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(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Polk County
TAP-T-0187(632)--8V-77

Effective Date
September 16, 2014

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

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I. OVERVIEW

PART 1 - GENERAL

1.01 SECTION INCLUDES

An overview of the work, standards, submittals, substitutions, scheduling and conflicts, testing and maintenance, guarantee, surface restoration, and measurement for payment expected with each traffic signal installation.

1.02 DESCRIPTION OF WORK

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

1.03 STANDARDS

The installation of the traffic control signals and appurtenances shall conform to the MUTCD.

Electrical equipment shall conform to NEMA standards, and all material and work shall conform to the requirements of the NEC, International Municipal Signal Association (IMSA), ASTM, the American Standards Association (ASA), and local ordinances that are in effect at the date of advertising of the project documents. Miscellaneous electrical equipment and materials shall be UL approved.

1.04 SUBMITTALS

A. Submit applicable brochures, technical data, catalogs, cuts, diagrams, manufacturer's drawings, samples if required, and other descriptive data including the complete description, trade name, model number, type, size, and rating.

B. Six copies of shop drawings shall be furnished for steel mast arm poles that are to be furnished on the project.

C. Six copies of catalog cuts and manufacturer's specifications shall be furnished for all standard "off-the-shelf" items. Engineer review of shop drawings and catalog cuts shall not relieve the Contractor of any responsibility under the contract documents.

D. Manufacturers shall certify electrical equipment, signal equipment, and materials to ensure compliance with the contract documents.

E. Forward to the Engineer three copies of a list of unit costs for each item listed on the schedule of unit prices by the preconstruction meeting. The sum of the costs for each item shall equal the total contract lump sum price for the traffic signal installation(s).

F. Upon request, the Contractor will provide material certifications to the Engineer.

1.05 SUBSTITUTIONS

A. Use only materials conforming to this specification.

B. Obtain approval of Engineer for substitutions prior to use.

1.06 SCHEDULING AND CONFLICTS

A. Schedule work to minimize disruption of public streets and facilities. Develop traffic control in accordance with the MUTCD. Submit a schedule of planned work activities.

B. Immediately notify the Engineer of any conflicts discovered or any changes needed to

accommodate unknown or changed conditions as soon as they are found.

1.07 TESTING AND MAINTENANCE OF SIGNAL EQUIPMENT

A. Notify the Engineer the date the signal or signal system will be ready for testing once the project is open to traffic.

B. A representative from the manufacturer and/or supplier of signal controller shall be 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. Required signal timing data will be provided by the Engineer.

C. Upon authorization by the Engineer, place the signal or signal system in operation for a consecutive 30 calendar day test period. The signal(s) shall not be placed into operation without prior notification and authorization by the Engineer. Any failure or malfunction of the equipment furnished by the Contractor due to quality of work and/or material defects, exclusive of minor malfunctions (such as lamp burnouts) occurring during the test period, shall be corrected at the Contractor's expense and the signal or system tested for an additional consecutive 30 calendar day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 calendar days.

D. Respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported, after signal turn on and prior to final acceptance of the completed traffic signal system.

1.08 GUARANTEE

A. Fully guarantee the traffic control signal installation against defective equipment and materials for 12 months, and quality of work for 6 months. If defects develop under normal operating conditions within these specified periods after acceptance of the completed installation by the Engineer, the defects shall be corrected by, and at the expense of the Contractor.

B. Provide guarantee in writing on company or corporation letterhead stationery to the Engineer prior to final acceptance. Transfer required equipment warranties to the Engineer prior to the date of final acceptance.

1.09 SURFACE RESTORATION

A. Replace or reconstruct sidewalks, curbs, driveways, roadway pavement, and any other surfaces, removed, broken, or damaged with the same kind/quality of materials. Whenever a part of a square or slab of existing concrete sidewalk, driveway, or pavement is broken or damaged, the entire square or slab shall be removed and reconstructed. Restoration is incidental to this contract item.

B. Whenever excavation is made across parkways, driveways, or sodded areas, the sod, topsoil, crushed stone, or gravel shall be replaced or restored as nearly as possible to its original condition and the whole area involved shall be left in a neat and presentable condition. Concrete sidewalks, pavements, base courses, and bituminous surfaces shall be replaced with new materials.

1.10 MEASUREMENT FOR PAYMENT

All measurements for payment will be made by the Engineer.

A. The Traffic Signal Installation(s) will be paid for at the contract lump sum price. This price shall be full compensation for furnishing all equipment, materials, and labor necessary or incidental to the construction of the complete signal installation.

B. Monthly estimates of the work performed will be made based on the schedule of unit prices and will be used to prepare progress payments to the Contractor. The schedule of unit prices will also be used to establish the total cost for any extra work orders related to traffic signal installation work items unless otherwise negotiated.

