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**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**

Follow the General Provisions (Requirements) and Covenants as well as the following:

- A. Schedule of Unit Prices:** Within 30 days after awarding of the contract for the project, 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:** Within 30 days after awarding of the contract for the project, submit a completed list of materials and equipment. Submit six copies to the Jurisdiction for written approval before any equipment or materials are ordered.
- C. Contractor Certification:** Submit the name 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 six copies of shop drawings for traffic signal poles and structures to be furnished on the project. Submit six copies of catalog cuts and manufacturer's specifications for all items in the equipment list.

**1.04 SUBSTITUTIONS**

Follow the General Provisions (Requirements) and Covenants.

**1.05 DELIVERY, STORAGE, AND HANDLING**

Follow the General Provisions (Requirements) and Covenants.

**1.06 SCHEDULING AND CONFLICTS**

Follow the General Provisions (Requirements) and Covenants.

**1.07 SPECIAL REQUIREMENTS**

Comply with the 2003 Edition of MUTCD for the following traffic signal specifications ([Section 8010](#)).

**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.

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**PART 2 - PRODUCTS****2.01 UNDERGROUND****A. Handhole:****1. General:**

- a. **Cable Hooks:** Galvanized steel cable hooks with a minimum diameter of 3/8 inch and a minimum length of 5 inches.
- b. **Granular Base:** Processed gravel or crushed stone complying with [Iowa DOT 4109, Gradation No. 3](#).

**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 and at the half the depth of the handhole.
- b. **Casting:** Gray cast iron and certified according to requirements of AASHTO M 306 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.**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.
- 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.
- 3) Continuous reel or straight pieces to minimize splicing.
- 4) For dissimilar conduit connections, provide an adhesive compatible with both materials.

**2.01 UNDERGROUND (Continued)**

- 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 4185.12](#).
  - 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, #14 American Wire Gauge (AWG).
  - 3. Tracer Wire:** Comply with #10 AWG, single conductor, stranded copper, Type thermoplastic high-heat nylon-coated (THHN), with UL approval, and an orange colored jacket.
  - 4. Communications Cable:** Comply with IMSA Specifications 39-2 or 40-2 for #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:** As allowed by the Jurisdiction or specified in the contract documents.
- D. Foundations:**
- Use Class C structural concrete complying with [Iowa DOT Section 2403](#).
  - Use reinforcing steel complying with [Iowa DOT Section 2404](#).
- E. Bonding and Grounding:**
- 1. Grounding Rods:** Provide 5/8 inch by 8 foot copper clad, steel ground rod at each pole and controller footing.
  - 2. Bonding Jumper or Connecting Wire:** Provide #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.
- 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:**
    - 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.
    - Use a sealant complying with [Iowa DOT Materials I.M. 491.18](#).

**2.02 DETECTION (Continued)****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 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. Operating Button:**

- a. Nonrusting metal alloy.
- b. Ensure the button does not protrude out from the case.
- c. Supply ADA compliant operating button.

**3. Signs:** Furnish push button signs complying with MUTCD.**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.

**2.02 DETECTION (Continued)**

- 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) Proper operation during sunrise and sunset.
  - 6) Ability to select direction of flow parameters.
  - 7) Ability to properly detect bi-directionally.
  - 8) Operate in presence mode with less than 4% error.
- c. Provide user-defined detection zone programming via a graphical user interface (GUI) using a monitor and mouse, or laptop computer. Store detection zones in non-volatile memory. Provide monitor and mouse, or computer software to the Jurisdiction.
- d. Comply with NEMA TS-1 environmental and physical standards with an operating temperature of -34°C to +74°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 6 to 48 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 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:** As specified in the contract documents.
- 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:** As specified in the contract documents.
- B. Controller:** As specified in the contract documents.
- C. 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 wired to the input from utility power.
- D. 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. Housing:**

- a. Individual signal sections made of a durable polycarbonate. Use color specified in the contract documents. Color to be an integral part of the materials composition.
- b. Self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together.
- c. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
- 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.

**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:** Rigid mounted, consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes.

**8. LED Modules:** Comply with current ITE standards.

**2.05 POLES, HEADS, AND SIGNS (Continued)****B. Pedestrian Traffic Signal Head Assembly:** Comply with current MUTCD and ITE standards.**1. Housing:**

- a. Made of a durable polycarbonate. Use color specified in the contract documents. Color to be an integral part of the materials composition.
- b. Self-contained unit capable of separate mounting or inclusion in a signal face containing one or more signal sections rigidly and securely fastened together.
- c. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
- 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.

**2. Visor:**

- a. Tunnel type visor attached to the housing door by stainless steel screws.
- b. Minimum of 7 inches in length.
- c. Encompass the entire top and sides (bottom open) of the pedestrian signal face and fit tightly against the housing door to prevent any perceptible filtration of light between the door and the visor. 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. Comply with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.
- b. Designed to support the loading necessary for all traffic control equipment. Capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure.
- c. Mast arm length and vertical pole height as specified in the contract documents.
- d. Ensure the mast arms, poles, and supporting bases are galvanized inside and out according to ASTM A 123.
- e. Continuous tapered, round, steel poles of the transformer base type. Fabricated from low carbon (maximum carbon 0.30%) steel of U.S. standard gauge.
- f. When a transformer base is not specified, provide a 6 inch by 16 inch handhole in the pole shaft for cable access. Provide a cover for the handhole. Secure the cover to the base with simple tools. Hardware to be corrosion resistant.
- g. Ensure minimum yield strength of 48,000 psi after manufacture. Supply base and flange plates of structural steel complying with AASHTO M 183 (ASTM A 36) and cast steel complying with ASTM A 27, Grade 65-35 or better.
- h. Where a combination street lighting/signal pole is specified in the contract documents, the luminaire arm is to be mounted in the same vertical plane as the signal arm unless otherwise specified. Use a single member tapered type arm for the luminaire arm type. Equip the pole with a minimum 4 inch by 6 inch handhole and cover located opposite the signal mast arm.

