SP-091004
(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Polk County

Project No.
ESL-1945(758)--7S-77

Effective Date
November 17, 2009

THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

TABLE OF CONTENTS

I **GENERAL REQUIREMENTS**
- 1.1 RELATED SPECIFICATIONS AND STANDARDS
- 1.2 LOCAL REQUIREMENTS
- 1.3 COORDINATION WITH UTILITIES
- 1.4 CONTRACTOR SUBMISSIONS
- 1.5 SUBSTITUTIONS
- 1.6 SCHEDULING AND CONFLICTS
- 1.7 TESTING OF SIGNAL EQUIPMENT
- 1.8 GUARANTEE
- 1.9 MEASUREMENT FOR PAYMENT

II **INSTALLATION REQUIREMENTS**
- 2.1 FOUNDATIONS
- 2.2 HANDHOLES
- 2.3 CONDUIT
- 2.4 ELECTRICAL
- 2.5 FIBER OPTIC CABLE
- 2.6 BONDING AND GROUNDING
- 2.7 TRAFFIC SIGNAL DISPLAYS
- 2.8 CONTROLLER
- 2.9 PAINTING
- 2.10 LOOP DETECTORS
- 2.11 SIGNS
- 2.12 LOCATE BOX

III **MATERIAL REQUIREMENTS**
- 3.1 TRAFFIC SIGNAL LAMPS
- 3.2 TRAFFIC SIGNAL CABLE
- 3.3 SIGNS
- 3.4 FIBER OPTIC CABLE AND ACCESSORIES
- 3.5 HANDHOLES
- 3.6 CONDUIT
- 3.7 LOOP DETECTOR SEALANT

IV **EQUIPMENT REQUIREMENTS**
- 4.1 TRAFFIC SIGNAL CONTROLLER SYSTEM, TYPE 170
- 4.2 TRAFFIC SIGNAL COMMUNICATIONS
- 4.3 VEHICULAR TRAFFIC SIGNAL HEADS
- 4.4 PEDESTRIAN TRAFFIC SIGNAL HEADS
- 4.5 ALUMINUM TRAFFIC SIGNAL PEDESTAL
- 4.6 GALVANIZED STEEL TRAFFIC SIGNAL SUPPORT
- 4.7 PEDESTRIAN PUSH BUTTON DETECTORS

V **ADDITIONAL BIDDING ATTACHMENTS**
- 5.1 SCHEDULE OF UNIT PRICES
- 5.2 EQUIPMENT AND MATERIALS LIST

PART I
GENERAL REQUIREMENTS

This part consists of the general provisions necessary when furnishing a traffic signal installation complete, in place and operational as described in the project plans and these special provisions.

1.1 RELATED SPECIFICATIONS AND STANDARDS

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

A. Specifications of the Underwriters Laboratories Inc.
B. National Electrical Code.
C. Manual on Uniform Traffic Control Devices for Streets and Highways, as adopted by the Department per 761 of the Iowa Administrative Code (IAC), Chapter 130.

1.2 LOCAL REQUIREMENTS

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

All work on the project shall be supervised on-site or performed by an International Municipal Signal Association (IMSA), Level II Certified Traffic Signal Technician. This work includes the installation of conduit, handholes, pole footings, wiring, traffic signal poles, traffic signal heads, video/observation cameras and traffic signal controller/cabinets.

1.3 COORDINATION WITH UTILITIES

A. Location: The Contractor shall be responsible for determining the exact location and elevation of all public utilities in proximity to any construction work and shall conduct all activities to ensure that public utilities are not disturbed or damaged.

B. Liability: The Contractor shall be fully Liable for any and all expenses incurred as a result of failing to obtain required clearances, location of utilities, and any damage to the public utilities caused by construction.

1.4 CONTRACTOR SUBMISSIONS

A. Material and Equipment List: A list of equipment and materials required for the project will be furnished each bidder with the proposal. Within sixty calendar days after awarding of the contract for the project, the Contractor shall complete the list by writing in the name of the equipment manufacturer and catalog number of each item listed on the project. The list shall be submitted in five copies to the Engineer for written approval before any equipment or materials are ordered.

B. Schedule of Unit Prices: Forward to the Engineer three copies of a list of unit costs for each item listed on the Schedule of Unit Prices attached to the Specifications 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). Bi-weekly estimates of the work performed on the project will be made by the Contracting Authority and the unit costs will be used to prepare progress payments to the Contractor.

C. IMSA Certification: The Contractor shall submit the name and contact information of the IMSA Level II Certified Traffic Signal Technician(s) working on the project and a copy of their IMSA certificate.

D. Shop Drawings, Catalog Cuts, Certifications: Six copies of shop drawings shall be furnished for steel mast arm poles to be furnished on the Project. Six copies of catalog cuts and manufacturer's specifications shall be furnished for all standard "off-the-shelf" items. Manufacturers shall certify electrical equipment, signal equipment, and materials to ensure compliance with these project documents. Upon request, the Contractor shall provide material certifications to the Engineer.

Review of shop drawings by the Engineer is for the purpose of checking for general conformance with the project design concept and contract documents. On each submittal, the Contractor shall specify in writing any deviations from the requirements of the plans or contract documents.

1.5 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

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

1.6 SCHEDULING AND CONFLICTS

A. Schedule work to minimize disruption of public streets and facilities. Develop traffic control in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways, as adopted by the Department per 761 of the Iowa Administrative Code (IAC), Chapter 130. 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 found.

1.7 TESTING OF TRAFFIC SIGNAL INSTALLATION

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 shall be provided by the Engineer.

C. Upon authorization of the Engineer, place the signal or signal system in operation for a consecutive 30-day test period. The signal(s) shall not be placed into operation without prior notification and authorization of the Engineer. Any failure or malfunction of the equipment furnished by the Contractor due to workmanship 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 30 consecutive calendar day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive 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.

1.8 GUARANTEE

A. All equipment and materials shall be provided with a standard industry warranty. If defects develop under normal operating conditions within the warranty period, 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 Contracting Authority prior to final acceptance. Transfer required equipment warranties prior to the date of final acceptance to the Contracting Authority.

1.9 MEASUREMENT FOR PAYMENT

All measurements for payment will by 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 II
INSTALLATION REQUIREMENTS

This part consists of the installation details necessary during the construction of a traffic signal complete, in place, and operational as described in the project plans and these special provisions.

An anti-seize compound shall be used in the installation of all mechanical connections and fasteners, including all nuts and bolts.

2.1 FOUNDATIONS

The concrete bases shall conform to the dimensions shown on the plans. The bottom of all foundations shall rest securely on firm undisturbed ground. Forms shall be used for the upper portion of all foundations. Whenever the excavation for a foundation is irregular in shape, forms shall be used to provide the proper dimensions of the foundations below grade. The material for the forms shall be of sufficient thickness to prevent warping or other deflections from the specified pattern. The forms shall be set 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 unless the Engineer shall direct otherwise. Concrete shall be consolidated by vibration during placement.

Footings shall be Class C structural concrete. Reinforcing Steel – deformed bars shall meet ASTM A 615, Grade 40. Fabricate and bend reinforcing steel cold, per approved submittals or plans.

Finish the top of the base level and round top edges with an 1/2 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.

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.

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.

Where the foundation cannot be constructed as shown on the plans because of an obstruction, the Contractor shall relocate the foundation or use other effective methods of supporting the pole as may be designated by the Engineer.

The Contractor shall be responsible for the proper elevation, offset, and level of each foundation.