II. CONDUIT SYSTEM AND CONCRETE BASES

PART 1 - GENERAL

1.01 SECTION INCLUDES

Section includes conduit system, handholes, and structural concrete bases as designated for removal, modification, installation, and construction in the project plans.

PART 2 - PRODUCTS

2.01 HANDHOLES

A. Furnish precast concrete handhole, or poured in place concrete handhole, each with cast iron ring and cover. The body of a handhole shall meet the requirements for Class 1500D concrete pipe as applicable.

B. Cast iron ring and cover may be rated light duty for non-traffic areas (145 pounds minimum); but shall be rated heavy duty for traffic areas (320 pounds minimum) where shown on the plans. Deviations in weights shall not exceed ±5%. The cover shall have the words TRAFFIC SIGNAL cast on the top of the cover.

C. Cable hooks shall be galvanized steel with a minimum diameter of 0.375 inch and a minimum length of 5 inches.

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

2.02 CONDUIT SYSTEM

A. Rigid steel conduit shall be galvanized steel and meet the requirements of ANSI Standard Specification C80.1. Fittings used with rigid steel conduit shall be galvanized steel only.

B. Polyvinyl chloride conduit (PVC) shall meet the requirements of NEMA TC-2, Type 2, and applicable UL Standards.

C. Sealing compound shall be readily workable soft plastic at temperatures as low as 30°F and shall not melt or run at temperatures as high as 300°F.

2.03 CONCRETE BASES

A. Footings shall be Class C structural concrete.

B. Reinforcing Steel:

1. Deformed bars; ASTM A 615, Grade 40

2. Fabricate and bend cold, per approved submittals or plans.

PART 3 - EXECUTION

3.01 HANDHOLES

A. Additional handholes may be installed, at the Contractor's expense, to facilitate the work.

B. Provide four cable hooks in all handholes. Anchor in the wall of the handhole utilizing appropriate anchoring devices.

C. When the use of forms is required they shall be set level and of sufficient thickness to prevent warping or other deflections from the specified pattern. A means shall be provided for holding conduit runs rigidly in place while the concrete is placed. All conduits shall enter the handhole at a depth of 12 inches from the top of the handhole. The ends of all conduit leading into the handhole shall fit approximately 2 inches beyond the inside wall. Cast iron rings and covers for handholes shall be set flush with the sidewalk or pavement, or 1 inch above the surface of the ground.

3.02 CONDUIT SYSTEM

A. When it is necessary to cut and thread steel conduit, no exposed threads will be permitted. Tighten all coupling until the ends of conduits are brought together. Conduit and fittings shall be free from burrs and rough places and conduit runs shall be cleaned, swabbed, and reamed before cables are installed. Use nipples to eliminate cutting and threading of short lengths of conduit. Paint damaged galvanized finish on conduit with zinc rich paint. Approved conduit bushings shall be installed on the exposed ends of rigid steel conduit.

B. Bell end fittings shall be installed on the exposed ends of PVC conduit.

C. Change in direction of conduit shall be accomplished by bending such that the conduit will not be injured or its internal diameter changed. Bends shall be of uniform curvature and the inside radius of curvature of any bend shall not be less than six times the internal diameter of the conduit. Extend conduit 2 inches to 4 inches above finished surface in all bases.

D. Place conduit buried in open trenches a minimum of 24 inches deep. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Place conduit in pavement areas a minimum depth of 24 inches below the finished pavement surface.

E. Deposit backfill material in layers not to exceed 6 inches in depth and compact thoroughly before the next layer is placed. Backfill material shall be free of cinders, broken concrete, or other hard or abrasive materials. Remove surplus material from the public right-of-way.

F. Place pushed conduit by jacking, pushing, boring, or any other means necessary to place the conduit without cutting, removing, or disturbing existing pavement. The size of a bored hole shall not exceed the outside diameter of the conduit that is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than 2 feet to the back of curb.

G. Seal conduit openings in the controller cabinet, handholes, and bases with sealing compound.

3.03 CONCRETE BASES

A. Concrete bases for poles and controllers shall be poured to form a monolithic foundation. The bottom of all foundations shall rest securely on firm undisturbed ground. The forms shall be set level or sloped slightly to blend with the adjacent ground level and means shall be provided for holding them rigidly in place while the concrete is being deposited. Anchor bolts for the signal poles or the controller cabinet shall be set in place by means of a template constructed to space the anchor bolts in accordance with the manufacturer's requirements. The center of the template and the center of the concrete base shall coincide. Concrete shall be consolidated by vibration during placement.

