

SP-090050
(New)



**SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION**

Polk County

**Project No.
HDP-44-6(14)--71-77**

**Effective Date
March 16, 2010**

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.

1. GENERAL

- A. This part of the Special Provisions consists of the general requirements necessary when furnishing a traffic signal installation complete, in place and operative as described in the project plans and these specifications.
- B. The Standard Specifications for Highway and Bridge Construction, Series of 2009, Iowa Department of Transportation, as modified by these specifications or other appropriate special provisions shall apply to this project. The installation of the traffic control signals and appurtenances shall be in conformance with the Manual On Uniform Traffic Control Devices, latest edition.

2. EQUIPMENT AND MATERIALS

- A. Fabrication or assembly process materials shall comply with the applicable parts of Section 2525 "Traffic Signalization" of the "2009 Standard Specifications" with the additions as stated herein.
- B. Equipment and materials shall be of new stock unless the plans provide for the relocation or the use of fixtures furnished by others. New equipment and materials shall be the product of reputable manufacturers of electrical equipment, and shall meet the approval of the Engineer.
- C. Shop Drawings and Catalog Cuts- Eight (8) copies of shop drawings shall be furnished for steel mast arm poles to be furnished on the Project. Eight (8) copies of catalog cuts and manufacturer's specifications shall be furnished for all standard off-the-shelf items.

Review by the Engineer of shop drawings and equipment and material lists shall not relieve the Contractor of any of their responsibility under the Contract or the successful completion of the work in conformity with the Plans and Specifications.

Before acceptance of the work, the Contractor shall furnish the Engineer with three (3) copies of the manufacturer's instructions for maintenance and operation of all signal equipment, wiring diagrams of the installation or system, and a parts list sufficient for the ordering of any parts.

- D. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to the requirement of the plans and these Special Provisions; all material and work shall conform to the requirements of the National Electrical Code, the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances.

Wherever reference is made in these Special Provisions or in the standard provisions to the code, the safety orders, the general order, or the standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect at the date of advertising of these Special Provisions.

- E. Certification from the manufacturers of all electrical equipment, signal supports, conduit and cable shall be supplied by the Contractor stating said material complies with these Specifications.

- F. Any existing equipment designated to be removed on the project shall remain the property of the City of Grimes. The Contractor shall deliver any removed equipment to the City Public Works Department.

3. SCHEDULE OF UNIT PRICES

Prior to any payment by the Owner for work completed on this project, the Contractor shall complete and forward to the Owner for approval three (3) copies of a list of unit costs for each item listed on the Schedule of Unit Prices attached to the Specifications. The sum of the costs for each item shall equal the total Contract Lump Sum price for the traffic signal installations. The Owner will make monthly estimates of the work performed on the project and the unit costs will be used to prepare progress payments to the Contractor. The unit costs will also be used to establish the total cost for any Extra Work Orders related to traffic signal installation work items.

4. TESTING AND MAINTENANCE OF SIGNAL EQUIPMENT

- A. The Contractor shall notify the Engineer the date the signal or signal system will be ready for testing.
- B. Upon concurrence of the Engineer, the Contractor shall 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 of the Engineer and concurrence by the Engineer that the signal(s) are ready to be placed into operation. Any failure or malfunction of the equipment, 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 day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.
- C. A representative from the manufacturer and /or supplier of the signal controller shall be at the project site when the signal installation is placed into operation, to provide technical assistance including, as a minimum, programming of all necessary input data. All required signal timing data will be provided by the Engineer.
- D. After signal turn on and prior to final acceptance of the completed traffic signal system, the Contractor shall respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

5. GUARANTEE

- A. In addition to the warranties or guarantees on specific traffic signal equipment listed elsewhere in these Special Provisions, the Contractor shall fully guarantee the traffic control signal installation against defective equipment, materials, and workmanship. Should any defect develop under normal and proper operating conditions within 12 months after acceptance of the completed installation by the Owner, this malfunction shall be corrected by, and at the expense of the Contractor, including all labor, materials, and associated costs.

- B. This guarantee shall be provided in writing on Company or Corporation letterhead stationery by the Contractor to the Owner prior to final acceptance. The Contractor shall transfer all required equipment warranties on the date of final acceptance to the Owner.

6. BASIS OF PAYMENT

The Traffic Signal Installation(s) measured as provided above will be paid for at the contract lump sum price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete signal installation and for all equipment, tools, labor, and incidentals necessary to complete the work.

7. HANDHOLES

- A. Handholes shall be installed at the locations shown on the plans, and at such additional points as the Contractor, at their own expense, may desire to facilitate the work.

The Contractor may furnish poured in place concrete handhole, with cast iron ring and cover, or pre-cast concrete handhole, with cast iron ring and cover.

- B. The body of the pre-cast handhole shall meet the requirements of Section 2403 of the Standard Specifications. The body shall have a flat top and bottom without flange or bell end.
- C. 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.
- D. The cover shall have the words TRAFFIC SIGNAL cast on the top of the cover.
- E. Cable hooks - Four (4) cable hooks shall be provided in all handholes as detailed on the plans. Cable hooks shall be galvanized steel with a minimum diameter of 3/8 inch and a minimum length of 5 inches and anchored in the wall of the handhole utilizing appropriate anchoring devices.
- F. 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. Any deviations from this requirement shall be approved by the Engineer. The ends of all conduit leading into the handhole shall fit approximately 2 inches beyond the inside wall. An aggregate drain conforming to the dimensions shown on the plan details shall be provided. Frames and covers for handholes shall be set flush with the sidewalk or pavement surface. In unpaved areas the top surface of the handhole shall be set with the surface of the ground.