Conduit, drains, and ground rods shall be installed as shown on the plans. Conduit inlets shall be installed as shown on the plans. As a minimum, one additional conduit inlet shall be installed per signal pole base and two per traffic signal controller base as shown on the plans. Inlets not used shall be capped below grade. A ground rod shall be placed at each controller or combination sign/street light pole foundation. The ground rod shall be a minimum of 5/8 inch diameter, by 10 feet long, copper plated steel.

The foundations must be given seven days to cure before poles are erected.

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

Any cost associated with installing wire/conduit into an existing signal or cabinet base/foundation/pad is considered incidental to the other pay items. When installing a conduit bend in an existing base the conduit size shall be equivalent to the conduit in the ground. The steel in the base shall not be cut or damaged and the concrete shall be broken away in the shape of a "U" with an approximate depth of at least 12 inches below the depth of the surrounding ground surface. Enough concrete shall be removed so the conduit will be inside the anchor bolts of the foundation. The conduit shall be placed in the "U" with concrete added in the "U" and finished to match the base.

The Contractor shall also provide and install conductors in the Pole shaft and in the Luminaire Arm. Unless otherwise indicated on the plans, luminaires will be supplied and installed by others. The Contractor shall also connect the conductors in the pole shaft to the 2/C street lighting cable as shown on the plans. Fused connectors shall be used in pole bases and when connecting multiple conductors.

Existing Pole Foundations:
All existing traffic signal pole foundations that become unused for the new traffic signal shall be removed. Foundations three feet or less in depth shall be removed completely. Foundations greater than three feet in depth shall be removed to one foot below grade. All holes shall be filled and surface restored to match the surrounding area. This work is considered incidental to the other pay items.

2.2 HANDHOLES

When precast concrete sections are used for handholes, the conduit entrances shall be neatly grouted between the conduit and the precast concrete. The handhole ring shall fit snugly inside the precast concrete section. The handhole ring on all 18 inch handholes shall be firmly attached using an adhesive caulk or other means approved by the Engineer.

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

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

Handholes shall be installed in a neat and workmanlike manner. 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.

EXISTING HAND HOLES:
All existing traffic signal hand holes that become unused for the new traffic signal shall be removed and discarded by the contractor. The sidewalk area shall be properly restored to match the surrounding area. This work is considered incidental to the other pay items.

2.3 CONDUIT

All conduit ends shall have bell ends. Bell ends shall be installed prior to pulling any wiring and shall be capped until wired is pulled. A sealing compound (duct seal) shall be used at all conduit openings at; signal footings, controller footings, handholes, and tubs.

Conduit buried in open trenches shall be placed a minimum of 36 inches deep and a minimum of 2 feet from the back of curb unless otherwise directed by the Engineer. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 2 feet below the finished pavement surface or as directed by the Engineer.

When underground conduits parallel an existing facility, maintain at least 1 foot of separation.

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.

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 to 4 inches above finished surface in all bases.

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.

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 which is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than two feet to the back of curb.

When it is impractical to push the conduit under pavement due to unanticipated obstructions, the Contractor may, with the Engineer's permission, cut the existing pavement.

All conduit, whether PVC or Steel shall include one polypropylene Pull Rope with a minimum 600 pounds proper tensile strength. All PVC Conduit installed shall include a 1c#10 Tracer Wire. A yellow tracer wire shall be used in conduits with <u>only</u> streetlight circuits. The Contractor shall install, splice, and test the tracer wire for continuity. Every tracer wire run shall be grounded at one end. Where communication/interconnect cable is installed, a 1c #10 Tracer Wire shall be installed to run continuous to the controller cabinet from each direction. All conduit will be proofed upon completion to verify continuity and integrity of the duct.

2.4 ELECTRICAL

All conductor cable combinations shall be installed as specified on the Plans. No substitutions will be permitted. The required number of conductors to each signal head shall be one conductor for each optical unit or set of optical units operating identically through the same cycle and one conductor for common return. Each overhead red, yellow, green signal head shall be wired with a separate cable from a splice in the pole base according to the conductor combination specified on the Plans. Within the cabinet, all signal cables shall be labeled as to their origin. If color or number coding is used, a key sheet shall be left in the print drawer and two copies shall be delivered to the Engineer.

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.

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

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.

All splices in the handhole compartment of a signal pole shall be made using silicone filled, screw-on wire connectors. Wires shall be twisted before the connector is added. Cable connections in signal heads and controller cabinets shall be made at the terminal blocks provided for that purpose, without using crimp-on connectors.

Slack for each cable shall be provided by a 4 foot length in each handhole and a 2 foot length in each signal and controller base (measured from the handhole compartment to the end of the cable). In those handholes where detector splices are made, a 4 foot length of cable slack shall be provided in both the detector wire and the detector lead-in cable.

Existing Wiring

Unless otherwise indicated on the plans, all existing wiring that become unused in this project shall be removed and discarded of by the Contractor. This work is considered incidental to other measured items.

2.5 FIBER OPTIC CABLE

The cable end shall be secured inside the controller cabinet so that no load is applied to the exposed fiber strands. The minimum bend radius for static storage shall not be less than ten times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.

The minimum bend radius during installation shall not be less fifteen times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer. The Contractor shall not use tie wrap devices on fiber optic cable.

A. Cable Slack: Slack shall be left in each handhole, at the top of any conduit riser, in each junction box, in each controller cabinet, and at each equipment rack or other point of termination. This slack cable requirement may be deleted where existing hand holes or through points lack sufficient area to maintain the minimum bend requirements. Where slack has been deleted, extra slack equal to the amount that would have been distributed in the through points shall be equally divided between the two controller cabinets and shall be in addition to the slack mandated at the cabinets. Slack in each handhole type shall be provided as designated on the plans. Slack cable shall be coiled and the coils bound at three points around the coil perimeter and supported in their static storage position.

B. Cable Installation in Conduits: A suitable cable feeder guide shall be used between the cable reel and the face of the conduit. The cable feeder shall be designed to protect the cable and guide the cable directly into the conduit off the reel. During the installation, the cable jacket shall be carefully inspected for jacket defects. If defects are found, the Engineer shall be notified prior to any additional cable being installed. The Contractor shall take care in the pulling of the cable to insure that the cable does not become kinked, crushed, twisted, snapped, etc. A pulling eye shall be attached to the cable and be used to pull the cable through the conduit. A pulling swivel shall be used to preclude twisting of the cable. The cable shall be lubricated prior to entering the conduit with a lubricant recommended by the manufacturer. Dynamometers or break away pulling swing shall be used to insure that the pulling tension does not exceed the specified force of 600 pounds or the cable manufacturer's recommendations, which ever is less. The mechanical stress on the cable shall 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. The pulling of the cable shall be hand assisted at each pull point.

Cable shall not be pulled through any intermediate junction box, manhole, pull box, pole base or any other opening in the conduit unless specifically required by the Engineer in specific facilities. The necessary length of cable to be installed shall be pulled from one junction box, manhole, pull box, pole base, or cabinet to the immediate next downstream manhole, box, pole base, or cabinet. The remaining length of cable to be installed in the next conduit shall be carefully stored in a manner that is not hazardous to pedestrian or vehicular traffic yet ensures that no damage to the cable shall occur. The cable shall be stored in a manner that shall allow that length of cable to be safely pulled into the next conduit. The Engineer shall approve the storing methods to be used.

At each hand hole or through point and at the cabinet, the cable shall be visibly and durably marked or tagged as "FIBER OPTIC CABLE, CITY OF DES MOINES". Additionally, each cable shall be visibly and durably marked or tagged with the cable number as shown on the plans.

