



**DEVELOPMENTAL SPECIFICATIONS
for
TRAFFIC SIGNALS (SUDAS)**

**Effective Date
October 16, 2012**

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

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The applicable sections of the Urban Standard Specifications for Public Improvements have been included and modified in this specification.

The applicable figures referenced in this specification are included in the plans.

DIVISION 1 - GENERAL PROVISIONS AND COVENANTS

I. SECTION 1030 - CONTRACTUAL PROVISIONS

PART 1 - INTENTIONALLY LEFT BLANK

PART 2 - CONTROL OF THE WORK

2.01 - 2.011 INTENTIONALLY LEFT BLANK

2.12 SHOP DRAWINGS, CERTIFICATES, AND EQUIPMENT LISTS

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B. Submission of Equipment Lists:

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2. The Contractor shall also 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.

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DIVISION 8 - TRAFFIC SIGNALS

II. SECTION 8010 - 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 under provisions of Section 1030, 2.12, B of this specification.
- B. Preapproved shop drawings: For projects utilizing shop drawings for steel mast arm poles, preapproved by the Engineer, furnish a copy of the drawings from the manufacturer. The drawings shall be marked to show applicable configurations and quantities for the project. Any minor variations from the preapproved shop drawings, such as alternate finishes, as described in the contract documents, are to be noted.
- C. For projects not utilizing preapproved shop drawings, six copies of shop drawings shall be furnished for steel mast arm poles that are to be furnished on the project.
- D. 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.
- E. Manufacturers shall certify electrical equipment, signal equipment, and materials to ensure compliance with the contract documents.
- F. 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).
- G. 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.

PART 2 - INTENTIONALLY LEFT BLANK

PART 3 - INTENTIONALLY LEFT BLANK

III. SECTION 8020 - 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 (75D) concrete pipe as applicable.
- B.** Cast iron ring and cover may be rated light duty for non-traffic areas (145 pounds (65 kg) minimum); but shall be rated heavy duty for traffic areas (320 pounds (145 kg) minimum) where shown on the plans. Deviations in weights shall not exceed $\pm 5\%$. 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 (9.5 mm) and a minimum length of 5 inches (125 mm).

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 (-1°C) and shall not melt or run at temperatures as high as 300°F (149°C).

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 (300 mm) from the top of the handhole. The ends of all conduit leading into the handhole shall fit approximately 2 inches (50 mm) beyond the inside wall. Cast iron rings and covers for handholes shall be set flush with the sidewalk or pavement, or 1 inch (25 mm) 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 6 times the internal diameter of the conduit. Extend conduit 2 inches to 4 inches (50 mm to 100 mm) above finished surface in all bases.
- D.** Place conduit buried in open trenches a minimum of 18 inches (0.5 m) 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 (0.6 m) below the finished pavement surface.
- E.** Deposit backfill material in layers not to exceed 6 inches (150 mm) 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 (0.6 m) 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 (12.5 mm) radius edger. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top 10 inches (0.25 m) 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 (50 mm) 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.

IV. SECTION 8030 - WIRING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Signal cable, power lead-in, loop detector lead-in, tracer wire circuit materials, and grounding, methods, 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 #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 #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 #6 AWG bare copper wire and bonding jumpers shall be #6 AWG bare copper wire connected by approved clamps.

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 (1.2 m) of cable slack in each handhole and 2 feet (0.6 m) 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.

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 #6 AWG or equal.
- C. Install a ground wire in all conduits that carries 120 V signal cables.

V. SECTION 8040 - VEHICLE DETECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

Pavement saw cutting, detector loop wire materials, placement, connection to lead-in, and loop sealant designated for installation of inductive loop detector in the plans.

PART 2 - PRODUCTS

2.01 LOOP DETECTOR SEALANT

- A. Sealant shall be rapid cure, high viscosity, liquid epoxy, or approved equal, formulated for use in sealing inductive wire loops and leads embedded in HMA and PCC. The sealant shall be usable on grades of 15% or less without excessive flow of material.
- B. Sealant shall be two-component system, which consists of a resin constituent identified as pourable, and a hardener identified as quick-setting. Approval of other sealants shall be based on specifications and/or test data regarding physical properties, performance properties, and chemical resistance.
- C. Cured sealant shall be unaffected by oils, gasoline, grease, acids, and most alkalis. The mixing of components and the filling of the cut shall be in accordance with the directions of the manufacturer.