8. CONDUIT SYSTEM

- A. The number, type, and size of conduit shall be as shown on the plans. Conduit shall meet the requirements of Section 2523 and Article 4185.10 of the Standard Specifications.

1. Conduit shown on the plans as rigid steel shall be galvanized steel meeting the requirements of ANSI Standard Specification C80.1, latest revision.
 2. Conduit shown on the plans as polyvinyl chloride (PVC) shall be rigid polyvinyl chloride conduit meeting the requirements of NEMA TC-2, EPC-40, and applicable UL Standards. All materials and methods for attaching and making fittings shall comply with applicable requirements of NEMA TC-3 and the manufacturer's recommendation and shall be subject to approval of the Engineer. HDPE conduit with an SDR of 13.5 may be used subject to approval of the Engineer.
- B.** Conduit shall be placed as shown on the plans. Change in direction of conduit shall be accomplished by bending the conduit. Bends shall be made so 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 (6) times the internal diameter of the conduit.
- C.** When heating PVC conduit to for a bend, an approved conduit heating device shall be used. Direct flame shall not be applied to the conduit.
- D.** When it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All couplings shall be tightened until the ends of conduits are brought together so that an electrical connection will be made throughout the entire length of the conduit run. All conduit and fittings shall be free from burrs and rough places and all conduit runs shall be cleaned, swabbed and reamed before cables are installed. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where the galvanized finish on conduit has been injured in handling, such places shall be painted with zinc rich paint. All fittings used with rigid steel conduit shall be galvanized steel only.
- E.** Approved conduit bushings shall be installed on the exposed ends of rigid steel conduit. Bell end fittings shall be installed on the exposed ends of P.V.C. conduit.
- F.** Conduit buried in open trenches shall be placed to a depth that provides a minimum of 18 to 24 inches of cover 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 depth that provides a minimum of 24 inches of cover below the finished pavement surface or as directed by the Engineer.
- G.** The backfill material from the placement of conduit in open trenches shall be deposited in the trench in layers not to exceed 6 inches in depth and each layer shall be thoroughly compacted by means of vibratory compaction or approved equal before the next layer is placed. All cinders, broken concrete, or other hard or abrasive materials shall be removed and shall not be used in the backfill material. All surplus material shall be removed from the public right-of-way.
- H.** Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original position

and the whole area involved shall be left in a neat and presentable condition. Concrete sidewalks, pavements, base courses and bituminous surfaces shall be replaced with new materials.

- I. Pushed conduit shall be placed by jacking, pushing, boring or any other means necessary to place the conduit without cutting or removing pavement. The size of a bored hole shall not exceed the outside diameter of the conduit that is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than 2 feet to the back of curb unless otherwise directed by the Engineer.
- J. All conduit openings in the controller cabinet, handholes, and bases shall be sealed with an approved sealing compound. This compound shall be readily workable soft plastic. It shall be workable at temperatures as low as 30°F, and shall not melt or run at temperatures as high as 300°F.
- K. A pull rope shall be left in each conduit run.

9. WIRING

- A. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow-to-yellow, and green-to-green. Circuits shall be properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.
- B. All cable runs shall be continuous from connections made in the handhole compartment of signal pole bases to the terminal compartment in the controller cabinet. Splicing will not be allowed in underground handholes unless specifically called for on the plans.
- C. Power Lead-In cable runs shall be continuous from the Power Company service point to the meter socket and from the meter socket to the controller cabinet. The size and number of conductors shall be as shown on the plans.
- D. Slack for each cable shall be provided by a 4 foot length in each handhole and a 2 foot length in each signal pole or pedestal and controller base (measured from the handhole compartment in the pole to the end of the cable). Coil cable slack in the handhole and place on the cable hooks.
- E. Cables shall be pulled through conduit by means of a cable grip designed to provide a firm hold upon the exterior covering of the cable or cables, with a minimum of dragging on the ground or pavement. This shall be accomplished by means of reels mounted on jacks or other suitable devices. Frame-mounted pulleys, or other suitable devices shall be used for pulling the cables out of conduits into handholes. Only vegetable lubricants may be used to facilitate the pulling of cable.

10. ELECTRICAL CABLE

A. General

- 1. Electrical cable for intersection signalization shall be rated 600 volts minimum.

2. The number of conductors and size of all electrical cable shall be as shown on the plans.
 3. 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.
- B.** Power Lead-In Cable- Power lead-in cable shall be 600 volt, single conductor, stranded copper, Type USE, with UL approval and size as shown on the plans.
- C.** Signal Cable- Signal cable shall be 600 volt, multi-conductor, with copper conductors. The signal cable shall meet the requirements of the International Municipal Signal Association (IMSA) Specification 19-1 or 20-1, latest revision thereof for polyethylene insulated, polyvinyl chloride jacketed signal cable. All conductors shall be No. 14 AWG unless otherwise specified on the plans.
- D.** Loop Detector Wire (With Plastic Tubing)- The loop wire shall meet the requirements of the IMSA Specifications 51-5, latest revision thereof for polyvinyl chloride insulated, nylon jacketed, loosely encased in a polyvinyl chloride or a polyethylene tube loop detector wire. The conductor shall be No. 14 AWG unless otherwise specified on the plans.
- E.** Detector Lead-In Cable- Detector lead-in cable shall meet the requirements of the IMSA Specifications 50-2, latest revision thereof for polyethylene insulated, polyethylene jacketed loop detector lead-in cable. All conductors shall be No. 14 AWG unless otherwise specified on the plans.
- F.** Tracer Wire
1. A tracer wire shall be installed in all conduits with signal cables, detector cables, or communications cables.
 2. The tracer wire shall be a No. 10 AWG, single conductor, stranded copper, Type THHN, with UL approval and an orange colored jacket.
 3. The tracer wire shall be spliced in the handholes to form a continuous network.