B. Finish the top of the base level and round top edges with a 0.5 inch radius edger. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top 10 inches of the base shall be formed square and flush with the surrounding paved area. Provide preformed expansion material between the base and the other paved area. When installed in an earth shoulder away from the pavement edge, the top of the concrete base shall be approximately 2 inches above the surface of the ground. The exposed surface of the base shall have a rubbed surface finish.

C. After the foundation or base has been poured, absolutely no modification of any sort may be made. If the anchor bolts, conduit, or any part of the foundation or base is installed in an incorrect manner as determined by the Engineer, the entire foundation or base shall be removed and a new foundation or base installed at the Contractor's expense.

D. Cover the anchor bolts in such a manner as to protect them against damage and to protect the public from possible injury prior to setting poles.

III. WIRING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Signal cable, power lead-in, loop detector lead-in, tracer wire circuit materials, grounding, methods, and fiber optic cable and accessories, designated for modification or installation in the contract documents.

PART 2 - PRODUCTS

2.01 CABLE

A. Cable for signalization shall be rated 600 V minimum. Cable shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.

B. Power lead-In cable shall be 600 V, single conductor, stranded copper, Type USE, with UL approval.

C. Signal cable shall be multi-conductor copper wire, and meet the requirements of IMSA Specification 19-1.

D. Loop detector wire (with plastic tubing) wire shall meet the requirements of IMSA Specification 51-5.

E. Detector lead-in cable shall meet the requirements of IMSA Specification 50-2.

F. Tracer wire shall be a No. 10 AWG, single conductor, stranded copper, Type THHN, with UL approval and an orange colored jacket.

G. Communication cable for signal interconnection circuits shall be No. 19 AWG, solid copper conductor, twisted pairs. The cable shall be polyethylene insulated, aluminum shielded, conforming to the requirements of REA Specification PE-39, for paired communication cable with electrical shielding.

H. Ground wire shall be a No. 6 AWG bare copper wire and bonding jumpers shall be #6 AWG bare cooper wire connected by approved clamps.

I. Fiber Optic Cable and Accessories:

1. Furnish fiber optic cable of the mode type, size, and number of fibers specified in the contract documents, and all associated accessories.

2. Meet the latest applicable standard specifications by ANSI, Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA).

3. Multimode Fiber:
Core Diameter: 62.5 um ± 1.0 µm
Cladding Diameter: 125.0 um ± 1.0 µm
Core Concentricity: ± 1%
Max. Attenuation: 3.50 dB/km @ 850 nm

4. Single-Mode Fiber:
Typical Core Diameter: 8.3 um ± 1.0 µm
Cladding Diameter: 125.0 um ± 1.0 µm
Core Concentricity: ± 1%
Attenuation Uniformity: No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm
Max. Attenuation: 0.25 dB/km @ 1550 nm, 0.35 dB/km @ 1310 nm

5. Dual layer UV cured acrylate coating applied by the fiber manufacturer, mechanically or chemically strip-able without damage to the fiber.

6. Glass reinforced plastic rod central member designed to prevent the buckling of the cable. Cable core interstices filled with water blocking tape to prevent water infiltration. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.

7. Buffer tubes of dual layer construction with a polycarbonate inner layer and polyester outer layer. Each buffer tube filled with a water-swellable yarn or tape. Buffer tubes stranded around the central member using reverse oscillation or "SZ" stranding process. Gel-free cable and buffer tubes.

8. Buffer tubes and fibers meeting TIA/EIA-598A, "Color coding of fiber optic cables", with 12 fibers per buffer tube.

9. Cable tensile strength provided by a high tensile strength aramid yarn and/or fiber glass.

10. All dielectric cables, without armoring, sheathed with medium density polyethylene (1.4 mm minimum nominal jacket thickness). Jacketing material applied directly over the tensile strength members and flooding compound. Jacket or sheath marked in a contrasting color with the manufacturer's name and the words "Optical Cable", the year of manufacture, and sequential meter or feet marks. Additionally, provide a durable weather proof label on the cable jacket showing the actual attenuation of each fiber

expressed in dB/km.

11. Cable fabricated to withstand a maximum pulling tension of 600 pounds during installation (short term) and 135 pounds upon installation (long term).

12. Shipping, storing, and operating temperature range of the cable: -40° C to + 70° C. Installation temperature range of cable: -10° C to + 60° C.

13. Each fiber of all fiber optic cable tested by manufacturer at the 100% level for the following tests:

Proof tested at a minimum load of 50 kpsi
Attenuation

14. Meet the appropriate standard Fiber Optic Test Procedure for the following measurements:

Fluid Penetration
Compound Drip
Compressive Loading Resistance
Cyclic Flexing
Cyclic Impact
Tensile Loading and Bending

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

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

17. Fiber Optic Connectors:

Only ST type connectors of ceramic ferrule and Physical Contact end finish to terminate multi-mode fibers to equipment.