C. Communications Cable Testing: A minimum of two fibers, selected at random, from each tube in the fiber optic cable shall be tested, both on-the-reel prior to installation and after installation using a high-resolution optical time domain reflectometer (OTDR). All single mode measurements shall be conducted at the 1310 ± 30 nm wavelength. All mulit-mode measurements shall be conducted at 850 ±30 nm wavelength. The Contractor shall record the identification, location, length, and attenuation measurements of each tested fiber and shall furnish all test reports to the Engineer. All cable readings/measurements shall be compared to the maximum allowable deviations in the cable specification and the levels of acceptance recommended by the manufacturer in their printed documentation. Any cable having measurements outside the allowable range shall be replaced and shall not be acceptable for installation on this project.

1. On-Reel Testing: Prior to the installation, the Contractor shall perform on-site, on-reel testing. This testing shall be for both attenuation and continuity. The tests shall be conducted at 850 nm for multi-mode fibers and at 1310 nm single mode fibers. The testing shall be performed using an OTDR by means of a pigtail splice. All test results shall be within ± 3% of factory-supplied attenuation measurements. Testing shall be done in one direction only. Hard copy or electronic copies (with applicable software) of the OTDR traces for the testing shall be furnished to the Engineer prior to installation of the cables. Except for the access to and the test preparation of any one end of the newly furnished cable to be tested, the Contractor shall preserve the cable in its originally-shipped condition. If any fiber of the cable fails the on-reel attenuation test, the cable shall be rejected and shall not be used on this project. The rejected cable shall be replaced at the Contractor's expense.

2. Cable Segment Testing: As each cable segment is terminated, the Contractor shall perform an end-to-end attenuation (power loss) test of each terminated fiber of each FO cable. This testing shall be performed using hand-held optical test sets and shall be tabulated and be included in the documentation package to be provided to the Engineer at the conclusion of the project. Overall loss for each link shall not exceed the cumulative specified maximum losses of the components. For example, at 850 nm, a one mile link with two splices and a connector on each end shall not exceed 7.0 dB:

1.0 mile x 5.6 dB/mile:	5.6 dB
0.2 dB per splice x 2:	0.4 dB
0.5 dB per connector x 2:	1.0 dB
Maximum allowable loss:	7.0 dB

The cable segment shall be rejected for use on this project if any terminated fiber of the cable segment fails the attenuation test. Rejected cables shall be repaired or replaced by the Contractor at the Contractor's expense. The Contractor shall retest all fibers of any repaired or replaced cable segment. The Contractor shall submit complete documentation of the cable segment attenuation tests. Such documentation shall be submitted in either hardcopy (written) form or in Engineer-approved electronic format on diskette.

3. Final System Testing: After the complete fiber optic system is installed and terminated, an OTDR reading shall be performed on all cables to insure that each section is in compliance with the issued specification. All fibers shall be tested. A hard copy of OTDR signature traces for all fibers for all sections shall be provided to the Engineer. Fibers which have been terminated shall be indicated in the report. In addition to the OTDR test report, the Contractor shall provide the test results of an Attenuation Test for the installed fibers using the insertion loss test procedure and the Transmitter/Receiver Power Level Test and the Continuity Test.

2.6 BONDING AND GROUNDING

Metal conduit, service equipment, anchor bolts, metal poles, pedestals, controller cabinets, interconnect cable shields, and all other electrical equipment shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. The grounding conductor shall be a No. 6 AWG copper, non-insulated wire.

Grounding shall be accomplished by bonding the grounding circuits to copper clad metal, driven electrodes. All electrodes shall be as a minimum, 5/8 inch in diameter by 10 feet long. The electrodes shall be driven vertically until the top of the rod is a minimum of 4 inches below grade. Bonding to the ground rod shall be made by means of suitable screw type positive ground rod clamps. The controller cabinet ground shall measure 10 ohms or less.

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

Install a ground wire in all conduit that carries 120 volt signal cables.

Grounding to existing water lines will not be permitted.

Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or to 1 inch, or longer, brass or bronze bolt installed in the lower portion of the shaft.

The service meter and socket shall be bonded to a ground electrode by use of a ground clamp and a No. 6 AWG copper wire.

Bonding of metallic conduit in concrete pull boxes and manholes shall be by means of galvanized grounding bushings and bonding jumpers. Where there is a change, at a pull box or manhole, from non-metallic conduit to metallic conduit, the grounding wire in the non-metallic conduit shall be bonded to the metallic conduit. Saddle clamps are not acceptable.

Existing ungrounded metal poles on which cabinets are mounted shall be grounded by means of a driven ground rod.

The interconnect cable shield shall be bonded to the controller ground buss at one controller termination point for each interconnect run.

2.7 TRAFFIC SIGNAL DISPLAYS

All Overhead traffic signal heads shall have backplates and be centered over their respective lanes, unless otherwise noted on the plans. Brackets shall be used to mount all pole-mounted and mast arm-mounted overhead signals which have top and bottom brackets and are adjustable in both horizontal and vertical planes. All overhead displays located on each mast arm shall have each red indication set at approximately the same elevation, unless otherwise directed by the Engineer. All optically limited signal heads shall be properly masked to limit their field of view as directed by the Engineer.

During the course of construction and until the signals are placed in operation, signal faces shall be covered or turned away from approaching traffic. When ready for operation, they shall be securely fastened in position facing toward approaching traffic.

2.8 CONTROLLER

The controller shall be installed at the location indicated on the Plans with the back of the cabinet toward the intersection such that the signal head can be viewed while facing the controller, unless otherwise directed by the Engineer.

The aluminum rack edge shall be labeled for each detector amplifier, load switch, and isolator.

2.9 PAINTING

Not Applicable

2.10 LOOP DETECTORS

Obtain Engineer approval of loop locations prior to saw cutting.

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.

Remove jagged edges or protrusions in the saw cuts before installing loop wire. The saw cuts must 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.

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.

Loop detector lead-in cable, shall be continuous from the terminal in the controller cabinet to a splice made with detector loop leads, in the first handhole provided adjacent to the detector loop. Apply Butyl Rubber Polymer Tape sealant between the wires and completely cover the silicone rubber. As an acceptable alternate, the Contractor may use a 3M Company Scotchcast Kit, or approved equal, for splicing in the handhole.

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 five turns per foot.

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.

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 four (4) inches 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 1/2 inches.
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.

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 his 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.

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

2.11 STREET NAME SIGNS

All signs shall be handled and installed carefully to prevent any damage to the sign faces. Any sign faces which are damaged prior to or as a result of improper installation will be rejected. Undamaged replacement signs shall then be promptly sent, at no extra cost to the Contracting Authority.

Sign mounting hardware shall include stainless steel bolts, washers, strapping, mounting brackets, etc.

Overhead mount: 18 inches x 48 inches - minimum of 2 places
18 inches x 60 inches - minimum of 3 places
18 inches x 72 inches - minimum of 3 places.

Pole mount: 12 inches x 36 inches - mount on bracket which is banded directly to pole. Greater than 36 inches - add stiffener

2.12 LOCATE BOXES

An outdoor-rated, single gang box to house communications/interconnect tracer wire shall be installed on the exterior of the controller cabinet. The location on the cabinet shall be determined by the project engineer. The locate box shall be constructed of die-cast aluminum with a die-cast zinc weatherproof cover and self-closing lid. The box shall be 2 ¾ inches x 4 ½ inches x 2 5/8 inches D. A 12 inch long ground wire shall be attached to a lug within the box.