2.02 SPLICE KIT

- A. As an acceptable alternate, the Contractor may use a 3M Company Scotchcast Kit, "Cat's Eye's" mechanical splices, or approved equal, for splices.

PART 3 - EXECUTION

3.01 LOOP DETECTOR INSTALLATION

- A. Obtain the Engineer's approval of loop locations prior to saw cutting.
- B. Saw shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. Provide a clean, straight, well-defined saw cut without damage to adjacent areas. Overlap saw cuts to provide full depth at corners.
- C. Remove jagged edges or protrusions in the saw cuts before installing loop wire. The saw cuts shall be cleaned to remove cutting dust, grit, oil, moisture, or other contaminants. Flush saw cuts clean with a stream of water under pressure, and dry the slots using oil-free compressed air.
- D. Install detector loop wire in the bottom of the saw cut. If necessary, hold down by means of a material such as tape or doubled-over pieces of the plastic tubing.
- E. The field loop conductors and tubing shall be continuous from the terminating handhole or base with no splices permitted. At the time of placing the loop wire in the saw cuts, the ends of the tubing shall be sealed to prevent any entrance of moisture into the tubing. Loop wires and tubing that are not embedded in the pavement shall be twisted with at least 5 turns per foot (0.3 m).
- F. Label each loop with durable tags corresponding to loop numbering as shown on the plans. Loops which are physically adjacent in an individual lane or adjacent lanes shall be wound with opposite rotation (i.e. #1 CW, #2 CCW, #3 CW, etc.). Rotation reversal can be accomplished by reversing leads at the handhole.
- G. Solder electrical splice between the detector lead-in cable and the loop wire using resin core solder. Provide a watertight protective covering for the spliced wire, the shielding on the detector lead-ins and the end of the tubing containing the loop wires. The use of open flame to heat the wire connection will not be permitted. The Contractor shall use a soldering iron, gun, or torch equipped with a soldering tip. The splice shall be made by the following method:
 1. Remove lead-in cable coverings and expose 4 inches (100 mm) of insulated wire.
 2. Remove insulation from each conductor of detector lead-in cable and scrape both copper conductors with knife until bright.
 3. Remove the plastic tubing from the loop wires for 1.5 inches (40 mm).
 4. Remove the insulation from the loop wires and scrape both copper conductors with knife until bright.
 5. Wash the exposed copper conductors with turpentine spirits to clean the conductors.
 6. Connect conductors by a soldered "Western Union" type splice, wrapped with waterproof tape and coated with a watertight protective covering.

7. Cover the exposed shielding, ground wire, and end of any unused loop lead-in where the sheathing was cut, with liquid silicone rubber. Apply butyl rubber polymer tape sealant between the wires and completely cover the silicone rubber.

H. Meter the installed loops by test instruments capable of measuring electrical values of loop wires and lead-ins to measure induced AC voltage, inductance in microhenries, high-low "Q" indication, leakage resistance in megohms, and the resistance of the conductors in ohms. Provide the Engineer a report on company letterhead indicating the inductance and leakage to ground test values for each loop. An inductance and leakage to ground test shall also be conducted and reported for the total detector lead-in and loop system with the test being conducted at the controller cabinet. Before beginning the required test period, the Engineer may independently meter any or all loops. Should any loop be found unacceptable, the Contractor may be required to complete additional tests, as required, at their own expense. An acceptable loop installation shall be defined as follows:

1. **Inductance:** The inductance reading on the loop tester is approximately the calculated value.
2. **Leakage to Ground:** Deflection of the pointer to above 100 megohms.
3. **Resistance:** The resistance of the circuit is approximately the calculated value. Any loop not meeting the requirements for an acceptable loop installation shall be repaired or replaced. The Contractor shall bear all costs of replacing loop installations deemed unsatisfactory by the Engineer.

VI. SECTION 8050 - 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.

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 (225 mm wide by 300 mm 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 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.

2.05 INDUCTIVE LOOP VEHICLE DETECTOR

A. Provide a detector harness for each detector amplifier. The harness shall be tagged to indicate the detector number(s) and phase. In case of a failure in the power supply unit for the card rack, fail-safe operation shall be provided in that a constant call shall be placed on all detector channels.

B. The detector unit shall be solid state, digital, dual channel, providing detection channel with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the detector unit shall be provided by relays.