Only SC type connectors of ceramic ferrule and Physical Contact end finish to terminate single-mode fibers to equipment.

ST or mechanical connectors not allowed for cable splices.

Maximum attenuation per connector: 0.75 dB.

18. Fiber Optic Jumpers/Patch Cords: For connections in the cabinet, provide factory-assembled duplex pigtail jumpers with dielectric strength member, durable outer jacket and ST or SC compatible connectors. Provide adequate length for connections and 2 feet minimum slack.

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

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

PART 3 - EXECUTION

3.01 CABLE

A. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow-to-yellow, and green-to-green. Identify circuits at the controller with durable labels attached to the cables.

B. Signal cable runs shall be continuous from connections made in the signal pole bases to the terminals in the controller cabinet. Splicing will not be allowed in underground handholes unless specifically called for in the contract documents.

C. Power lead-in cable runs shall be continuous from the secondary service point to the meter socket and from the meter socket to the controller cabinet.

D. Loop detector lead in cable, shall be continuous from the terminal in the controller cabinet to a splice made with the detector loop leads, in the first handhole or pole base provided adjacent to the detector loop.

E. Tracer wire shall be spliced in the handholes and controller to form a continuous network.

F. Provide 4 feet of cable slack in each handhole and 2 feet of cable slack in each pole and controller base. Coil cable slack in handhole and place on the hooks.

G. Pull cables through conduit by means of a cable grip designed to provide a firm hold upon the exterior covering of the cable(s), with a minimum of dragging on the ground or pavement. This shall be accomplished by means of reels mounted on jacks, frame mounted pulleys, or other suitable devices. Only NEC or UL approved lubricants may be used to facilitate the pulling of cable.

H. Fiber Optic Cable and Accessories:

1. 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 in the pulling of the cable to insure that the cable does not become kinked, crushed, twisted, snapped, etc.

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

3. Do not pull cable shall 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.

4. At each handhole, visibly mark or tag cable, "CITY FIBER OPTIC"

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

6. Cable bend radius for static storage not less than ten times the outside diameter of the cable, or as recommended by the manufacturer. Cable bend radius during installation not less than 15 times the outside diameter of the cable, or as recommended by the manufacturer.

7. Provide cable slack in each handhole, junction box and cabinet as specified in the contract documents. 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.

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

I. Fiber Optic Cable Field Testing: Provide for each fiber both on-reel testing prior to installation and final testing after installation using a high-resolution optical time domain reflectometer (OTDR). Conduct measurements for single-mode fibers at 1310 ± 30 nanometer wavelength. Conduct measurements for multimode fibers at 850 ±30 nanometer wavelength. Record the identification, location, length and attenuation measurements of each fiber, and furnish test reports to the Engineer. Replace any cable that fails testing, at Contractor's expense.

1. On-Reel Testing: Perform testing for attenuation and continuity using OTDR and a pigtail splice. Complete testing in one direction only. Acceptable test results will be within ± 3% of factory-supplied attenuation measurements. Except for access to and test preparation of one end of the newly furnished cable, preserve the cable in its originally-shipped condition. Furnish test reports to the Engineer prior to installation.

2. Cable Segment Testing: As each cable segment is terminated, perform an end-to-end attenuation test of each terminated fiber of each fiber optic cable. Perform testing using hand-held optical test sets. Include test results in documentation package provided to the Engineer at the conclusion of the project. Acceptable test results will not exceed the cumulative specified losses of the components. For example, at 850 nm, a one kilometer multimode fiber link with two splices and a connector on each end will not exceed 5.6 dB:

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

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

3. Final System Testing: After complete fiber optic system is installed and terminated, but prior to capping unused fibers; perform OTDR readings on all cables to ensure that each section is in compliance with the specifications. Provide copies of OTDR trace signatures for all fibers for all cable sections to the Engineer. Also provide test results for attenuation test for the installed fibers using the insertion loss procedure and the transmitter/receiver power level test and the continuity test.

3.02 GROUNDING

A. Bond poles and cabinets to form a continuous grounded system.

B. Grounding of the conduit and neutral at the service point shall be accomplished as required by the NEC, except bonding jumpers shall be No. 6 AWG or equal.

C. Install a ground wire in all conduits that carries 120 V signal cables.

IV. NEMA CONTROLLER AND CABINET

PART 1 - GENERAL

1.01 SECTION INCLUDES

NEMA Controller, NEMA cabinet, NEMA conflict monitor, flasher, inductive loop vehicle detector, and auxiliary equipment designated for installation in the project plans.

1.02 STANDARDS

Controller, cabinet, and auxiliary equipment shall conform to the requirements of NEMA TS1 or TS2.