PART III
MATERIAL REQUIREMENTS

This part consists of material requirements necessary for the construction of a traffic signal installation complete, in place, and operational as described in the project plans and these special provisions.

3.1 TRAFFIC SIGNAL LAMPS

The Contractor shall provide materials that meet or exceed industry standards for the type of operating conditions under which the bulbs will be used. Only newly manufactured bulbs will be considered as responsive to these specifications.

All vehicular and pedestrian signal lamps signal lamps shall be light emitting diode (LED) and have the following specifications:

The number of LEDs per signal head shall be sufficient to achieve intensity to meet Institute of Transportation Engineers (ITE) photometric test criteria in "Vehicle Traffic Control Signal Heads".

All signals shall comply with ITE standards for LED signals, including color.

Operating voltage shall be between 92 VAC and 135 VAC, 60 HZ +/-3 HZ. Operating temperature shall be between -40°F and +170°F.

LEDs shall be in multiple series circuits connecting no more than 6% of the total LEDs in any single circuit, or the failure of any single circuit shall not result in more than a 6% reduction in total luminous intensity.

Enclosure shall be dust and water resistant.

Beam spread shall meet all aspects of the ITE specifications.

Lenses shall be replaceable polycarbonate (U stabilized) convex, minimum 0.125 inch thick, free of bubbles, flaws and imperfections. Non-polycarbonate lenses shall be accepted provided they meet the ITE color standards and 32 foot drop test. Chromaticity shall be measured in accordance with ITE standards at 44 points, meeting specifications after 30 minute warm up.

Candlepower distribution shall meet ITE specifications. Brightness shall be maintained in the event of voltage fluctuations or sags within 30% across the operating voltage and temperature range.

Lead wires shall be a minimum of 1.5 feet with NEMA #8 locking fork type terminals for connection to terminal block. Pedestrian signals shall have a screw in base and shall not use transformers. Gaskets shall be supplied and installed if applicable.

Each LED signal lens shall include all necessary components for LED technology. These include, but not limited to: LENS, LEDS, LED circuit board, #18 AWG wire leads with strain relief and insulation rated at 105 degrees C, conductors, electronic switching module, rigid housing, and neoprene one piece gasket.

The lens shall be field replaceable and shall be smooth on the outside. The lens shall require no special tools or sealant for field replacements.

Electrical components shall meet all applicable codes including ITE and cognizant nationally recognized electrical testing laboratories.

Independent testing laboratory certification to demonstrate wattage and ITE conformance shall be supplied to the traffic engineer prior to ordering.

The LED traffic signal shall meet current ITE standards for intensity and spatial distribution after 30 minutes warm up of continuous operation.

The light output shall have a dominate wavelength of 620-635 nanometers (nm) for Red and 596-610 nm for Portland orange and at least 505 nm for green. Lens may be tinted or colored as long as the chromativity of the lens matches that of the LED's and that luminous intensity is not reduced.

Control circuiting shall prevent current flow through the LED's in the off state to avoid false indication in daylight and evening hours.

Light intensity shall not vary (nor flicker) by more than 30% over the allowable voltage and temperature operating range.

Operating current measured across each LED shall not exceed an average of 30 milliamps (mA).

All LEDs shall be "AlloGap" technology or equal, and rated for 100,000 hours or more (@ 77°F and 30 mA). (ALGaAs technology is not acceptable).

Transient voltage suppression of 1500 volts for 1 millisecond (ms) and fusing with a maximum rating of 2 Amps are required.

LEDs shall be arranged uniformly through the signal head and in an appropriate number of parallel strings to insure that no string accounts for more than 6% of the total.

Each LED signal shall be serialized by the manufacturer with date and lot numbering to facilitate warrant compliance.

Certification: The Engineer shall be furnished with a certification from the manufacturer of the signal head that the equipment furnished under this specification complies with all provisions of this specification. If there are any items, which do not comply with this specification, a list of those exceptions must be detailed on the certification.

Lamp Failures

1. The Contractor shall promptly replace any lamp which fails either during installation or within the 30 calendar day test period.

3.2 TRAFFIC SIGNAL CABLE

The number of conductors and size of all traffic signal cable shall be as specified on the plans. All wire shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable. All wiring shall be copper. Aluminum wire will not be accepted.

A. Cable for signalization shall be rated 600 volts 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 volt, 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 Specifications 51-5.

E. Detector lead-in cable shall be No. 14 AWG, meeting the requirements of IMSA Specification 50-2 or latest revision thereof.

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

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

3.3 SIGNS

A. Sign Faces: Shall meet all requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways, as adopted by the Department per 761 of the Iowa Administrative Code (IAC), Chapter 130.

The background sheeting used on all signs, with the exception of pedestrian pushbutton signs, shall be prismatic retroreflective sheeting with pressure sensitive adhesive. Any other applied material, including legends, letters, numbers, or borders, again with the exception of pedestrian push-button signs, shall also be prismatic retroreflective sheeting with pressure sensitive adhesive.

This material shall have a standard warranty to be free from any defects. A copy of the standard warranty shall be provided as a part of the bid package.

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

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

C. Sign Mounting Brackets: All pole mounted signs shall be supplied with a sign bracket. The mounting assembly shall be a cable type as described in Section 4.3C of this specification. Approval of other bracket supports shall be based on specifications and/or test data about their physical properties and performance properties.

3.4 FIBER OPTIC CABLE AND ACCESSORIES

A. Fiber Optic Cable: Furnish and install the loose tube fiber optic cable(s) of the type, size, and number of fibers specified and all associated accessories.

The cable shall meet the latest applicable standard specifications by American National Standards Institute (ANSI), Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA) for the type mode cable of the size specified and the specifications herein.

1. Multimode Fiber - Grade Index

Core Diameter:	62.5 µm ± 1.0 µm
Cladding Diameter:	125.0 µm ± 1.0 µm
Core Concentricity:	± 1%
Max. Attenuation:	6.03 dB/mile

2. Single-Mode Fiber

Typical Core Diameter:	8.3 µm ± 1.0 µm
Cladding Diameter:	125.0 µm ±1.0 µm
Core Concentricity:	± 1%
Attenuation Uniformity:	No point discontinuity greater than 0.1 µm at either 1300 nm or 1550 nm
Max. Attenuation:	0.40 dB/mile

The coating shall be a dual layer UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically strippable without damage to the fiber.

The central member of the cable shall be a glass reinforced plastic rod designed to prevent the buckling of the cable. The cable core interstices shall be 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.

Buffer tubes shall be of dual layer construction with the inner layer made of polycarbonate and the outer layer made of polyester. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conducting homogeneous gel or a waterblocked with a water-swellable yarn or tape. If gel is used it shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents. Buffer tubes shall be stranded around the central member using reverse oscillation, or "SZ", stranding process.

The buffer tubes shall meet TIA/EIA-598A, "Color coding of fiber optic cables". The single mode cable shall include a total of 3 loose tubes with 12 fibers in each for a total of 36 fibers. The multi mode cable shall include one loose tube with 12 fibers. The tube and fiber colors shall follow the industry color code (BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, RS, AQ).

The cable tensile strength shall be provided by a high tensile strength aramid yarn and/or fiber glass.

All dielectric cables, without armoring, shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 0.055 inch. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The jacket or sheath shall be marked with the manufacturer's name and the words "Optical Cable", the year of manufacture, and sequential feet marks. The markings shall be repeated every foot. The actual length of the cable shall be within the range plus one percent of the length marked. The marking shall be in a contrasting color to the cable jacket. Additionally, the jacket marking shall have a durable weather proof label which shows the actual attenuation of each fiber expressed in dB/mile.