11. CONCRETE BASES

- A.** Concrete bases for poles and controllers shall conform to the dimensions shown on the plans. Excavations for these bases shall be made in a neat and workmanlike manner. The bottom of all foundations shall rest securely on firm undisturbed ground. 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 or sloped slightly to blend with the adjacent ground level and means shall be provided for holding them rigidly in place while the concrete is being deposited. All conduits and anchor bolts shall be installed and held rigidly in place before concrete is deposited in the forms. A ground rod shall be placed at each pole and controller base as shown on the plans. Anchor rods for the signal poles or the controller pads 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.

- B.** The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of 2 inch. The top 10 inches of the base shall be formed square. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top of the base shall be flush with the surrounding paved area and preformed expansion material shall be provided between the base and the other paved area. When installed in an earth shoulder away from the pavement edge, the top of the concrete base shall be approximately 2 inches above the surface of the ground. The exposed surface of the base shall have a rubbed surface finish.
- C.** After the foundation or base has been poured, absolutely no modification of any sort may be made. If the anchor bolts, conduit, or any part of the foundation or base is installed in an incorrect manner as determined by the Engineer, the entire foundation or base shall be removed and a new foundation or base installed at the Contractor's expense.
- D.** Prior to setting poles, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury. Bases shall not be used for further construction until Section 2403 of the Standard Specifications is met for minimum age for concrete.
- E.** Concrete for concrete bases and handholes shall be Class C structural concrete meeting the requirements of Section 2403 of the Standard Specifications.
- F.** Reinforcing steel shall be of the type and size as shown on the plans and shall conform to the requirements of Section 2404 of the Standard Specifications.

12. BONDING AND GROUNDING

- A.** All conduit, steel poles and pedestals shall be bonded to form a continuous system, and be effectively grounded. Bonding jumpers shall be No. 6 AWG bare copper wire or equal connected by approved clamps.
- B.** 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.
- C.** Ground electrodes shall be provided at each signal pole and pedestal and at the controller as detailed on the plans.
- D.** A No. 6 AWG bare copper ground wire shall be installed in all P.V.C. conduits that carry 120-volt signal cables.

13. SIGNAL APPURTENANCES

- A.** Signal Faces

1. All traffic signal displays shall be installed as indicated on the plans. 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.
 2. 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.
- B. Controller Cabinet-** The controller cabinet shall be installed at the location and in the direction indicated on the Plans, unless otherwise directed by the Engineer.
- C. Pole Erection**
1. All poles shall be erected vertically, with mast arms oriented at 90 degrees to the curb line, unless otherwise specified. The bases shall be securely bolted to the cast-in-place concrete foundations. Leveling shall be accomplished by the use of metal shims and/or one nut or two nuts on each anchor rod or as directed by the pole manufacturer. One nut shall be turned on each anchor rod and the pole placed in position on these nuts. The top nuts shall then be turned into place loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts.
 2. Each pole shall be grounded by installing a No. 6 AWG bare copper ground wire between the pole and the ground rod at the foundation.
- D.** If the painted surface of any equipment is damaged in shipping or installation, such equipment shall be retouched or repaired in a manner satisfactory to the Engineer.

14. REPLACING DAMAGED IMPROVEMENTS

- A.** Improvements such as sidewalks, curbs, driveways, roadway pavement and any other improvements removed, broken, or damaged by the Contractor shall be replaced or reconstructed with the same kind of materials found on the work or with materials of equal quality. The new work shall be left in serviceable condition satisfactory to the Engineer. Whenever a part of a square or slab of existing concrete sidewalk, driveway, or pavement is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed.
- B.** Surface restoration shall be considered incidental to the bid items of the project and will not be paid for separately.

15. LOOP DETECTOR INSTALLATION

- A.** The location of each loop shall be marked on the pavement with crayon or spray paint. The Contractor shall obtain the approval of the Engineer prior to cutting the saw slots.
- B.** The saw shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. The blade used for the saw cut shall provide a clean, straight, well-defined

3/8 inch wide saw cut without damage to adjacent areas. The depth of the saw cut shall be 2 inches. Where the loop changes direction, the saw cuts shall be overlapped to provide full depth at all corners. Right angle or corners less than 90 degrees shall not be used.

- C.** Before installing the loop wire, the saw cuts shall be checked for the presence of jagged edges or protrusions. Should these exist, they must be removed. The slots must be cleaned and dried to remove cutting dust, grit, oil, moisture or other contaminants. Cleaning shall be achieved by flushing clean with a stream of water under pressure, and following this, the slots should be cleared of water and dried using oil-free compressed air.
- D.** Detector loop wire shall be installed using a 3/16 inch to 1/4 inch thick wood paddle. If the wire does not lie close to the bottom of the saw cut, it shall be held down by means of a material such as tape or doubled-over pieces of the plastic tubing.
- E.** The detector loop wire shall be placed into the slot with the number of turns specified. The tubing shall be of a continuous length from the point of splicing of the loop wire to the lead-in cable. The field loop conductors installed in the pavement shall run continuously from the terminating handhole or base with no splices permitted. The field loop conductors shall be spliced to the lead-in cable and the lead-in cable shall run continuously from the terminating handhole or base to the detector sensing unit except on multiple loop installations where additional loop conductors may be spliced to the lead-in cable as directed by the Engineer. At the time of placing the loop wire in the sawed slots, the ends of the tubing shall be sealed to prevent any entrance of moisture into the tubing.
- F.** Each loop shall be coiled as indicated by the Engineer and the beginning conductor banded in the terminating handhole or base with a symbol "S" to denote start of conductor. Each loop shall be further identified by phase or function as shown on the project plans, with durable tags, or as directed by the Engineer. Loops that are physically adjacent in an individual lane or adjacent lanes shall be wound with opposite rotation (i.e. #1 CW, #2 CCW, #3 CW, etc.). Rotation reversal can be accomplished by reversing leads at the handhole.
- G.** Multiple loop configurations, spliced to a single lead-in loop, to be connected in series shall have the "S" conductor of one loop connected to the unbanded conductor of the adjacent loop.
- H.** All lengths of loop wires and tubing that are not embedded in the pavement shall be twisted with at least five (5) turns per foot, including lengths in conduits and handholes.
- I.** The electrical splice between the loop lead-in cable to the controller and the loop wire shall be soldered using resin core solder and provided with a watertight protective covering for the spliced wire, the shielding on the loop 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 all lead-in cable coverings leaving 4 inches of insulated wire exposed.