PART 2 - PRODUCTS

2.01 CONTROLLER

A. The Controller Shall Provide:

1. Two through eight phase operation.

2. Fully prompted, menu driven programmability.

3. The following internal functions:
- **a.** Local time base scheduler including automatic accommodation for daylight savings time.
- **b.** Local coordination control.
- **c.** Local preemption control with at least four programmable internal preemption sequences.

4. Means for receiving actuation on all phases. The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by the traffic phase for the set Passage time from the end of the actuation but subject to the Maximum green. The actuation of any detector on a traffic phase not having the right-of-way shall cause the transfer of the right-of-way to that traffic phase at the next opportunity in the normal phase sequence.

B. The controller shall be microprocessor type, solid state.

C. The controller shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases. The length of timing settings shall not deviate by more than ±100 milliseconds from the set value at a power source frequency of 60 Hz.

Controller timing shall be set by means of a front-panel keyboard with momentary contact pushbuttons for entering data. It shall not be necessary to remove or change wires or contacts, or to use any tools in making interval adjustments.

D. The controller shall be of the latest model with the most current software and documentation.

E. Component parts and terminals shall be readily accessible when the controller modules are removed from the enclosure for adjustments, testing, or service. Modules shall be removable and inserted without the use of any tools. Modules of unlike function shall be mechanically keyed or electrically inter-locked to prevent insertion into the wrong opening. All modules of the same function shall be interchangeable.

F. Mount the control devices, indicators, fuse holders, switches, input/output connectors, and other components required for controller operation on the front panel of the controller. The front panel of the unit shall be permanently marked to identify the fuses, indicators, switches, controls, etc.

G. Components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur. Components under 24 hours a day operating conditions in their circuit applications shall have a minimum life of five years.

H. Each phase shall have identical control parameters, which may be independently set.

I. Provide indications, labeled appropriately, to facilitate the determination of the operation of the controller unit. These indications shall consist of the following, as a minimum:

1. Phase(s) in service.

2. Next phase(s) to be serviced.

3. Presence of vehicle and pedestrian calls, including memory and detector actuations.

4. Ring status indicators, including the following: minimum green; passage; yellow clearance; red clearance; walk; pedestrian clearance; reason for termination; and rest state.

J. The controller shall be capable of programming each phase to operate in the following modes:

1. Nonlocking/locking vehicle detector memory.

2. Vehicle recall.

3. Pedestrian recall.

K. Data shall be retained in a memory medium that does not require battery backup.

L. The timing of the maximum green shall commence at the beginning of the green interval. In the absence of detector actuations or assertion of recall switches, the right-of-way indications shall remain on the traffic phase on which the last actuation occurred.

M. Transfer right-of-way to conflicting phases only after the display of the appropriate change clearance intervals.

N. Pedestrian actuations received during steady or flashing DON'T WALK indications a phase shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence. Successive pedestrian actuations shall not cause extension of pedestrian intervals.

During coordinated operation if phases are placed in a pedestrian recall mode of operation to operate the controller as a pretimed controller, the WALK intervals shall automatically adjust

with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase.

O. If power is interrupted, the controller shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching.

2.02 CONTROLLER CABINET AND AUXILIARY EQUIPMENT

A. House the controller and associated equipment in a sturdy, unpainted aluminum cabinet having no sharp edges, corners, or projections. The size of the cabinet shall provide ample space for housing the controller and auxiliary equipment. Provide a hinged door, with an approved doorstop assembly, permitting complete access to the interior of the cabinet. When closed, the door shall fit closely to neoprene or other suitable gasketing material, making the cabinet weatherproof and dust-tight. Door shall be provided with a strong lock and two sets of keys. Door hinges and pins shall be of a non-corroding material. The cabinet shall contain strong mounting tables, sliding trays, or other suitable supports for the controller and associated equipment.

B. In addition to the main door of the controller cabinet, there shall be an auxiliary police door provided in the main door provided with a strong lock and two keys of different design than that of the main door of the cabinet. The panel behind the auxiliary police door shall contain a switch to change from normal function to flashing operation. The controller shall remain in full operation during flashing operation. Provide a signal on-off switch to interrupt power to the signal heads only and continue controller operation.

C. Locate a maintenance panel on the inside of the main door containing the following test switches:

1. Controller Power Switch.

2. Detector Test Switches.

3. Stop Time Switch.

4. Signal Flash Switch.

D. The cabinet shall be provided with the following:

1. A heavy-duty clear plastic envelope, securely attached to the inside wall of the cabinet or cabinet door, for stowing cabinet wiring diagrams. Minimum dimensions shall be 9 inches wide by 12 inches deep.