The cable shall be fabricated to withstand a maximize pulling tension of 600 pounds during installation (Short term) and 135 pounds upon installation (Long term).

The shipping, storing, installing and operating temperature range of the cable shall be -40°F to +158°F.

The manufacturer shall test at the 100% level all fiber optic cable for the following tests:

a. Each fiber proof tested at a minimum load of 350 MPa.
b. Each fiber tested for attenuation and the reading shall be part of cable labeling.

The cable shall meet the appropriate standard Fiber Optic Test Procedure for the following measurements:

a. Fluid Penetration
b. Compound Drip
c. Compressive Loading Resistance
d. Cyclic Flexing
e. Cyclic Impact
f. Tensile Loading and Bending

The cable ends shall be available for testing. The cable ends must be sealed to prevent moisture impregnation.

B. Fiber Optic Jumpers/Patch Cords: All fibers in the multi-mode fiber optic cable shall be terminated in the distribution unit within the traffic controller cabinet.

Length of patch cord will vary according to distribution unit to traffic signal controller, fiber optic modem, or video modem location within controller cabinet and shall provide for a minimum of 2 feet total slack.

Controller cabinet patch cords shall consist of factory-assembled patch cords, each of which shall contain two multi-mode fibers. Each such fiber shall have an STPC (ST compatible, Physical Contact) connector with ceramic ferrule on each end (i.e., a total of four STPC connectors per cord). Each patch cord shall have a dielectric strength member and a durable outer jacket designed to withstand handling.

Simplex or duplex pigtail jumpers shall be used, in cases of existing 48-Fiber hybrid cable, to branch traffic signal controller/CCTV circuits from splice enclosure in handholes to distribution units/modems in controller cabinets.

Field pigtail jumpers shall consist of factory-assembled patch cords, each of which shall contain two multi-mode fibers. Each such fiber shall have an STPC (ST compatible, Physical Contact) connector with ceramic ferrule on one end (i.e., a total of two STPC connectors per cord) and no connector on the other end (for fusion or mechanical splcie). Each patch cord shall have a dielectric strength member and a durable outer jacket designed to withstand handling.

C. Distribution Unit/Fiber Closet: All fibers, unless stated otherwise in the plans, shall be terminated in the distribution unit. The unit shall be a rack mount, drawer type enclosure that is dust and moisture repellent.

The size of the unit shall be adequate for the number of fibers, proper winding area, and splices. A minimum of 24 ST type connectors shall be provided for each traffic signal controller cabinet.

The enclosure shall be mounted on a EIA 19 inch rack in an area that does not interfere with the normal maintenance of the cabinet electronics and shall have a maximum dimensions of 3.5 inches H x 18.5 inches W x 11.25 inches D. The distribution unit shall be of a slide out drawer type for easy front access with removable rear tray cover to provide easy rear access. The enclosure shall provide for side cable entries and be capable to accommodate up to 48 ST multimode adapters.

The field jumpers/cable shall be secured to the enclosure in a manner that does not degrade the fiber optic cable but insure a firm and secure mount. Sufficient lengths of every loose tube shall be coiled within the enclosure to provide spare distance and reach the fiber interface panel.

All multimode fibers shall be terminated with ST connectors.

D. Connectors: Only ST type connectors of ceramic ferrule and Physical Contact end finish shall be used to terminate fibers to equipment. ST or mechanical connectors shall not be used to splice cables.

Maximum attenuation per connector shall be 0.75 dB.

E. Splices: Fusion splices shall be used to splice all continuous fiber runs in splice enclosures.

The fiber cable shall be installed in continuous runs as designated on the plans. Splices shall be allowed only in the splice enclosures and controller cabinets as located on the plans. Maximum attenuation per splice shall be 0.3 dB.

F. Breakout Kits: Breakout kits shall be provided for separation and protection of individual fibers with buffer tubing and jacketing materials suitable for termination of the fiber and fiber optic connector as specified.

G. Splice Enclosure: Ends of continuous fiber cable runs and/or traffic signal controller branch circuit points will be spliced in an outside plant splice enclosure located in handholes as shown on plans.

Enclosure will provide enough trays to splice all fibers, both single mode and multi mode.

Enclosure shall provide environmental protection of cable and splices from water and dirt.

3.5 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 plus or minus five percent. 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 3/8 inch and a minimum length of 5 inches.

3.6 CONDUIT

A. Rigid steel conduit shall be galvanized steel and meet the requirements of ANSI Standard Specification C80.1, latest revision. 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.

3.7 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 asphaltic concrete and Portland cement concrete. 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.

PART IV
EQUIPMENT REQUIREMENTS

This part consists of the equipment requirements necessary for the construction of a traffic signal installation complete, in place, and operative as described in the project plans and this specification.

4.1 TYPE 170, TRAFFIC SIGNAL CONTROLLER SYSTEM

A. Related Specifications: Unless otherwise stated herein, 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 Jurisdiction.

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 Jurisdiction 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 Jurisdictional 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 two seconds) the Monitor Unit shall be capable of disabling the RED FAILURE detection, until the signal heads are energized (approximately four 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.

   d. The conflict monitor unit shall be capable of ignoring the watchdog and placing intersection in flash if line voltage is less than 98 (+/-2) VAC RMS.

10. A "PDA-2" Power Distribution Assembly shall be provided in lieu of the PDA-1 and the 24 volt D.C. Supply.

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

12. Four 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 Type 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 (McCain).

15. Each cabinet shall include 2 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 form 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 30V MOV with (30 Joule Rating) P/n ERZ-C20 KE 470 or equal. The output of all load switch outputs shall be protected with a 150V MOV (80 Joule Rating). P/n ERZ-C20 DK 241U or equal. The MOVs shall be connected from the AC positive field terminal to the chassis ground.
For the 332A 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 ½ the peak: 20,000 Amperes.

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

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 Engineer. The Contractor shall supply two blank 27256 PROM chips per controller.

D. Operational Modifications: When specified on the Plans, 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 inch x 12 inch, 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 Jurisdictional 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 be provided with a standard industry warranty. Any parts found to be defective shall, upon concurrence of the defect by the manufacturer, be replaced free of charge.

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.

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 Traffic Signal Shop located at 2000 SE Scott. Since staff are not always present at this shop, it is the responsibility of the deliverer to call Mark Dakovich at (515) 208-1489 to schedule delivery.

The City of Des Moines 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.

The Contractor/Supplier is responsible for picking up the controller(s) from the Signal Shop and is solely responsible for bringing the controller(s) to full operation at the intersection(s). No assistance will be provided by the Signal crew once the software is working correctly and the signal timings have been verified in the Signal Shop. Having a knowledgeable representative at the project site(s) when the controller(s) is ready to be turned on is paramount to the safety and efficiency of this operation.

A. The conflict monitor unit shall be capable of ignoring the watchdog and placing intersection in flash if line voltage is less than 98 (+/-2) VAC RMS.

4.2 FIBER OPTIC DATA LINK OR ETHERNET CARD

A. Fiber Optic Data Link

When specified in the plans, a fiber optic data link shall be provided. It shall be of the type that will install in Type 170 controller chassis and provide a dual mode, double duplex, multi-drop communications link designed to interconnect traffic control equipment. Data links shall include the following functional requirements:

1. Master or Local operation mode set by board mounted switch.

2. Two sets of front mounted fiber optic receptacles with ST type connectors.

3. Accommodate 850nm, Multimode fiber optic cable.

4. Complies with 170 and NEMA Environmental specifications.

5. Includes a rechargeable NiCad battery backup to maintain communications in case of power disruption. Battery assembly shall be secured to board and charge circuit shall be built in.