2. Remove the insulation from each conductor of a pair of lead-in cable conductors 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. The conductors shall be connected 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.
 8. As an acceptable alternate, the Contractor may use a commercially available splice kit with prior approval by the Engineer.
- J.** After the installation of loops, the Contractor should meter the loops by test instruments capable of measuring electrical values of installed loop wires and lead-ins to measure inductance in micro-henries and leakage resistance in megohms. The Contractor shall also provide the Engineer with a report on company letterhead indicating the inductance and leakage to ground test values for each loop. The test shall be conducted from the curbside handhole. An inductance and leakage to ground test shall also be conducted and reported for the total detector lead-in and loop system with the test being conducted at the controller cabinet. Before beginning the required test period, the Engineer may independently meter any or all loops. Should any loop be found unacceptable, the Contractor may be required to complete additional tests, as required, at their own expense. The values indicated are for tests on a single loop at curbside.
- K.** 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. Any unusual reading on the above shall be reported to the Engineer before sealing the loop in the pavement.
- L.** An unacceptable loop installation shall be defined as follows:
1. Inductance: The inductance reading is below the calculated value.

2. Leakage to Ground: Deflection of the pointer to below 100 megohms.
3. Any loop not meeting the requirements for an acceptable loop installation shall be repaired or replaced as directed by the Engineer. The Contractor shall bear all costs of replacing loop installations deemed unsatisfactory by the Engineer.

16. LOOP DETECTOR LOOP SEALANT

- A. The saw slot filler shall be a 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 saw slot filler shall be usable on grades of 15 percent or less without excessive flow of material, unless otherwise approved by the Engineer.
- B. The sealer shall be a two-component system that consists of a resin constituent identified as pourable and a hardener identified as quick setting. The sealer shall be from an approved supplier as per Iowa DOT IM 491.18. Approval of other sealants shall be based on specifications and/or test data about their physical properties, performance properties and chemical resistance.
- C. The cured sealer 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.

17. ACTUATED CONTROLLER

- A. General
 1. The controller shall conform to the requirements of the National Electrical Manufacturer's Association (NEMA) Standard TS-2, most current revision, and to the specifications contained herein.
 2. The controller to be provided shall provide two through eight-phase operation.
 3. The controller shall provide fully prompted, menu driven programmability and provide a graphic display screen to indicate intersection operation.
 4. The controller shall provide the following internal functions:
 - a. Provision of a local time base scheduler including automatic accommodation for day light savings time.
 - b. Provision for local coordination control.
 - c. Provision for local preemption control with at least four (4) programmable internal preemption sequences.
 - d. Provide local control of remotely selected NEMA and special functions.

5. The controller shall be microprocessor type, modular, solid state providing the phasing and operation as shown on the plans. The controller shall be designed for use on nominal 120 volt, 60 Hz, single-phase alternating current.
6. The controller unit shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases.
7. The controller equipment furnished shall be new, of the latest model, fabricated in a first-class workmanlike manner from good quality material. The manufacturer shall replace free of charge to the Contractor and/or Owner any part that fails in any manner by reason of defective material or workmanship within a period of 12 months from the date that the equipment was placed into operation following installation.

B. Components

1. The controller unit shall use modern integrated circuits and computer technology to the fullest extent feasible and incorporate digital timing techniques.
2. All component parts and terminals shall be readily accessible when the controller modules are removed from the enclosure for adjustments, testing or service.
3. The controller unit shall be designed so that the length of interval, portion, period or unit extension shall not deviate by more than plus or minus 100 milliseconds from its set value at a power source frequency of 60 Hz.

C. Chassis

1. The controller unit shall be modular in design. Modules shall be removable and inserted without the use of any tools. Modules of unlike function shall be mechanically keyed or electrically inter-locked to prevent insertion into the wrong opening. All modules of the same function shall be interchangeable.
2. The front panel of the unit shall be permanently marked to identify the fuses, indicators, switches, controls, etc. so that the operation of the controller shall be readily apparent.
3. The control devices, indicators, fuse holders, switches, input/output connectors, and other components required for the operation and adjustment of the timer shall be mounted on the front panel.
4. Certification of a manufacturer's controller assembly by an independent testing laboratory shall be provided to the Engineer. This certification shall indicate that the manufacturer's controller assembly is in accordance with the environmental standards and meets the test procedures as specified in the NEMA Standard No. TS-2, most current revision.

5. All components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur.
6. The design life of all components under 24 hours a day operating conditions in their circuit applications shall be not less than five (5) years.
7. Controller timing shall be set by means of a front-panel keyboard. Momentary contact pushbuttons shall be used for entering numeric data.