2. A ventilation fan controlled by a thermostat, and suitable dust filters for the capacity of the ventilating system. The filters shall be dry type, easily removed and replaced, and standard dimensions commercially available. Ventilation fan shall be fused separately and wired after the main AC+ circuit breaker.

3. At least an eight-position back panel when the plans call for expansibility to four phases and at least a 12 position back panel when the plans call for expansibility to eight phases.

4. Power protection devices that include the main AC+ power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

The AC+ field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 117 VAC operation. It shall be equipped with a solderless connector suitable for terminating the power lead-in wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

The distribution of the 117 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.

a. Radio interference suppressors (RIS), adequate in number to handle the power requirements for the cabinet, shall be wired in series with and after the main AC+ circuit breaker. The RIS shall be designed to minimize interference in all broadcast, transmission, and aircraft frequency bands.

b. The lightning arrestor/surge suppressor on the AC service shall meet or exceed the following requirements:

1) Capable of withstanding repeated 20,000 ampere surges (minimum of 25).

2) Have internal follow current limiters (resistive elements).

3) Contain a minimum of three active clamping stages.

4) Self-extinguish within 8.3 milliseconds after trailing edge surge.

5) Parallel impedance of limiters shall be less than 15 ohms.

5. An easily accessible AC+ convenience outlet with a 3-wire grounding type receptacle with ground fault protection. This receptacle shall be separately fused from the main AC+ circuit breaker.

6. An incandescent lamp receptacle mounted on the interior wall of the cabinet that accommodates a standard base light bulb. Lamp shall be controlled by a manual switch mounted on the maintenance panel. Fuse and connect lamp with the convenience outlet.

7. A complete system documentation. Documentation shall consist of:

a. Three complete operations manuals for each controller and associated equipment including equipment wiring diagrams, schematics, and parts lists sufficient for ordering any parts.

b. Three sets of cabinet wiring diagrams. Indicate corresponding phase numbers for each movement from the intersection layout diagram on the cabinet wiring diagram.

E. Use molded composition barrier type terminal blocks for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one piece construction with a minimum of twelve terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 V.

Arrange terminal block facilities in function groupings and mount to either panels or brackets fastened to the interior walls of the cabinet. Retain each terminal block using either machine or self-tapping screws that are easily removed and replaced.

The minimum terminals are as follows:

1. Terminal with circuit breaker with integral power line switch for the incoming power line.

2. Terminal unfused for the neutral side of the incoming power line.

3. Terminals and bases for each vehicle and pedestrian signal circuit.

4. Terminals for vehicle phase detector and pedestrian pushbutton cables. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.

5. Terminals and bases for signal flasher and outgoing signal field circuits.

6. Terminals for controller input and output circuits including those circuits not used on the project.

7. Terminals for required auxiliary equipment.

Provide adequate electrical clearance between terminals. Label terminals in accordance with the cabinet wiring diagrams. Terminals shall be accessible without removal of equipment contained in the cabinet.

F. Furnish hardware necessary for assembly and installation of the cabinet.

G. Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple pin jack, a spring connected mounting, or approved equivalent arrangement.

H. Neatly train wiring throughout the cabinet and attach to the interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced, tied, or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors. Arrange the controller, auxiliary equipment, panel(s), terminals, and other accessories within the cabinet to facilitate the entrance and connection of incoming conductors.

Except where terminated by direct soldering, wires shall be provided with terminal lugs for attachment to terminal blocks using screws. Wires shall be identified and labeled in accordance with the cabinet wiring prints.

All wire insulation shall have a minimum rating of 600 V.

I. The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod.

J. Load switches shall provide LED indicator lights on the front of the load switch to designate the active circuit. The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights, or conflicting signal indications.

2.03 CONFLICT MONITOR

A. Provide a solid state conflict monitor or malfunction management unit within the cabinet external to and electrically independent of the controller and enclosed in a finished metal case. The monitor shall detect the occurrence of conflicting green, yellow, or walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously should conflicts be sensed.

B. The conflict monitor shall utilize liquid crystal displays providing four indicators that display an active red, yellow, green, and walk input for each channel monitored.

C. If the actual conflict has been cleared, a reset switch (front mounted) on the conflict monitor shall return the controller to normal operation when depressed.

2.04 FLASHER

A. Provide a separate solid state flasher to permit substitution of flashing signal indications for normal vehicle or pedestrian actuated operation. The solid state flasher shall have no contact points or moving parts and shall utilize zero-point switching. The flasher unit shall have a built-in effective radio interference filter. LED indicator lights shall be provided on the front of the flasher to indicate the active circuit. Flashing rate shall not vary when the power source remains within the specified limits.