C. The detector unit shall include the following capabilities:

1. Detection of all licensed motor vehicles.
2. Indicator light for visual indication of each vehicle detection.
3. Fail-safe operation (continuous call) in the event of detector loop failure.
4. Respond to an absolute change (delta L).

D. The detector unit shall be capable of disabling delay timing by external means during that detector's associated green phase. The delay inhibit on each detector unit shall be in effect during the associated green phase.

E. The detector unit shall contain a fuse or other reliable protection in the power supply. The fuse shall provide short circuit protection to the power supply and be accessible without removal of the case.

F. The detector unit shall be capable of normal operation without interference and false calls between sensor units (crosstalk). It shall be possible to install the connecting cable in the same conduit as the signal cables, power cables, and other detector cables without affecting the normal operation of the detector.

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.

VII. SECTION 8060 - TYPE 170, CONTROLLER AND CABINET

PART 1 - GENERAL

1.01 SECTION INCLUDES

170 Controller, 170 cabinet, 170 conflict monitor, and auxiliary equipment designated for installation in the contract documents.

PART 2 - PRODUCTS

2.01 CONTROLLER, CABINET, AND AUXILIARY EQUIPMENT

A. Related Specifications: Unless otherwise stated, all equipment furnished under this specification shall be new, meeting the requirements of "California/New York Type 170, Traffic Signal Controller System-Hardware Specification," U.S. Department of Transportation, Publication FHWA-IP-78-16, December 1978, with the following exceptions:

1. Any reference to the State of California shall mean the Contracting Authority.
2. Chapter 1, Section II "General" paragraph 3, the second sentence shall be deleted.

3. Chapter 1, Section VIII "Electrical, Environmental and Testing Requirements" shall be modified as follows:

- a. Any reference to the Contractor shall mean equipment manufacturer or supplier.
- b. Paragraph 5.2 shall be changed to read "Two manuals containing the flow chart, listing, and instructions of the test program shall be furnished to the Engineer when the controller unit is delivered."
- c. Paragraph 6.1 the words "State Approval" shall be deleted.
- d. Paragraph 6.2 shall be deleted.
- e. Paragraph 6.3.6 shall be deleted.

4. When specified, the Model 332A Cabinet furnished for the project shall meet the requirements of Chapter 11 "Specifications for Cabinet Model 332A," and the Model 336 Cabinet shall meet the requirements of "Specifications for Cabinet Model 336" dated February 1982, except that the color specified in Section 1, paragraph 3 shall be changed to silver. Molex Flash Blocks shall be provided for all eight vehicle phases to program either red or yellow flashing indications. A detector input panel shall be provided on the rear left side of the cabinet. Cabinet locks as specified in Section I, paragraph 4 shall be changed to Corbin Type 2 locks. An aluminum cabinet shall be furnished.

The aluminum surface shall have an anodic coating applied. The anodic coating and anodic coating process shall meet the requirements of Section 2.4.1 and 2.4.2 of the "Traffic Signal Control Equipment Specifications," California Business, Transportation and Housing Agency, Department of Transportation, January 1989. Alternative aluminum surface treatments, which produce an equivalent uniformly textured surface, may be substituted as approved by the Engineer.

5. All loop detector amplifier units furnished for this project shall be Model 222, two-channel loop detector sensor units meeting the requirements of Chapter 4 with the following exceptions:

- a. Digital design capable of normal operation when operated with a grounded loop.
- b. Shall comply with all performance requirements when connected to an inductance of from 50 to 1500 microhenries.
- c. Each detector channel shall respond to an absolute inductance change (Delta L) rather than as a percentage of the total inductance (Delta L/L).

6. In Chapter 11, Section III "Cabinet Accessories" paragraph 4, a new subsection will be added "Each vehicular and each pedestrian phase shall be provided with a separate switch pack."

7. A model 412C prom module shall be provided, configured to the following table:

Memory Socket	Address Range	Device Type	Chip No.*
U1	8000-FFFF	32K EPROM	INT 27256A
U2	3000-4FFF	8K ZPRAM	DAL 1225
U3	7010-7FFF	8K ZPRAM	DAL 1225
U4	1000-2FFF	8K RAM	HD 6264

*or approved equal

8. A Model 242 two-channel isolator shall be provided to introduce stop timing to the controller from the conflict monitor and the manual flash switch.