6. Expansion port, which will allow for up to two additional fiber optic ports for directional branching of communication circuits.

7. Status LED's which provide visual signal indicators associated with communications between the modems and can be easily viewable by a maintenance technician. Signals displayed shall include:

   a. Transmit Data 1 (TD-1)
   b. Receive Data 1 (RD-1)
   c. Transmit Data 2 (TD-2)
   d. Receive Data 2 (RD-2)
   e. Power (PWR)
   f. Built-In Test Fail (Fault)

B. Ethernet Card

When specified in the plans, an internal 170 Ethernet Card shall be provided to allow for Ethernet connection via the City's network. It shall be of the type that will install in a Type 170 controller chassis, connecting via RJ45 cable to an Ethernet switch located elsewhere within the controller cabinet. It shall include the following functional requirements:

1. Network interface to provide the following:

   a. 10Base-T/100Base-TX Ethernet Connection
   b. RJ45 connector
   c. Protocols: TCP/IP, UDP/IP, ARP, SNMP, TFTP, Telnet, DHCP, BOOTP, HTTP, and AutoIP

2. Serial interface to provide the following:

   a. 300 to 230, 400 bps data rate
   b. 7 or 8 data bit characters
   c. Parity – odd, even, none
   d. Stop bits: 1 or 2
   e. Control Signals: RTS/DCD, CTS
   f. Flow Control: XON/XOFF, RTS/CTS

3. Temperature hardened (-40° to 75° C)

4. Password protection with 256 bit AES encryption for secure communications

5. Power requirements to be +12 volts and 12 volts ± 5% @A 75mA

6. Embedded webserver

7. E-mail alert capability

8. Full TCP/IP protocol stack

9. Provide two serial ports that communicate via a single communications channel. The host Interface connects through the card edge to the local controller. The Auxiliary Port utilizes a DB9 connector and can be used to bring copper or wireless communications into the main data stream. The Auxiliary Posrt is to be switch selectable, so that it can operate as either a DCE or DTE interface. IN DCE mode, it will operate in parallel with the Host interface, and can be used to configure the Etherport via a PC terminal program. In DTE mode, it will provide an external interface for the host which can be connected to another DCE device such as a FSK modem. Full "handshaking" is to be provided to facilitate interoperability across different transmission systems.

10. Management shall be SNMP, Telnet, serial, internal Web server, and Microsoft Windows®-based utility configuration.

11. Indicators shall be provided to show 10Base-Tconnection, 100Base-T connection, and link & activity-full/half duplex.

C. Ethernet Switch

When specified in the plans, a Gigibit Ethernet hardened field switch shall be provided. The switch shall be construction for modular port configuration housed in a high strength metal enclosure designed for DIN-Rail mounting and convection cooling. Nominal dimensions 1.75in H x 8.75in W x 10.0in D and weigh less than 4.75 lbs. The standard configuration will be with (4) 10/100 copper ports and (2) Gigabit singlemode fiber ports with one spare GBIC slot for suture growth. Power input shall be AC. Manufactured in United States and Warranted for 3 years from day of contract acceptance for all parts and labor.

Additionally the Ethernet Switch shall provide:

a. Two modular slots for user selection of 100Mb and 10MB fiber ports, Gigabit fiber ports, 10/100 copper ports, and PoE. Up to a maximum of 16 ports.

b. Relay contacts for external "Alarm" monitoring of internal power, and of selected software operations. Form C, one NC indicating internal power, one NC software controllable.

c. SNMP, rich commands including access control

d. SNMPv3 for encrypted authentication & access security

e. RMON with statistics, history, alarms and events

f. GUI with Hubview/Bitview support

g. CLI with multi-level password security

h. VLANs, Port-based, Tag-based, with GVRP

i. Spanning Tree Protocol, 802.1w

j. LACP Link Aggregation Control Protocol, 802.3ad

k. Rapid Spanning Tree Protocol, 802.1d

l. Link-Loss-Learn (LLL) for fast switch buffer flush

m. Ring Redundancy software available for sub-second recovery of ring faults

n. QoS, multi-level 802.1p, ToS and DiffServ

o. IGMP Snooping and multicast pruning

p. Telnet, both client and serve support

q. Secure Web Management with SSL Secure Sockets Layer and TLS Transport Layer Security protocol support

r. Port Security, controlled access by MAC address, support of 200 MAC addresses for port security

s. Port mirroring for selective traffic analysis

t. Event Log for the 1000 most recent events

u. Port Settings Control, copper and fiber ports

v. SMTP provides email alerts of traps and event

w. SNTP with world–wide time zones

x. Radius server and TACACS+ Terminal Access Controller Access Control System

y. IP support for SNMP both TCP/IP and UDP/IP

z. Passive or active FTP and TFTP for load/save convenience

aa. CLI Script method supported for ease of upgrading multiple switches

bb. BootP/DHCP for auto configuration

cc. Back pressure and flow control option per

dd. Temperature rating of –40C to 75C and NEMA TS2 certified, or – 50C to 95C by the IEC 60068 Type Test method

ee. Store and Forward with IEEE 802.3x full-duplex flow control. All ports non-blocking. System aggregate forward and filter rate 6.0 Mpps.

ff. Address table: 4K nodes, with address aging time of 155 seconds typical

gg. Latency: 6μs + packet time max (TX – TX, TX – FX, FX – FX, TX-G, G-G)

hh. MTFB of greater than 10 years calculated via Telcordia Bellcore method and/or MilStd Handbook 217

4.3 VEHICULAR TRAFFIC SIGNAL HEADS

The purpose of the specification is to describe minimum acceptable design and operating requirements for vehicular traffic signal heads with either 8 inch or 12 inch diameter lens openings, including all fittings and brackets as specified on the Plans.

A. Main body Assembly: Each section shall be complete with a one-piece, hinged door with water tight gaskets and two stainless steel locking devices. The hinged pins shall be designed so that the doors may be easily removed and reinstalled without use of special tools.

The optical system shall be so designed as to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens. When the door of the optical unit is closed, all joints in the assembly between the interior and exterior of the reflector shall be closed against suitable gaskets in order that the units may be double dust-tight. Between the door and the lens, there shall be a neoprene gasket securely fastened around the outer surface of the lens, said gasket to be engaged by the rim of the reflector holder when the door is closed to render the union between the reflector holder and the door assembly dust-tight.

Each polycarbonate lens shall have a tunnel visor not less than 8 inches in length and designed to shield each lens. Polycarbonate tunnel visors shall have a minimum thickness of 0.1 inch.

The reflector holder shall be designed to separately support the reflector and socket in proper relation to the lens. The reflector holder shall either be hinged to the left-hand side of the signal body when viewed from the front with the right-hand side held in place by a spring catch or other quickly releasable means, or 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 device and the spring catch or equivalent shall be of a flexible nature which will permit the reflector holder to be pushed inwardly for at least 1/16 inch 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. It shall not be necessary to remove any screws or nuts in order to swing the reflector holder out of the body section to obtain access to the light socket. The reflector shall be Alazak treated aluminum or an approved equal. Glass is not acceptable. The reflector assembly shall be interchangeable and shall be designed so that it can be easily removed without the use of tools.

The lamp receptacle shall be 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 degrees 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 long, composed of wire with insulation designed to withstand 221°F. The wiring leads shall be terminated with spade lugs for ease of connection to terminal block. The socket shall be equipped with a gasket to insure a dust-tight fit between socket and reflector.