B. Obtain flashing of vehicular signal indications from one or more flashers, each of which is a self contained device designed to plug into a panel in the controller cabinet. If the flashing is provided by two flashers, they shall be wired to assure that the flashing of all indications on the same approach is simultaneous.

C. The cabinet shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid state flasher. This transfer relay assembly shall be controlled by either the flash mode switches located on the police and maintenance panels, or the conflict monitor. The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.

PART 3 - EXECUTION

3.01 CONTROLLER CABINET AND AUXILIARY EQUIPMENT

A. Install the controller cabinet on pre-placed caulking material on the concrete base. After the cabinet is installed, place caulking material around the base of the cabinet.

B. For card rack style detectors, mount detector mounting racks on shelf in the controller cabinet. Wire all detector slots in the cabinet to provide for future use. Label card rack positions with loop numbers.

V. SIGNAL HEADS, PUSHBUTTONS, AND SIGNS

PART 1 - GENERAL

1.01 SECTION INCLUDES

Traffic signal heads, signal lamps, pedestrian pushbuttons, and pushbutton signs designated for installation in the contract documents.

PART 2 - PRODUCTS

2.01 TRAFFIC SIGNAL HEADS

A. The housing for the individual signal sections shall be made of a durable polycarbonate clean, smooth, and free from flaws, cracks, blowholes, and other imperfections and containing no sharp fins or projections. The housing shall be a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together 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. Provide doors and lenses with water-tight gaskets, hinges, and means to secure to the body of the housing by simple locking devices of non-corrosive material.

B. The optical system shall prevent any objectionable reflection of sun rays. Lenses shall be

polycarbonate.

C. The visors section shall be durable polycarbonate not less than 0.10 inches in thickness designed to fit tightly against the door and not permit any perceptible filtration of light between the visor housing door. Visors shall be of the tunnel-type at least 8 inches long for 12 inch rectangular signals, at least 9.5 inches long for 12 inch diameter signals, and angle slightly downward.

D. Lenses shall be 12 inches in diameter with LED modules complying with current ITE standards.

E. Equip each three section signal head with a six position terminal block and each five section signal head with an eight position terminal block for termination of field wiring.

F. The signal heads, including door fronts and visors shall be black. The color shall be an integral part of the materials composition.

G. Where shown on the plans, furnish and attach 5 inch backplates to the signal faces. Construct backplates of one piece durable black plastic capable of withstanding a 100 mph wind.

2.02 PEDESTRIAN PUSH BUTTONS

A. Pedestrian push button detectors shall be the direct push contact type. The entire assembly shall be weather tight, secure against electrical shock, and able to withstand continuous hard usage. The contacts shall be normally open with no current flowing except at the moment of actuation. The housing shall be made of aluminum alloy and furnished with suitable mounting hardware.

B. Furnish pushbutton signs conforming to the requirements of the MUTCD and consistent with the legend as shown in the contract documents.

C. Where shown on the plans, furnish Accessible Pedestrian Signal (APS) Push Button Stations complying with the following requirements.

1. Audible walk indication tone, vibrotactile arrow and locator tone complying with MUTCD.

2. Voice messages as specified in the contract documents and per MUTCD.

3. Weatherproof speaker with automatic volume adjustment to 5 dBA over ambient sound. Maximum volume 100 DB at 3 feet.

4. Nonrusting metal alloy, ADA compliant, 2 inch diameter push button with tactile arrow and 3 pounds maximum operational force.

5. Solid state switch rated at 20 million operations minimum.

6. Program and audio file updates via USB or Ethernet.

7. Operating temperature of -30°F to +165°F.

PART 3 - EXECUTION

3.01 TRAFFIC SIGNAL HEADS

A. Signal mounting hardware for side of pole mounted signals shall be universally adjustable or

fixed. Fixed mountings shall consist of 1.5 inch pipe and appropriate fittings with a natural aluminum finish. Signals shall be secured to pole by using a minimum 5/8 inch wide stainless steel banding material.

B. Mast arm signal head assemblies shall be universally adjustable and rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets which are easily adjustable in both horizontal and vertical planes.

VI. POLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

Traffic signal mast arm poles, traffic signal pedestals, and traffic control signs designated for installation in the contract documents.

PART 2 - PRODUCTS

2.01 TRAFFIC SIGNAL POLES

A. Poles shall be manufactured in accordance with the requirements of the Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals as approved by AASHTO.

B. Unless otherwise specified in the contract documents, the traffic signal mast arm and pole assemblies shall be designed to support the number of signal heads and signs as shown in the plans.

C. The mast arms and support poles shall be tapered, round, steel poles of the transformer base type. Mast arms shall be continuous to 50 feet in length. Vertical pole configuration shall provide for two-piece combination pole with internal tapped plate connection to allow for addition or removal of luminaire pole extension. The poles shall be fabricated from low carbon (maximum carbon 0.30%) steel of U.S. Standard gauge.