D. Interval Programming

1. The controller unit shall provide for setting of the timing of each interval or period by means of keyboard pushbutton switches.
2. The controller unit shall utilize fully prompted, menu programmability to input controller data.
3. The keyboard and switches shall be on the front panel of the unit. They shall be easily identifiable and it shall not be necessary to remove or change wires or contacts or to use any tools in making interval adjustments.
4. Each phase shall have identical control parameters that may be independently set for each phase.
5. The controller unit shall be capable of providing functions with the following minimum timing ranges and timing increments:
 - a. Minimum Green shall have a range from 0-99 seconds in 1-second increments.
 - b. Passage shall have a range from 0-9.9 seconds in 0.1-second increments.
 - c. Maximum Green 1 shall have a range from 0-99 seconds in 1-second increments.
 - d. Maximum Green 2 shall have a range from 0-99 seconds in 1-second increments.
 - e. Yellow Clearance shall have a range from 3-9.9 seconds in 0.1-second increments.
 - f. Red Clearance shall have a range from 0-9.9 seconds in 0.1-second increments.
 - g. Walk shall have a range from 0-99 seconds in 1-second increments.
 - h. Pedestrian Clearance shall have a range from 0-99 seconds in 1-second increments.
 - i. Seconds Per Actuation shall have a range from 0-9.9 seconds in 0.1-second increments.

E. Operational Requirements

1. The controller shall provide multi-phase operation and shall be fully actuated with means for receiving actuation on all phases.
2. The controller shall permit a non-actuated mode of operation on any of the phases by assertion of the vehicle recall function of the desired phase.
3. The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by the traffic phase for on Passage Time portion from the end of the actuation but subject to the Maximum.

The actuation of any detector on a traffic phase not having the right-of-way shall cause the transfer of the right-of-way to that traffic phase at the next opportunity in the normal phase sequence.

4. The timing of the Maximum Green shall commence with one of the following:
 - a. With the first actuation or demand for right-of-way on a traffic phase not having the right-of-way.
 - b. At the beginning of the Green interval if an actuated or demand for right-of-way has been previously registered on a traffic phase not having right-of-way.
5. In the absence of detector actuations or assertion of recall switches, the right-of-way indications shall remain on the traffic phase on which the last actuation occurred.
6. The transfer of right-of-way to conflicting phases shall occur only after the display of the appropriate change clearance intervals.
7. An actuation received during a change clearance interval for a traffic phase shall cause the right-of-way to return to that phase at the next opportunity in the normal phase sequence.
8. If the right-of-way is transferred by the operation of the Maximum or extension limit, the traffic phase losing the right-of-way shall again receive it without further actuation at the next opportunity in the normal phase sequence.
9. When pedestrian actuation is received a WALK interval shall be provided concurrently with the associated Green traffic phase interval. A flashing DON'T WALK Pedestrian Clearance interval shall follow the WALK interval during which the Green traffic phase continues to be displayed. A steady DON'T WALK shall follow the flashing DON'T WALK. A countdown indicator will display the time remaining for each WALK or DON'T WALK interval.
10. In absence of pedestrian actuation or the assertion of pedestrian recall function, pedestrian signals shall remain in a steady DON'T WALK condition.

11. Pedestrian actuations received by a phase during steady or flashing DON'T WALK indications of that phase shall be remembered and shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence. Successive pedestrian actuations shall not cause extension of pedestrian intervals.
12. During coordinated operation if phases are placed in a pedestrian recall mode of operation to operate the controller in as a pre-timed controller, the WALK intervals of the non-coordinated phases shall automatically adjust with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase. The adjustment of the WALK interval for the non-coordinated phases shall be similar to the adjustment in the WALK interval for the coordinated phases with timing plan changes.

18. CONTROLLER CABINET AND AUXILIARY EQUIPMENT

- A. General- The cabinet and auxiliary equipment shall conform to the requirements of the National Electrical Manufacturer's Association (NEMA) Standard TS-2, most current revision, and to the specifications contained herein.
- B. Cabinet
 1. The controller and all associated equipment shall be furnished completely housed in a sturdy aluminum cabinet. The cabinet shall be of clean-cut design and appearance having no sharp edges, corners or projections. The size of the cabinet shall be such as to provide ample space for housing the controller and all associated electrical and auxiliary devices that are to be furnished with it as herein specified. A hinged door, with an approved doorstop assembly, shall be provided permitting complete access to the interior of the cabinet. When closed, the door shall fit closely to neoprene or other suitable gasketing material, making the cabinet weatherproof and dust-tight. The door shall be provided with a strong lock and two sets of keys. The door hinges and pins shall be of a non-corroding material.
 2. In addition to the main door of the controller cabinet, there shall be an auxiliary police door provided in the main door provided with a strong lock and keys of different design than that of the main door of the cabinet. The panel behind the auxiliary police door shall contain a switch to change from normal function to flashing and vice versa. When placed in the flashing operation, the switch shall cause the signals to display the flashing indication identified in the signal sequence diagram. The signal control shall remain in full operation. A signal on-off switch shall also be provided to interrupt power to the signal heads only and continue controller operation. An auto-manual switch shall also be provided in conjunction with a momentary contact switch to allow an individual to obtain manual control of the traffic signals without opening the main door of the cabinet. The remote switch shall be provided with a coiled cord and stored within the police panel.
 3. The aluminum exterior surfaces of the controller cabinet shall be unpainted.