B. Specialized Options: All screws, latching bolts, and hinge pins shall be stainless steel to prohibit rust and corrosion.

One section of the three-section signal shall be equipped with a six position terminal block for termination of field wiring. Each five-indication signal shall be equipped with an eight (8) position terminal block.

All vehicular signal head housing shall be of the black polycarbonate type. The inside of visor shall be flat black. The black color shall be permanently molded into the components. The doors of the polycarbonate sign shall also be black.

Construct backplates of two piece durable black plastic capable of withstanding a 100 M.P.H wind.

C. Traffic Signal Mounting Brackets:

All overhead mounted signal heads shall have backplates. The traffic signal mounting bracket be an articulated serrated bracket assembly that includes top and bottom signal mounting brackets and provides a rigid-mount for the traffic signal head. It shall include internal wiring capability, and three axes of traffic signal adjustment, as well as vertical height adjustment. All necessary hardware for complete installation on a mast arm shall be included. The mounting assembly shall be of a cable type.

When a tenon-mount is indicated, the assembly shall be capable of mounting over a standard 2-inch Schedule 40 galvanized pipe tenon that extends 4 inches from the mast arm. A locking bolt shall be incorporated to secure the bracket to the tenon.

When a midpoint clamp bracket is specified, the assembly shall include mounting equipment including a stainless steel cable and hardware that allows the bracket to be securely tightened by means of a threaded nut around an existing mast arm.

4.4 PEDESTRIAN SIGNAL HEADS

The purpose of this specification is to describe minimum acceptable design and operating requirements for one-section, pedestrian traffic signal heads with "Hand" and "Walking Person" symbol messages to include all fittings and brackets, as specified on the plans. Pedestrian signal heads shall meet the requirements outlined in them ost recent ITE specifications for LED pedestrian traffic signal control heads.

A. General Construction: The general construction shall include a single piece cast aluminum or polycarbonate housing, a single piece double parabolic reflector, a 3-line two color message lens, a single piece cast aluminum or polycarbonate swing down door frame, a blankout sun visor, LED modules, and other hardware.

All LEDs shall be rated for 100,000 hours or more (@ 77°F and 30 mA).

The individual symbols shall each be a minimum of 12 inches in height and 7 inches in width. Message configuration color and size shall be ITE Equipment Standard "Pedestrian Traffic Signal Control Signal Indications" most recent version. Internal illumination shall be provided by an LED module without transformer.

Optically, the pedestrian signal shall be capable of displaying, brightly and uniformly, the alternate messages "Hand" symbol in portland orange and "Walking Person" symbol in white. When subjected to strong ambient light conditions, the messages shall "blankout" when the signal is not engergized. The signal shall be furnished with the LED module and hardware. The signal shall be designed so that all components are readily accessible from the front by merely opening the signal door.

B. Main Body Assembly: The housing shall be one piece corrosion resistant aluminum alloy die casting or polycarbonate complete with intergrally cast top, bottom, sides, and back. Four integrally cast hinge lug pairs, two at the top and two at the bottom of each case. The case, when properly mated to other pedestrian signal components and mounting hardware shall provide a dustproof and weatherproof enclosure and shall provide for easy access to and replacement of all components.

The door frame shall be one piece corrosion resistant aluminum alloy die casting or polycarbonate, complete with two hinge lugs cast at the bottom and two latch slots cast at the top of each door. The door shall be attached to the case by means of two ASTM A193, Type 304 stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel spring pins. Latching or unlatching the door shall require no tools.

Each signal shall be provided a sun visor designed to eliminate sun phantom.

The optical system shall be designed so as to minimize the return of outside rays entering the unit from above horizontal (sun phantom). The optical system shall consist of; a three-line two color message lens, a double parabolic reflector, LED modules, and a sun visor. The inside face of each message section shall be silkscreened with a transparent coating of an appropriate color in the word message areas to produce a portland orange "Hand" symbol and an white "Walking Person" symbol when illuminated by LED traffic signal lamp operating at rated voltage. The entire background shall be a fired ceramic mask, black in color.

C. Specialized Options: All screws, latching bolts, and hinge pins shall be stainless steel to prohibit rust and corrosion.

Prior to final assembly, the case, door frame, Clamshell mounting, and visor (aluminum portion only) shall be thoroughly cleaned and then etched with an iron phosphate solution. An appropriate chemical sealer shall then be applied with a top grade T.G.I.C. polyester powder then being electrostatically applied and oven baked. The housing shall be black with the visor being black.

D. Miscellaneous Requirements: The pedestrian heads shall be constructed of the highest quality materials. High-grade workmanship shall be used throughout. Each head shall have a smooth surface both inside and outside and shall contain no sharp fins or sharp projections of any kind.

All components of the vehicular traffic signal heads furnished under this specification shall comply with the latest Institute of Transportation Engineers Standards on Adjustable Face Vehicle Traffic Control Signal Heads.

E. Certification: The Engineer shall be furnished with a certification from the manufacturer of the pedestrian head that the equipment furnished under this specification complies with all provisions of this specification. If there are any items which do not comply with this specification, a list of those exceptions must be detailed on the certification.

F. Countdown Pedestrian Indicator: The countdown pedestrian indicator unit shall fit in a traditional 16 inch X 16 inch pedestrian signal head housing. The unit shall display a digital numerical count in addition to the graphic display to show how much time remains to clear the intersection. The unit shall be able to monitor the timing sequence from the traffic signal controller and adjust the countdown to match the "WALK" and flashing "DON'T WALK" time intervals without the need for any additional adjustments to the settings of the unit. The unit shall automatically learn any new sequences and adjust its countdown accordingly.

The unit shall be set at the factory to operate in the "clearance countdown" option that counts down during the flashing "DON'T WALK" time interval only. The count down shall start with the digital display in the blinking mode at the same time the graphic hand is displayed in blinking mode. The digital display shall finish counting down at the same instance that the hand is displayed in non-blinking mode. The digital countdown shall remain off through the walk interval until the controller once again displays the graphic hand in blinking mode.

To accommodate the emergency and manual preemption, the unit shall compare each countdown interval to the one prior to it. When the intervals are not equal, the unit shall blank out the count down digits and the traffic signal controller shall then mandate what indicator is displayed.

4.5 ALUMINUM TRAFFIC SIGNAL PEDESTALS

The purpose of this specification is to describe minimum acceptable design, material, and fabrication requirements for aluminum traffic signal pedestals and/or aluminum shafts.

A. Construction: The pedestal base shall be cast-aluminum, square shape to maximize working area, with a handhole. The size of the handhole shall be at least 4 inches by 6 inches and equipped with a cover which 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 4 bolt pattern uniformly spaced on a 13 3/4 inches diameter bolt circle. Poles with shaft lengths greater than 10 feet shall be supplied with a base collar. The exterior of the base shall be smooth and have a neat appearance. The top of the base shall be threaded to receive a standard aluminum shaft as described in Section C below.

B. Anchor Bolts: Four ¾ 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.

C. Pedestal Shafts: The length of the shaft shall be as specified in the plans or bid documents. The shaft shall be fabricated from aluminum alloy 6063-T6, ASTM B209 or approved equal, Schedule 40 (wall thickness not less than 0.23 inches, and shall have a satin brush or spun finish. The shaft shall have an outer diameter of 4½ inches.

The top of the shaft shall be designed to receive a pole-top mounting bracket for a traffic signal head or a pedestal-mounted traffic signal controller, while the bottom of the shaft shall be threaded to screw into a standard cast-aluminum pedestal base as described in Section A above.