After manufacture, they shall have a minimum yield strength of 55,000 psi. The base and flange plates shall be of structural steel conforming to AASHTO M 183 (ASTM A 36) and cast steel conforming to ASTM A 27, Grade 65-35 or better. It shall not be permissible to fabricate poles and mast arms by welding two sections together.

D. Welding and fabrication shall conform to the Structural Welding Code AWS D1-180, as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel Highway Bridges. Longitudinal butt welds, shall have a minimum 60% penetration for plates 0.375 inch and less in thickness, and minimum of 80% penetration for plates over 0.375 inch in thickness.

Personnel performing nondestructive testing shall be qualified in accordance with the American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A, and applicable Supplements B (Magnetic Particle) and C (Ultrasonic). Evidence shall be presented for approval of the Engineer, concerning their qualifications. A report shall be required showing that welds have been inspected and either found satisfactory or found unsatisfactory but repaired and reinspected and found satisfactory. The cost of all nondestructive testing shall be paid by the Contractor and will be considered incidental to other items in the contract.

The mast arms and pole assemblies shall be galvanized inside and out in accordance with ASTM A 123.

E. The pole shall be equipped with a minimum 8 inch by 12 inch handhole and cover located in the transformer base of the pole. Securing of the cover to the base shall be done with the use of simple tools. Hardware shall be corrosion resistant.

F. Where a combination street lighting/signal pole is specified on the plans, the luminaire arm is to be mounted in the same vertical plane as the signal arm unless otherwise indicated on the plans. The luminaire arm type shall be a single member tapered type arm. The pole shall be equipped with a minimum 4 inch by 6 inch handhole and cover located opposite the signal mast arm.

G. The mast arms and poles shall be equipped with all necessary hardware, shims, and anchor bolts to provide for a complete installation without additional parts. The anchor bolts shall meet the requirements of ASTM A 36 or better and be hot dip galvanized for a minimum of 12 inches on the threaded end.

The anchor bolts shall be threaded a minimum of 6 inches at one end and have a 4 inch long, 90 degree bend at the other end.

H. The fabricator shall submit drawings, or preapproved show drawings, for anchor bolts and base design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A 153, Class D, or electrodeposited coated of the same coating thickness, and so designed for this purpose.

Traffic signal poles shall be detailed on shop drawings, or preapproved shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate. See Section I, Part 1, 1.04 in this specification.

I. The fabricator shall certify that the mast arms and pole assemblies are capable of withstanding winds up to 80 mph with a 1.3 gust factor without failure; that only certified welding operators in accordance with AWS D1.1-80 or latest revisions were used; and that only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

2.02 TRAFFIC SIGNAL PEDESTALS

A. The pedestal shaft shall be fabricated of aluminum tubing with a wall thickness of not less than 0.125 inches. It shall have a satin brush or spun finish. The top of the shaft shall have an outer diameter of 4.5 inches and be provided with a pole cap.

B. The pedestal base shall be cast aluminum, square in shape, with a handhole. The size of the handhole shall be at least 4 inches by 6 inches and equipped with a cover that can be securely fastened to the shaft with the use of simple tools. Bases shall have a minimum weight of 20 pounds and shall have a four bolt pattern uniformly spaced on a 12.5 inch diameter bolt circle. The exterior of the base shall be smooth and have a neat appearance.

C. Four 3/4 inch by 15 inch hot rolled steel anchor bolts shall be supplied, complete with all hardware required for installation. The anchor bolts shall have a right angle bend at the bottom end and be hot dip galvanized at the threaded end.

D. The fabricator shall certify that the pedestals are capable of withstanding winds up to 80 mph with a 1.3 gust factor without failure.

2.03 SIGNS

All traffic signs shall conform to the requirements of MUTCD and Iowa DOT specifications.

PART 3 - EXECUTION

3.01 TRAFFIC SIGNAL POLES

A. Erect poles so as to be vertical under normal load, with mast arms oriented at 90 degrees to the curb line. Securely bolt bases to the cast-in-place concrete foundations.

B. After leveling the poles, expansive type grout shall be troweled between the pole base and the foundation for gaps of 1 inch or greater. Exposed edges of grout shall be neatly finished. Place a weep hole in the grout.

C. Ground each pole by installing a No. 6 AWG bare copper ground wire between the pole and the ground rod at the foundation.

D. If the painted or galvanized surface of any equipment is damaged in shipping or installation, such equipment shall be retouched or repaired in a manner satisfactory to the Engineer.

3.02 SIGNS

Mount signs on the mast arms utilizing a universally adjustable mast arm mounted sign bracket.