4. The cabinet shall be mounted on an 18 inch high aluminum riser. The riser shall be made out of the same material as the cabinet.
5. The cabinet shall contain strong mounting shelves for the controller and associated equipment.
6. All field terminals shall be suitably identified and accessible without removal of equipment contained in the cabinet.
7. A heavy-duty clear plastic envelope, securely attached to the inside wall of the cabinet or cabinet door, shall be provided for stowing cabinet electrical prints. Minimum dimensions shall be 9 inch wide by 11 inch deep.
8. The cabinet shall be furnished with all of the hardware necessary for assembly and installation.
9. The cabinet shall contain a ventilating fan controlled by a thermostat and suitable dust filters for the capacity of the ventilating system. The filters shall be of the dry type and easily removed and replaced and be of standard dimensions commercially available.
10. The cabinet shall be provided with at least an 8-position back panel when the plans call for expandability to four phases. At least a 12-position back panel shall be provided in the cabinet when the plans call for expandability to eight phases.

C. Electrical Design

1. The distribution of the 120 volts AC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.
2. The cabinet shall be provided with power protection devices that include the main AC+ power circuit breakers, radio interference suppressers, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

The AC+ field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 120 volts AC operation with a minimum rating as shown on the plans. It shall be equipped with a solderless connector suitable for terminating the power lead-in wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

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

The controller cabinet shall be furnished with a lightning arrestor on the AC service. The surge arrestor shall meet or exceed the following requirements:

- a. The unit must be capable of withstanding repeated 20,000-ampere surges (minimum of 25).
 - b. The unit must have internal follow current limiters (resistive elements).
 - c. The unit shall contain a minimum of three (3) active clamping stages.
 - d. The unit must self-extinguish within 8.3 milliseconds after trailing edge surge.
 - e. Parallel impedance of limiters must be less than 15 ohms.
3. The controller shall contain a connector enabling outgoing and incoming electrical circuits to be connected or disconnected easily without the necessity of installing or removing individual wires. The connector may be a multiple pin jack, a spring connected mounting, or approved equivalent mounting.

In the event of a power interruption, the controller shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching.

4. Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple plug, a spring connected mounting or approved equivalent arrangement.
5. All cabinet wiring shall be neatly trained throughout the cabinet and attached to the Interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced or tied or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors.

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

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

6. A maintenance panel containing test switches shall be located on the inside of the main door. These switches shall include the following:
- a. Controller Power Switch
 - b. Detector Test Switches

- c. Stop Time Switch
- d. Signal Flash Switch

7. An AC+ convenience outlet with a 3-wire grounding type receptacle shall be provided and be easily accessible. This receptacle and the incandescent lamp shall be separately fused from the main AC+ circuit breaker. The outlet shall be provided with ground fault protection.
8. The unit shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid-state flasher. This transfer relay assembly shall be controlled by either the "AUTO-FLASH" mode switch located on the Police Panel or the conflict monitor. The flasher shall remain operational with the controller removed from the cabinet. The rate of flash shall be 50-60 flashes per minute with equal on and off intervals. The cabinet shall be wired to flash as shown on the plans.

The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.

9. The cabinet shall be furnished with two incandescent lamps. One lamp shall have a gooseneck assembly and be a mini-cylinder lamp. The lamp shall be equipped with a 25 Watt, R14 bulb. The second lamp receptacle shall be mounted on the interior wall of the cabinet and shall accommodate a standard base light bulb. Manual switches mounted on the maintenance panel shall control these lamps. The lamps shall be fused and connected with the convenience outlet as referenced above.
10. The cabinet duct fan unit shall be fused separately and wired after the main AC+ circuit breaker.
11. Molded composition barrier type terminal blocks shall be used for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one-piece construction with a minimum of twelve terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 volts. All terminals shall be identified and labeled in accordance with the cabinet wiring diagram.

The terminal block facilities shall be arranged in function groupings and mounted to either panels or brackets fastened to the interior walls of the cabinet. Each terminal block shall be retained using either machine or self-tapping screws and shall be easily removed and replaced.

The minimum terminals are as follows:

- a. Terminal with circuit breaker with integral power line switch for the incoming power line.
- b. Terminal unfused for the neutral side of the incoming power line.

- c. Terminals and bases for each vehicle and pedestrian signal circuit.
- d. Terminals for vehicle phase detector and pedestrian pushbutton cables.
- e. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.
- f. Terminals and bases for signal flasher and outgoing signal field circuits.
- g. Terminals for all controller input and output circuits including those circuits not used on the project.
- h. Terminals for all required auxiliary equipment.
- i. Terminals for fiber optic interconnect cable.
- j. Terminals for telephone line connection to provide for dial-up connection to the on-street arterial master.

Adequate electrical clearance shall be provided between terminals. The controller, auxiliary equipment, panel(s), terminals and other accessories shall be so arranged within the cabinet that they will facilitate the entrance and connection of incoming conductors.

- 12. The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod.
- 13. All load switches shall conform to the triple-signal solid-state type load switch as specified in the NEMA Standard No. TS-2, most current revision. Dual-signal type load switches shall not be allowed. LED indicator lights shall be provided on the front of the load switch to designate the active circuit.

The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights or conflicting signal indications. Each switch shall have a capacity of not less than 10 amperes of incandescent lamp load at 120 volts AC.

- 14. A Solid State conflict monitor shall be provided and located within the cabinet external to and electrically independent of the controller unit and enclosed in a finished metal case. The monitor shall detect the occurrence of conflicting Green, Yellow or Walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously to the time should conflicts be sensed. The conflict monitor shall conform to the specifications of NEMA TS-2, most current revision, and shall be compatible with the controller.

The conflict monitor shall utilize liquid crystal displays providing four indicators that display an active Red, Yellow, Green, and Walk input for each channel monitored.

Stop timing shall remain present during this operation. If the actual conflict has been cleared a reset switch (front mounted) on the conflict monitor shall return the controller to normal operation when depressed.

