position framed battery trays.
 - q. Quick swap hot battery replacement system.
 - r. Heavy duty smart safety battery connection system, 30A silver plated plugs.
 - s. Battery manufacturer's 2-year warranty.

6. Control Compartment

- a. All components to match existing components in use for maintenance of spare parts and known reliability.
- b. Factory prewired cabinet.
- c. All control wiring: 19 strand #14 AWG THHN.
- d. Provide permanent terminal labels.

7. Identification Nameplates:

- a. Identify the function of circuit breakers, switches and other components as required by laminated engraved plastic nameplates fastened with minimum of two 1/4 inch, #4-40 machine screws.

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

2.05 POLES, HEADS, AND SIGNS

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

1. General:

- a. Provide signal heads complete with all fittings and brackets for a complete installation.
- b. All exterior surfaces shall be black in color.
- c. Traffic signal vehicle head housings and assemblies shall be EAGLE polycarbonate or approved equal.
- d. Pack or crate each signal separate and complete by itself. Clearly mark the outside of each package or crate showing the manufacturer, type, catalog number, purchaser, purchase order number, and project.

2. Housing:

- a. Individual signal sections made of a durable polycarbonate. Color shall be black. Color to be an integral part of the materials composition.
- b. Main body assembly shall consist of one or more polycarbonate sections having integral cast serrations so when assembled with the proper brackets, may be adjusted in increments and locked securely to prevent moving. Sections shall be designed so that when assembled, they interlock with one another. Provide waterproof joints between all sections. Hold sections firmly together by locknuts or other means approved by the Engineer. Plug any open end on assembled signal face housing with an ornamental cap and gasket.
- c. Equip with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
- d. Provide doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material. Doors are to be easily removed and reinstalled without use of special tools.

3. 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.

4. **Lenses:** 12-inch diameter polycarbonate. Do not use glass lenses.
5. **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:** When specified in the contract documents, assure the optical unit and visor are designed as a whole to eliminate the return of outside rays entering the unit from above the horizontal.
6. **Terminal Block:**
 - a. Mounted in the back of the second section of the signal head and secured at both ends.
 - b. Three-section signal equipped with a six position terminal block.
 - c. Four- and five-section signal equipped with an eight position terminal block.
7. **Backplate:**
 - a. Manufactured one-piece, durable, black thermoplastic capable of withstanding a 100 mph wind.
 - b. Thickness: 0.125 inch.
 - c. Rounded corners with 2 ½ inch radii.
 - d. Provide minimum 5 inches of black field around the assembly.
 - e. Supplied with attaching bolts or screws in sufficient quantity to securely hold back plates to the signal heads.
 - f. Provide Pelco (or approved equal) vacuumed formed backplates compatible with EAGLE polycarbonate housings.
 - g. Provide backplates with all vehicle signal heads, unless otherwise directed by the Engineer.
8. **Mounting Assemblies:**
 - a. **General:**
 - 1) Provide watertight assemblies.
 - 2) Plug open segments of fittings with ornamental plugs and gaskets.
 - 3) Banding is not allowed on upright signal poles. Drill and tap all signal heads on upright signal poles.
 - b. **Side of Pole Mount:** Provide black nylon 1- way upper and lower arm assemblies.
 - c. **Mast Arm Mount:** Provide SKYBRACKET cable mount or Astro-Brac Tallon (or approved equal) and all necessary components for a complete installation.
9. **LED Modules:** Comply with current ITE standards and provide LED signal modules with a 15- year warranty.

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

1. General:

- a. All exterior surfaces shall be black in color.

2. Housing:

- a. Made of a durable polycarbonate. Color to be black and an integral part of the materials composition.
- b. Provide a single unit, nominal 16 inch x 18 inch, with “egg crate” housing and mounting attachments. Left half shall display a “Hand” symbol and a “Walking person” symbol. Right half shall display clearance interval countdown numerals.
- c. Equip with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
- d. Doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material. Doors are to be easily removed and reinstalled without use of special tools. Lenses shall be made of vandal resistant polycarbonate or acrylic plastic.

3. Visor:

- a. 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.

4. LED Module:

- a. Provide light emitting diode (LED) lamps with incandescent look that meet or exceed ITE PTCSI-2 LED Pedestrian Signal Specifications.
- b. Ensure immediate blank out of the countdown timer display upon recognizing a shortened “Walk” or a shortened “Flashing Don't Walk” interval.

5. Mounting Assemblies:

a. General:

- 1) Provide watertight assemblies.
- 2) Plug open segments of fittings with ornamental plugs and gaskets.
- 3) Banding is not allowed on upright signal poles. Drill and tap all signal heads on upright poles.

- b. Side of Pole Mount:** Provide black nylon one-way upper and lower arm assemblies.