9. The Model 210 monitor unit shall meet the requirements of Chapter 3 with the following additional requirements:

- a.** The monitor unit shall be capable of red failure detection in accordance with NEMA specifications. Following a long power outage, (greater than 2 seconds) the monitor unit shall be capable of disabling the red failure detection, until the signal heads are energized (approximately 4 seconds).
- b.** The monitor unit shall have the required circuitry to allow the early detection of a conflict caused by a green or yellow signal "hang up" and shall preclude the presentation of the conflicting signal display at the intersection.
- c.** Any additional harnesses or hardware required shall be furnished with the monitor unit.

10. A "PDA-2" Power Distribution Assembly shall be provided in lieu of the PDA-1 and the 24 VDC supply.

11. A standard print shelf drawer shall be provided and installed above the input file.

12. Two ACIA ports shall be provided.

13. One Model 400 internal modem shall be supplied for each controller to provide for communications between controllers. If a master controller is specified, a Hayes compatible dial-up modem, designated for plug-in compatibility with 170 series traffic controllers, shall be supplied for communications between the master and a central office computer over standard lease or dial-up telephone lines.

14. All components supplied shall be on CalTrans Qualified Product Listing and operate successfully with MultiSonics OSAM and BITrans 233 software.

15. Each cabinet shall include two fluorescent lighting fixtures mounted inside the front and back portion of the cabinet. These fixtures shall include a cool white lamp with protective cover and shall operate by a normal power UL listed ballast. Two door actuated switches shall be installed to turn on the cabinet light when the door is open, front door front light back door back light. Each switch should work each individual light.

16. Each cabinet shall be provided with devices to protect the control equipment from surges and over voltages. This shall include incoming power lines, the Input File, the Output File, and communication lines.

All inductive loop detector inputs shall be protected with a 30 V MOV with (30 Joule Rating) P/n ERZ-C20 KE 470 or equal. The output of all load switch outputs shall be protected with a 150 V MOV (80 Joule Rating). P/n ERZ-C20 DK 241U or equal. The MOVs shall be connected from the AC positive field terminal to the chassis ground.

For the 332A cabinet, appropriate input surge protection shall be mounted on the Lower Input Termination Panel (LIP). The power distribution assembly (PDA#2) of each controller cabinet shall include a surge protection unit on the AC Service Input. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effect of lightning transient voltages applied to the AC line. The protection device shall be a two stage series parallel device. It shall include the following features and functions:

- a.** Maximum AC line voltage: 140 VAC.
- b.** Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20000 A.

- c. The protector shall be provided with the following terminals:
- 1) Main line (AC line first stage terminal).
 - 2) Main Neutral (AC neutral input terminal).
 - 3) Equipment line out (AC line second stage output terminal, 10 A).
 - 4) Equipment neutral out (neutral terminal to protected equipment).
 - 5) GND (Earth connection).
 - 6) The main AC line in and the equipment line out terminals shall be separated by a 200 microhenry (minimum) inductor rated to handle 10 A AC Service. The first stage clamp shall be between main line and ground terminals.
 - 7) The second stage clamp shall be between equipment line out and equipment neutral.
 - 8) The protector for the first and second stage clamp shall have a MOV or similar solid state device rated at 20 KA and be of a completely solid stage design (i.e., no gas discharge between tubes allowed).
 - 9) The main neutral and equipment neutral out shall be connected together internally and shall have an MOV similar solid state device or gas discharge tubes rated at 20 KA between main neutral and ground terminals.
 - 10) Peak clamp voltage: 350 V at 20 KA (voltage measured between equipment line out and equipment neutral out terminals. Current applied between main line and ground terminals with ground and main neutral terminals externally tied together.). Voltage shall never exceed 350 V.
 - 11) The protector shall be epoxy encapsulated in a flame retardant material.
 - 12) Continuous service current, 10 Amps at 120 VAC RMS.
 - 13) The equipment line out shall provide power to the Type 170 and to the 24 V power supply.
 - 14) Provide communications line protector with a mounting connector for incoming and outgoing communication line.

B. Manufacturers: The controller units, cabinets, and auxiliary control equipment furnished under this specification shall be from a manufacturer whose Type 170 controller system has been approved and purchased by either the State of California or the State of New York. The Engineer may allow exceptions to this requirement provided that the equipment to be furnished has been successfully operated on the street by a public agency for more than one year and has been certified by an independent testing laboratory as meeting the requirements of Chapter 1, Section VIII, U.S. Department of Transportation, Publication FHWA-IP-78-16.