15. The cabinet shall be equipped with a separate solid-state flasher to permit substitution of flashing signal indications for normal vehicle or pedestrian actuated operation. The solid-state flasher shall have no contact points or moving parts and shall utilize zero-point switching. The flasher unit shall have a built-in effective radio interference filter. It shall be possible to completely remove the controller unit for inspection or maintenance when the flashing feature is energized, without disturbing the flashing feature. LED indicator lights shall be provided on the front of the flasher to indicate the active circuit.

Flashing shall be at the rate of not less than 50 or more than 60 flashes per minute with approximately 50% on and 50% off periods. Flashing rate shall not vary so long as the power source remains within the specified limits.

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

D. Documentation

1. Complete system documentation shall be provided. Such documentation shall, as a minimum consist of:
 - a. Three (3) complete operations manuals for each controller and associated signal equipment including equipment wiring diagrams, schematics, and parts lists sufficient for ordering any parts.
 - b. Three (3) sets of cabinet wiring diagrams. The corresponding phase numbers for each movement shall be indicated on the intersection layout diagram on the cabinet wiring diagram.
2. The controller shall be provided with the most current software and documentation.

E. Guarantee

1. The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class workmanship manner from good quality material.
2. The entire controller unit shall be warranted to be free from defects in workmanship and materials for a minimum of one year from date of acceptance. Any parts found to be

defective shall, upon concurrence of the defect by the manufacturer, be replaced free of charge.

3. The Owner shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

19. INDUCTIVE LOOP VEHICLE DETECTOR

- A. This specification contains the minimum design and operating requirements for solid state, digital inductive loop vehicle detectors capable of detecting the presence of a moving or standing vehicle.

A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.

- B. Sensor (Amplifier) Unit

1. The sensor unit shall be solid state, digital, providing detection channel(s) with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the sensor unit shall be provided by relays. Vehicle presence shall result in a continuous call indication.
2. Dual channel, card rack mounted, detector units with delay and extend features shall be used.
3. The sensor unit shall have the following qualities:
 - a. Sensitivity adjustment to allow as a minimum the selection of high, medium or low sensitivity.
 - b. Be capable of providing reliable detection of licensed motor vehicles.
 - c. Provide an indicator light for visual indication of each vehicle detection.
 - d. Will not require external equipment for tuning or adjustment.
 - e. Provide operation in the pulse mode or presence mode. Mode to be switch selective on the front panel of the unit.
 - f. Provide a self-tuning system that is activated automatically with each application of power. Automatic and continuous fine-tuning shall be provided to correct for environmental drift of loop impedance.
 - g. Provide for fail-safe operation (continuous call) in the event of detector loop failure.

20. VEHICLE TRAFFIC SIGNAL HEADS

A. This section of the specifications describes the minimum acceptable design and operating requirements for vehicular signal heads with 12 inch diameter lens openings, including all fittings and brackets as shown on the plans. All components of the vehicular signal heads furnished under this specification shall comply with the latest version of the Institute of Transportation Engineers (ITE) Standard(s) for Adjustable Face Vehicle Traffic Control Signal Heads. All sections of the signal heads shall be equipped with LED modules.

B. Signal Head Assembly

1. The housing for the individual signal sections shall be made of a durable polycarbonate. It shall be clean, smooth and free from flaws, cracks, blowholes, and other imperfections. It shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together. It shall be equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane. Doors and lenses shall be provided with suitable watertight gaskets and doors shall be suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material.
2. The optical system shall be so designed as to prevent any objectionable reflection of sunrays even at times of the day when the sun may shine directly into the lens.
3. The visors for each signal section shall be durable polycarbonate not less than 0.10" in thickness. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be of the tunnel-type at least 8 inch long for all 12 inch rectangular pedestrian signals, at least 9-1/2 inch long for 12 inch diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.

C. Specialized Options

1. One section of each 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.
2. The color of all polycarbonate signal heads shall be black in their entirety. The color shall be an integral part of the materials composition.
3. Signal mounting hardware for side of pole mounted signals shall consist of 1-1/2 inch pipe and appropriate aluminum fittings with a black finish. The signals shall be secured to the pole by using a minimum 5/8 inch wide stainless steel banding material.

4. Mast arm signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes. Mast arm brackets shall be aluminum.
 5. Where shown on the plans, 5 inch backplates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Backplates shall be construction of one-piece durable black plastic capable of withstanding a 100 M.P.H. wind.
- D. Miscellaneous Requirements- The signal 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.
- E. Certification- The Owner 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 that do not comply with this specification, a list of those exceptions must be detailed on the certification.

21. LED SIGNAL MODULES

- A. The vehicle signal indications shall be equipped with LED modules.
- B. The LED signal indications shall meet the current requirements set forth by in ITE's publication, "Equipment and Material Standards of the Institute of Transportation Engineers", latest edition.

22. PEDESTRIAN PUSH BUTTONS

- A. Pedestrian pushbuttons shall be of the direct push contact type.
- B. The push button shall be weatherproof and of sturdy design. The entire assembly shall be weather tight, secure against electrical shock, and able to withstand continuous hard usage. The contacts shall be normally open with no current flowing except at the moment of actuation.
- C. The housing shall be made of aluminum alloy and furnished with suitable mounting hardware. The housing shall have a black finish. The front of the housing shall be freeze proof.
- D. Pushbutton signs shall be furnished and shall conform to the requirements of the Manual On Uniform Traffic Control Devices (MUTCD). Signs shall be as indicated on the plans.
- E. The Owner shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

23. TRAFFIC SIGNAL POLES

- A. General

1. This section of the Specification describes minimum acceptable design, material, and fabrication requirements for traffic signal poles. 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.
2. The traffic signal mast arm and pole assemblies shall be designed to support the number of signal heads and signs as shown on the plans. The mast arm and pole assemblies shall be designed to support a minimum of two signal heads and a traffic control sign at the outboard end of the arm.
3. The mast arms and support poles shall be continuous tapered, round, steel poles of the transformer base type as shown on the plans. The poles and mast arms shall be fabricated from one length of steel sheet with one continuous arc welded vertical seam, unless otherwise approved by the Engineer. For mast arms greater than 50 feet in length, a slip fit connection will be permitted on the mast arm to achieve the mast arm length specified.