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.
- 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. Provide a handhole directly opposite the traffic signal mast arm connection point for cable access. Provide a cover for the handhole. Secure the cover to the base with simple tools. Use corrosion resistant hardware.
- f. Provide a lug in the pole base near the handhole to permit connection of a #6 AWG grounding wire.
- g. 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.
- h. Where a combination street lighting/signal pole is specified in the contract documents the following apply:
 - 1) Ensure the luminaire arm is mounted in the same vertical plane as the signal arm unless otherwise specified.
 - 2) Use a luminaire arm of the single member tapered type.
 - 3) Fabricate the pole with a minimum 4 inch by 6 ½ inch handhole and cover located opposite the signal mast arm near the bottom of the luminaire pole.
 - 4) Luminaire extension to be a separate pole connected to the signal pole via a bolted internal tapped plate connection above the mast arm. Provide steel plates welded to the bottom of the luminaire pole and the top of the signal pole.
 - 5) Luminaire extension pole to provide a 35-foot luminaire mounting height, unless otherwise approved by the Engineer.
 - 6) Luminaire arm length to be 15 feet with an orientation of 10 degrees counterclockwise from the mast arm, unless otherwise noted in the contract documents.
 - 7) Luminaire arm to be capable of supporting a pan-tilt- zoom camera, a video detection camera, and/or a radar detector.
- i. Where a combination street lighting/signal pole is not specified in the contract documents, the following apply:
 - 1) Provide a traffic signal pole that will support a future luminaire extension.
 - 2) Provide a steel plate welded to the top of the pole to receive the future luminaire extension. Steel plate to be tapered unless otherwise specified in the contract documents.
 - 3) Future luminaire to be installed 35 feet above the pavement surface with luminaire arm extended 15 feet from the pole, unless otherwise specified in the contract documents.
- j. Provide a J- hook wire support (a curved 3/8 inch diameter steel bar) 6 inches to 12 inches above and 90 degrees with respect to the opening for each mast arm and luminaire arm.

- k. Poles and mast arms may not be fabricated by shop welding two sections together.
 - l. Fabricate traffic signal poles and mast arms to handle the loading indicated in the contract documents.
 - m. Provide a rodent guard (complying with Iowa DOT Materials I.M. 443.01 for placement between the pole base and the foundation).
- 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.
- 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 Iowa DOT 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.
 - 5) Refer to Section 8010 3.05 B.2 for tightening procedure and requirements.
 - 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.

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 shall be 4 ½ 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 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. Provide a lug in the base near the handhole to permit connection of a #6 AWG grounding wire.
 - 2) **Base:** Minimum weight 20 pounds with a four bolt pattern uniformly spaced on a 12 ½ inch diameter bolt circle. Meet or exceed AASHTO breakaway requirements.
2. **Anchor Bolts:** Four ¾ 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 Pushbutton Station:** Refer to contract documents for specific product information.

F. Traffic Signs:

1. Comply with Iowa DOT Section 4186.
2. Provide SKYBRACKET or Astro-Brac Tallon (or approved equal) for mast arm mounted signs.
3. Comply with MUTCD and the contract documents for the street name sign dimensions, letter height and font, and sheeting.

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. Do not place handholes in paved areas without Engineer's approval.
- b. 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.
- c. 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 Iowa DOT Materials I.M. 491.13) in the opening of the knockout area after placement of conduit.

6. Backfill: Place suitable backfill material according to SUDAS Section 3010.

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

B. Conduit:

1. General:

- a. Place conduit to a minimum depth of 30 inches and a maximum depth of 60 inches below the gutterline. When conduit is placed behind the curb, place to a minimum depth of 24 inches and a maximum depth of 48 inches below top of curb.
- b. Change direction at handholes or by bending, such that the conduit will not be damaged 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.

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. When placing conduit under pavements, use the trenchless installation methods described in SUDAS Section 3020.
- b. If trenchless methods that compact soils in the bore path are used, provide sufficient cover to prevent heaving of overlying paved surfaces.
- c. 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. Refer to the contract documents for specific color coding for each type of signal head. Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.
2. Install continuous runs of vehicle and pedestrian signal cables from the vehicle or pedestrian signal head to the handhole compartment of the signal pole base. Install continuous runs of vehicle and pedestrian signal cables from the handhole compartment of the signal pole base to the terminal compartment in the controller cabinet. Do not splice signal cables in underground handholes.
3. Install continuous runs for pedestrian push button, video detection, and emergency vehicle preemption cables from the unit to the controller cabinet.
4. Install continuous runs of power lead-in cables from the service point to the meter socket and from the meter socket to the controller cabinet.
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 in the handhole. Provide a minimum of 4 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. Install a tracer wire in all conduits with the exception of conduits between detector loops and handholes. Use a silicon-filled wire nut to splice the tracer wire in each handhole and at the controller to form a continuous run.

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 breakaway 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. Secure cables inside controller cabinet so that no load is applied to exposed fiber strands.
- e. 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.
- f. Provide cable slack in each handhole, junction box, and cabinet as specified in the contract documents. Provide 100 feet of slack coiled in the handhole nearest the fiber trunk line and the handhole nearest the controller cabinet. Where handholes or junction boxes lack sufficient area for cable storage or bend radius requirements, provide equivalent additional slack in adjacent facilities. Coil and bind slack cable at three points around the cable perimeter and support in its static storage position.
- g. Install fiber optic accessories according to the manufacturer's recommendations and as specified in the contract documents.