C. Software: The software for this project will be provided by the Contracting Authority. The Contractor shall supply two blank 27256 PROM chips per controller.

D. Operational Modifications: When specified in the contract documents, the following operational modifications shall be made by the equipment manufacturer through either software changes to the "Local Intersection Program," through hardware changes, or as determined by the manufacturer. Any changes to the software or hardware not already detailed on the plans shall receive approval of the Engineer prior to implementation.

1. For those locations providing for protected/permissive display of the left turn indication, the operation shall be such that the protected left turn arrow is displayed only when there are a sufficient number of left turning vehicles queued to actuate the left turn phase calling detector. In the absence of left turn phase detector actuations, left turn demand is to be accommodated by displaying only the circular green permitting a permissive left turn to be made.

E. Auxiliary Control Equipment:

1. Cabinets shall be furnished with all necessary auxiliary control equipment to properly operate eight signal phases and four pedestrian phases, which includes conflict monitor unit, isolation modules, detector sensing units as specified on contract documents, and load switch packs.
2. A heavy-duty clear plastic envelope, minimum dimensions of 9 inches x 12 inches (225 mm x 300 mm), shall be attached inside the cabinet for storing timing and maintenance records, electrical prints, etc.

F. Certification: In addition to the testing certification required in Chapter 1, Section VIII "Electrical, Environmental and Testing Requirements," paragraph 6, the Engineer shall be furnished with a certification from the equipment manufacturer or supplier stating that the equipment furnished under this specification complies with all provisions of this specification. With prior approval of the Engineer, minor exceptions to this specification may be allowed, provided these exceptions are detailed on the certification.

G. Warranty: All Type 170 Controllers and auxiliary equipment furnished under this specification shall have a warranty to be free from defects in materials for 18 months from date of shipment, or 12 months from date of installation. Any parts found to be defective shall, upon concurrence of the defect by the manufacturer, at no additional cost to the Contracting Authority be replaced free of charge.

H. Manufacturer or Supplier: A representative from the manufacturer and/or supplier of the Type 170 controllers shall be at the project site when the controllers are ready to be turned on, to provide technical assistance including, as a minimum, programming of all necessary input data. All required signal timing data shall be provided by the Engineer.

PART 3 - EXECUTION

3.01 CONTROLLER, CABINET, AND AUXILIARY EQUIPMENT

- A.** A minimum of one week prior to the scheduled "turn-on", the Contractor or supplier shall deliver the controller(s), (not including the cabinets), to the Local Municipality's Traffic Signal Shop. Since staff is not always present at this shop, it is the responsibility of the deliverer to call ahead and make sure someone will be present.
- B.** The Local Municipality will install and verify the specified software and timings. Should any controllers be found faulty at the shop, the person/company who delivered the equipment will be contacted. The signal shop is not responsible for trouble shooting this equipment nor is any part of this process intended to replace "burn-in" responsibilities of the manufacturer.
- C.** The Contractor is responsible for picking up the controller(s) from the signal shop and is responsible for bringing the controller(s) to full operation at the intersection(s). No assistance will be provided by the signal crew once the software is working correctly and the signal timings have been verified in the signal shop. Having a knowledgeable representative at the project site(s) when the controller(s) is ready to be turned on is paramount to the safety and efficiency of this operation.

VIII. SECTION 8070 - 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 (2.54 mm) 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 (200 mm) long for 12 inch (300 mm) rectangular signals, at least 9.5 inches (240 mm) long for 12 inch (300 mm) diameter signals, and angle slightly downward.
- D.** The reflector holder shall separately support the reflector and socket in proper relation to the lens. The reflector holder shall have one side hinged to the signal body and the other side held in place by a quick release mechanism. The reflector shall be mounted in a manner that does not require it to be removed from its normal position during bulb replacement. Both the hinge and the release mechanism shall be of a flexible nature which will permit the reflector holder to be pushed inwardly for at least 1/16 inch and to align itself correctly with the lens when the door of the optical unit is closed and pressed against the rim of the reflector holder. By such means, the joint between the reflector holder and the lens shall be rendered dust-tight. The reflector holder shall swing from the body section for access to the light socket without it being necessary to remove any screws or nuts. The reflector shall be Alzak treated aluminum or Lexalite^(C) polycarbonate. The reflector assembly shall be interchangeable and shall be designed so that it can be easily removed without the use of tools.
- E.** The lamp receptacle shall be of the fixed focus type, positioning the lamp filament at the correct focal point in respect to the reflector. The assembly shall be designed so that the lamp socket can be rotated through 360° and eight positions of adjustment for proper positioning of the lamp filament after relamping the signal. The lamp socket shall be equipped with color coded wire, either red, yellow, or green, depending upon the lens color of the section. The socket wires shall be a minimum of 26 inches (0.7 m) long, composed of wire with insulation designed to withstand 220°F (105°C). Terminate the wiring leads with spade lugs. Equip the socket with a gasket to insure a dust-tight fit between the socket and reflector. When polycarbonate reflectors are furnished, gaskets shall be fabricated of silicone material.
- F.** 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.