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

4.6 GALVANIZED STEEL TRAFFIC SIGNAL SUPPORTS

The purpose of this specification is to describe minimum acceptable design, material, and fabrication requirements for galvanized steel traffic signal supports.

A. Construction: The mast arms shall be of the length specified and shall be designed to support traffic signals and/or signs as shown on the plan. All mast-arms shall have a 4 percent rise when in-place and fully loaded.

Poles shall be manufactured in accordance with the requirements of the latest Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals as approved by the American Association of State Highway and Transportation Officials.

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.

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 percent penetration for plates 3/8 inch and less in thickness, and minimum of 80 percent penetration for pates over 3/8 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 shall be considered incidental to the traffic signal installation.

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

The pole shall be equipped with a minimum 8 inch x 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.

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 x 6 inch handhole and cover located opposite the signal mast arm.

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.

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.

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.

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.

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

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.

4.7 PEDESTRIAN PUSH-BUTTON DETECTORS

The purpose of this specification is to describe minimum acceptable design and operating requirements for side-of-pole mount, pedestrian push-button detectors, including all fittings and brackets as specified on the plans.

A. Construction: Pedestrian push-button detectors shall be of the direct push type without levers, handles, or toggle switches. Each detector shall consist of a solid state electronic switch with no moving plunger or moving electrical contracts. The case shall have one outlet for a ½ inch pipe. The operating button shall be made of stainless steel and shall be of sturdy design. This button shall not protrude out from the case. The entire assembly shall be weather tight, secure against electrical shock and of such construction as to withstand continuous hard usage. The contact shall be normally open and no current flowing except at the moment of actuation. The push-buttons supplied shall be ADA accessible push button assembly with momentary LED indicator. The push-button casing shall be black in color, oval with a raised directional arrow.

B. Certification: The Engineer shall be furnished with a certification from the manufacturer of the detectors that the equipment furnished under this specification complies with all provision of this specification. If there are any items which do not comply with this specification, a list of those exceptions must be detailed on the certification.

C. Audible Pedestrian Pushbutton: Pushbutton assembly shall be black in color, have an integrated R10-3b pushbutton sign and ADA compliant pushbutton with raised directional arrow. The pushbutton shall provide an LED light which lights when the button is pushed. Pushbutton shall provide the options of sounds during the clearance interval, direction of travel messages, and special messages determined by the user.

5.1 SCHEDULE OF UNIT PRICES
TRAFFIC SIGNALIZATION
Army Post Widening - SE 5th to SW 9th
06-2009-005

ITEM	UNIT	TOTAL QUANTITY	UNIT COST	EXTENSION
8 Phase Controller, Cabinet, and Accessories	EACH	1		
Controller Cabinet Riser	EACH	1		
Pedestrian Pushbutton with Sign	EACH	8		
2 ch. Inductive Loop Detector - Card Rack	EACH	8		
12" R, Y, G, Yarrow, G arrow w/backplate, mast arm mount, LED	EACH	2		
12" R, Y, G w/backplate, mast arm mount, LED	EACH	4		
12" R, Y, G side of pole mount, LED	EACH	4		
16" Hand/Walking Person with Countdown Timer, LED	EACH	8		
Type I	EACH	5		
Type III	EACH	1		
Signal - 16c #14	LIN FT	491		
Signal - 7c #14	LIN FT	134		
Signal - 5c #14	LIN FT	468		
Signal - 2c #14	LIN FT	1151		
Detector - 1c #14 Loop	LIN FT	2808		
Detector - 2c #14	LIN FT	3080		
Power - 1c #6	LIN FT	233		
Ground - 1c #6	LIN FT	603		
Tracer - 1c #10	LIN FT	1639		
Luminaire - 1c #10	LIN FT	420		
Luminaire - 1c #8	LIN FT	693		
Pull Rope	LIN FT	1612		
Detector Sawcut	LIN FT	1296		

5.1 SCHEDULE OF UNIT PRICES
TRAFFIC SIGNALIZATION
Army Post Widening - SE 5th to SW 9th
06-2009-005

ITEM	UNIT	TOTAL QUANTITY	UNIT COST	EXTENSION
1" PVC, trenched	LIN FT	314		
3" PVC, pushed	LIN FT	1087		
3' Dia. X. 8' Footing	EACH	2		
3' Dia. X. 10' Footing	EACH	2		
Controller Cabinet Footing	EACH	1		
Combination Signal/Lighting Mast Arm - 26'	EACH	1		
Combination Signal/Lighting Mast Arm - 36'	EACH	1		
Combination Signal/Lighting Mast Arm - 44'	EACH	1		
Combination Signal/Lighting Mast Arm - 46'	EACH	1		
L-1 Connector	EACH	8		
Y-1 Connector	EACH	6		
Street Name Sign - 48" x 18", Install Only	EACH	2		
Street Name Sign - 60" x 18", Install Only	EACH	2		
Traffic Sign - 30" x 36", R3-5L	EACH	3		
Traffic Sign - 30" x 36", R10-12	EACH	2		
Communications Equipment	EACH	1		
Fiber Closet with Fiber Terminations	EACH	1		
Locate Box	EACH	1		
	TOTAL SIGNALIZATION COST			

5.2 EQUIPMENT AND MATERIALS LIST
TRAFFIC SIGNALIZATION
Army Post Widening - SE 5th to SW 9th
06-2009-005

Plan Quantity	Units	ITEM	Manufacturer	Catalog Number
1	EACH	8 Phase Controller, Cabinet, and Accessories		
1	EACH	Controller Cabinet Riser		
8	EACH	Pedestrian Pushbutton with Sign		
8	EACH	2 ch. Inductive Loop Detector - Card Rack		
2	EACH	12" R, Y, G, Yarrow, G arrow w/backplate, mast arm mount, LED		
4	EACH	12" R, Y, G w/backplate, mast arm mount, LED		
4	EACH	12" R, Y, G side of pole mount, LED		
8	EACH	16" Hand/Walking Person with Countdown Timer, LED		
5	EACH	Type I		
1	EACH	Type III		
491	LIN FT	Signal - 16c #14		
134	LIN FT	Signal - 7c #14		
468	LIN FT	Signal - 5c #14		
1151	LIN FT	Signal - 2c #14		
2808	LIN FT	Detector - 1c #14 Loop		
3080	LIN FT	Detector - 2c #14		
233	LIN FT	Power - 1c #6		
603	LIN FT	Ground - 1c #6		
1639	LIN FT	Tracer - 1c #10		
420	LIN FT	Luminaire - 1c #10		
693	LIN FT	Luminaire - 1c #8		
1612	LIN FT	Pull Rope		
314	LIN FT	1" PVC, trenched		

5.2 EQUIPMENT AND MATERIALS LIST
TRAFFIC SIGNALIZATION
Army Post Widening - SE 5th to SW 9th
06-2009-005

Plan Quantity	Units	ITEM	Manufacturer	Catalog Number
1087	LIN FT	3" PVC, pushed		
1	EACH	Combination Signal/Lighting Mast Arm - 26'		
1	EACH	Combination Signal/Lighting Mast Arm - 36'		
1	EACH	Combination Signal/Lighting Mast Arm - 44'		
1	EACH	Combination Signal/Lighting Mast Arm - 46'		
8	EACH	L-1 Connector		
6	EACH	Y-1 Connector		
3	EACH	Traffic Sign - 30" x 36", R3-5L		
2	EACH	Traffic Sign - 30" x 36", R10-12		
1	EACH	Communications Equipment		
1	EACH	Fiber Closet with Fiber Terminations		