**2.05 POLES, HEADS, AND SIGNS (Continued)**

- i. If allowed by the Engineer, poles and mast arms may be fabricated by welding two sections together, resulting in a smooth joint and factory welded as follows:
  - 1) Ensure a minimum of 60% penetration for plates 3/8 inch and less in thickness for longitudinal butt welds, except within one foot of a transverse butt-welded joint. Ensure a minimum of 80% penetration for plates over 3/8 inch in thickness.
  - 2) Ensure 100% penetration for longitudinal butt welds on poles and arms within one foot of a transverse butt-welded joint.
  - 3) Ensure 100% penetration, achieved by back-up ring or bar, for transverse butt welds for connecting.
  - 4) Examine 100% of transverse butt welds and 100% penetration longitudinal butt welds by ultrasonic inspection according to the requirements of AWS D1.1-80.AH.
  - 5) Comply with Structural Welding Code AWS D1-180, as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel Highway Bridges and by Supplemental Specifications No. 969.

**2. Hardware:**

- a. Equipped with all necessary hardware and anchor bolts to provide for a complete installation without additional parts.
- b. Anchor bolts complying with ASTM A 36, hot dip galvanized and threaded a minimum of 6 inches at one end and have a 4 inch long, 90 degree bend at the other end.
- c. Washers complying with ASTM F 436.
- d. Heavy hex nuts complying with ASTM A 563.
- e. All hardware made of steel, hot dipped galvanized complying with ASTM F 2329, or ASTM B 695, Class 50, Type I, or electrodeposited coated of the same coating thickness and designed for this purpose.

**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 12 1/2 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 with right angle bend at the bottom end, complete with all hardware required for installation.

**E. Traffic Signs:**

1. Comply with [Iowa DOT Section 4186](#).
2. Use a universally adjustable mast arm mounted sign bracket.
3. Comply with MUTCD and the contract documents for the street name sign dimensions, letter height and font, and sheeting.

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**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 [Iowa DOT Materials I.M. 491.13](#)) in the opening of the knockout area after placement of conduit.
- d. Cut conduit ends within the handhole at 90 degrees.

**6. Cable Hooks:** Install cable hooks centered between the knockouts and the top of the handhole.**7. Backfill:** Place suitable backfill material according to [Section 3010](#).**8. 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 36 inches below top of curb.
- b. Change direction at handholes or by bending, such that the conduit will not be injured 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 footing or structural base.

**3.01 UNDERGROUND (Continued)**

- 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 [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. 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. 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 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 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.

**3.01 UNDERGROUND (Continued)**

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.

**D. 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 overexcavation to ensure support and stability of the foundation.
2. **Footing:** 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 10 inches of the footing to be square and flush with the surrounding paved area. Provide preformed expansion material between the footing and paved areas.
    - 3) When installed in an unpaved area, set the top of the footing 2 inches above the surface of the ground.
  - 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 footing.
    - 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.
    - 3) Allow the footings to cure a minimum of 4 days prior to erecting the poles and 7 days prior to installing the mast arms. Times may be shortened if supported by strength test results.
3. **Backfill:** Place suitable backfill material according to [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 each signal pole and controller footing.
3. Use PVC conduit within the footing to accommodate the connection between the top of the footing and the grounding 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.

**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. 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. 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.
7. Twist, with at least five turns per foot, all lengths of loop wires and tubing that are not embedded in the pavement.
8. Identify all detector loop lead-in cables with appropriate detector numbers.
9. 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.
10. 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.
- 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.

- 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.

**B. Traffic Signal and Pedestal Poles:**

1. Erect all poles vertically under normal load.
2. Securely bolt the bases to the cast-in-place concrete foundations.
  - a. Mast Arm Poles: Level by using two nuts on each anchor bolt or according to the manufacturer's recommendations.
  - b. Pedestal Poles: Level by using metal shims and one nut on each anchor bolt or according to the manufacturer's recommendations.

**3.05 POLES, HEADS, AND SIGNS (Continued)**

3. After leveling the poles, use non-shrink grout (complying with [Iowa DOT Materials I.M. 491.13](#)) or 1/4 inch square banded galvanized hardware cloth between the pole base and the foundation. Neatly finish exposed edges of grout to present a pleasing appearance. Place a weep hole in the grout.
  4. Apply anti-seize compound to all mechanical fasteners on pole access doors.
- C. Traffic Signs:** Install signs using universally adjustable sign brackets banded to the pole. Apply anti-seize compound to all mechanical fasteners.

**3.06 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 the applicable sections of the SUDAS Standard Specifications or as directed by the Engineer.

**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.

**3.08 DOCUMENTATION (Continued)**

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 construction plans.
- 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.

END OF SECTION