G. The signal heads, except door fronts and visors shall be federal yellow. Doorfronts and visors shall be black, except for City of Des Moines which shall be federal yellow. The color shall be an integral part of the materials composition.

H. Where shown on the plans, furnish and attach 5 inch (125 mm) backplates to the signal faces. Construct backplates of two piece durable black plastic capable of withstanding a 100 mph (160 km/h) wind.

2.02 TRAFFIC SIGNAL LAMPS

A. 135 Watt - 12 inches (300 mm) Traffic and Pedestrian Signal Heads

Maximum Wattage	135 Watts
Light Center Length	3 inches (75 mm)
Rated Life	8,000 Hours
Rated Initial Lumens	1,750 Lumens
Rated Voltage	120-125 V
Fused Bulb	Yes

B. 60 Watt - 9 inches (225 mm) Pedestrian Signal Heads

Maximum Wattage	60 Watts
Light Center Length	2-7/16 inches (61.9 mm)
Rated Life	8,000 Hours
Rated Initial Lumens	610 Lumens
Rated Voltage	120-125 V
Fused Bulb	Yes

C. The lamps shall have a standard medium screw type brass base and a clear glass envelope etched to show the manufacturer's insignia or trademark and the rated wattage.

D. The filament shall be supported in a minimum of four points to resist breakage of the filament from vibrations and handling.

E. Each lamp shall contain a reflector disc located between the base and the filament to reflect light out of the front of the glass.

F. Each lamp shall be gas-filled with Krypton (Kr) gas, with a minimum of 90% Kr concentration by gas volume.

2.03 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.

PART 3 - EXECUTION**3.01 TRAFFIC SIGNAL HEADS**

- A.** Signal mounting hardware for side of pole mounted signals shall consist of 1.5 inch (38 mm) pipe and appropriate fittings, each painted with one coat of primer and two coats of federal yellow enamel. Signals shall be secured to pole by using a minimum 5/8 inch (15 mm) wide stainless steel banding material.
- B.** Mast arm signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets which are easily adjustable in both horizontal and vertical planes.

IX. SECTION 8080 - POLES**PART 1 - GENERAL****1.01 SECTION INCLUDES**

Traffic signal mast arm poles, traffic signal pedestals, and overhead mounted street name 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 (15.2 m) 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 (380 kPa). 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 (9.5 mm) and less in thickness, and minimum of 80% penetration for plates over 0.375 inch (9.5 mm) 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 (200 mm by 300 mm) 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 (100 mm by 150 mm) 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 (300 mm) on the threaded end.

The anchor bolts shall be threaded a minimum of 6 inches (150 mm) at one end and have a 4 inch (100 mm) long, 90° bend at the other end.

H. The fabricator shall submit drawings, or preapproved shop 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 8010, 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 (128 km/h) 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 (3.2 mm). It shall have a satin brush or spun finish. The top of the shaft shall have an outer diameter of 4.5 inches (115 mm) 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 (100 mm by 150 mm) 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 (9 kg) and shall have a four bolt pattern uniformly spaced on a 12.5 inch (317.5 mm) diameter bolt circle. The exterior of the base shall be smooth and have a neat appearance.

C. Four 3/4 inch by 15 inch (19 mm by 375 mm) 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 (128 km/h) with a 1.3 gust factor without failure.

2.03 SIGNS

- A. All traffic signs shall conform to the requirements of MUTCD.
- B. Street name signs shall be white letters, Series C Caps, 8 inches (200 mm) high on a green background. The sign shall have a white border, 0.75 inches (19 mm) wide. The sheeting material for the signs shall be encapsulated lens sheeting.

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° 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 (25 mm) or greater. Exposed edges of grout shall be neatly finished. Place a weep hole in the grout.
- C. Ground each pole by installing a #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

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