10. Fiber Optic Cable Field Testing: To be completed by others.

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.

Construction of the foundations may require hand excavation to verify location of utilities.

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) Provide preformed expansion material between foundation and adjacent paved areas.
 - 3) When installed in an unpaved area, set the top of the foundation 2 inches above the surface of the ground.
 - 4) Remove all forms before backfilling after required cure time.
 - 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. **Backfill:** Place suitable backfill material according to SUDAS Section 3010.

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 the handhole nearest each signal pole foundation and controller footing.
3. Bond poles, pedestals, pushbutton stations, and cabinets to ground rods with copper wire. Connect ground wires to ground rods with approved mechanical connectors.
4. Bond rigid steel conduit ends in handholes with copper wire and approved fittings.

3.02 DETECTION

- A. Video Detection System:** Install according to the manufacturer's recommendations and as specified in the contract documents. Coordinate with overhead utility companies to assure required clearances are provided and assure utility locations do not obstruct or interfere with the operation of the video detection.
- B. Radar Detection System:** Install according to the manufacturer's recommendations and as specified in the contract documents.
- C. Video/Radar Hybrid Detection System:** Install according to the manufacturer's recommendations and as specified in the contract documents.
- D. Detector Loop Cable Installation:**
 - 1. Coordinate the location of the detector loop with the Engineer. Obtain 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. 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. #1 clockwise, #2 counter-clockwise, #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.

E. Pedestrian Push Button Detectors:

1. Install according to the manufacturer's recommendations.
2. Seal the wire entrance into the pedestrian push button assembly.
3. The placement of the pedestrian pushbuttons is critical in meeting ADA requirements. Final pushbutton placement to be approved in the field by the Engineer.

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.

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, apply caulking material around the base of the cabinet.
3. Mount with 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.

4. All field wiring must be directly attached to the wiring lugs. Attachment of wiring shall be in a neat and workmanlike manner.
 5. Seal conduit openings in the controller cabinet with an approved sealing compound per Section 2.0.B.1.b.
 6. Deliver in good condition to the Engineer all wiring diagrams, service manuals, instructions for installing and maintaining the equipment.
 7. Inspection of the installation by the Engineer or their representative shall be completed prior controller activation to assure proper installation in accordance with the manufacturer's recommendations.
- B. Controller:** Install according to the manufacturer's recommendations and as specified in the contract documents.
- C. Multi- Malfunction Unit:** Install according to the manufacturer's recommendations and as specified in the contract documents.
- D. UPS Battery Backup System:** Install according to the manufacturer's recommendations and as specified in the contract documents.
- E. 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. When ready for operation, plumb and aim heads.
5. Note the date of activation on the back of each LED module in black permanent marker.

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 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, in two passes as listed in Table CR 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 CR 8010.01 Bolt Tightening

Anchor Bolt Size	First Pass	Second Pass	Total Rotation
Less than or equal to 1 ½ inch diameter	1/6 turn	1/6 turn	1/3 turn
Greater than 1 ½ 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 been stripped and should be reported to the Engineer.

4. After leveling the poles, install a rodent guard between the pole base and the foundation.
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 by drilling and tapping to the pole. Apply anti-seize compound to all mechanical fasteners.

3.06 TEMPORARY TRAFFIC SIGNAL

Construct according to the configuration specified in the contract documents.

3.07 SURFACE RESTORATION

- A. Replace or reconstruct features removed as a part of the work, such as sidewalks, driveways, curbs, roadway pavement, unpaved areas, or any other items.
- B. Complete restoration according to the applicable sections of the SUDAS Standard Specifications or as directed by the Engineer.

3.08 TESTING

- A. Cabinet testing: deliver cabinet to City of Cedar Rapids Traffic Signal Shop a minimum of two weeks prior to installation for testing.
- B. Notify the Engineer five working days in advance of the time and date the signal or signal system will be ready for activation. Do not turn on the signal or signal system without authorization of the Engineer and on-site representative from the City of Cedar Rapids Traffic Engineering Division.
- C. Ensure a representative from the manufacturer and/or supplier of the detection system or other authorized person is at the project site when the detection system is ready to be turned on to provide technical assistance including, as a minimum, programming of the system.
- D. All required signal timing data will be provided by the Engineer.
- E. 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.

- F. 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.
- G. If there are multiple traffic signals within the project, the test period shall not begin until all signals within the project are installed and ready to be tested.

3.09 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.
 - 9. Complete list of serial numbers for all devices and components supplied by the Contractor.
- B. Supply all documentation in electronic form, along with two complete sets of paper documentation. One set to be placed in the controller cabinet and the other set (less construction plan) to be delivered to the Engineer.

FIGURES

- CR 8010.102 Traffic Signal Pole Foundation
- SUDAS 8010.104 Inductive Loop Vehicle Detectors
- CR 8010.105 Mast Arm Pole Details
- SUDAS 8010.107 Wood Post Span Assembly
- CR 8010.990 Cabinet Footing Details
- CR 8010.991 Precast Handhole Details
- CR 8010.992 Push Button Pedestal Pole and Placement Details
- CR 8010.993 Video Detector Mounting Detail

END OF SECTION