The poles and mast arms shall be fabricated from low carbon (maximum carbon 0.30%) steel of U.S. Standard gauge. The base and flange plates shall be of structural steel conforming to AASHTO M183 (ASTM A36) or cast steel conforming to ASTM A27, Grade 70-36 or better.

After manufacture, poles and mast arms shall have a minimum yield strength of 48,000 PSI.

It may be permissible to fabricate poles and mast arms by welding two sections together. The method used for connecting the sections shall result in a smooth joint and shall be factory welded as follows:

- a. All longitudinal butt welds, except within one foot of a transverse butt-welded joint, shall have a minimum 60 percent penetration for plates 3/8 inch and less in thickness, and a minimum of 80 percent penetration for plates over 3/8 inch in thickness.
- b. All longitudinal butt welds on poles and arms within one foot of a transverse butt-welded joint shall have 100 percent penetration.
- c. All transverse butt welds for connecting sections shall have 100 percent penetration achieved by back-up ring or bar.
- d. All transverse butt welds and all specified 100-percent-penetration longitudinal butt welds on poles and mast arms shall be examined 100 percent by ultrasonic inspection according to the requirements of AWS D1.1-80.AH.

Welding, fabrication, and inspection shall conform to the Iowa Department of Transportation Standard Specification for Structural Steel, a separate specification.

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

- B. Mast Arm-** The mast arms shall be designed to support traffic signals and/or signs as shown on the plans and indicated in these Special Provisions. They shall be certified by the fabricator that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure. The mast arms shall be of the length as shown on the plans.
- C. Poles-** The pole shall be designed to support the traffic signals and/or signs as shown on the plans. The pole shall be equipped with a minimum 8 inch by 12 inch handhole and cover located in the transformer base of the pole. Securing of the cover to the base shall be done with the use of simple tools. Hardware shall be corrosion resistant.
- D. Combination Pole**
 - 1. Where a combination street lighting/signal pole is specified on the plans, the above applies with the luminaire arm to be mounted in the same vertical plane as the signal arm unless otherwise indicated on the plans.
 - 2. The luminaire arm shall be of the single member tapered type. Luminaire arms shall match those utilized at the intersection of 1st Street and Destination Drive, Grimes, Iowa.
 - 3. The luminaire arm shall provide the spread and nominal mounting height as shown on the plans.
 - 4. Where a combination street lighting/signal pole is specified on the plans, the pole shall be equipped with a minimum 4 inch by 6 inch handhole and cover located opposite the signal mast arm.
- E. Hardware**
 - 1. 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.
 - 2. The anchor bolts shall meet the requirements of Section 2525 of the Standard Specifications or better.
 - 3. The anchor bolts shall be hot dip galvanized for a minimum of 12 inches on the threaded end.

4. 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.
5. The fabricator shall submit drawings for anchor bolts and base design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A153 or electrodeposited coated of the same coating thickness and so designed for this purpose.

F. Galvanizing and Painting

1. The poles, mast arms, luminaire arms, and transformer bases be galvanized inside and out in accordance with ASTM A123, latest revision.
2. All galvanized exterior surfaces of the poles, mast arms, luminaire arms, and transformer bases that are visually exposed shall be coated with a Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. The coating is to be electrostatically applied and cured in a gas fired convection oven by heating the steel substrate to a minimum of 350°F. and a maximum of 400°F. The color of the powder coat shall be black. A sample shall be submitted to the Engineer for approval.

G. Shop Drawings- All traffic signal poles shall be detailed on shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate.

H. Certifications- The fabricator shall certify that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure. They shall also certify that only welding operators certified in accordance with Iowa Department of Transportation Supplemental Specification for Structural Steel were used. The welding consumables shall be in accordance with the approved list furnished by the Iowa Department of Transportation; 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.

24. TRAFFIC SIGNS

- A.** Traffic signs shall conform to the requirements of Section 4186 of the Standard Specifications and shall appear as those utilized at the intersection of 1st Street and Destination Drive, Grimes, Iowa.
- B.** Traffic signs shall be mounted on the mast arms utilizing a universally adjustable mast arm mounted sign bracket.
- C.** The street name signs (MUTCD D3-1) shall be 18-inches tall with white letters, Series B Caps, 12 inches high (9 inches for small caps) on a black background. The sign shall have a white border, 0.50 inches wide. The thickness of the aluminum sign blank shall be 0.125 inches. The corners of the sign blank shall have a 1.50 inch radius. The sheeting material shall meet the requirements of Section 4186 of the Standard Specifications.

25. ROADWAY LUMINAIRE

- A.** Roadway luminaires shall conform to the requirements of Articles 2523.07 and 4185.03 of the Standard Specifications. Luminaires shall match those utilized at the intersection of 1st Street and Destination Drive, Grimes, Iowa
- B.** The roadway luminaires shall be 150-watt, 240 volt high-pressure sodium, Type III, medium cutoff, regulator type ballast.
- C.** The luminaires shall be furnished with lamps rated at 28,000 lumens.
- D.** Luminaires shall be fitted with flat refractors.

26. STREET LIGHTING CONTROL EQUIPMENT

- A.** Provide the following street lighting and light pole receptacle power and control equipment in each of the traffic control cabinets located at Highway 44 and James Street and Highway 44 and Main Street.
- B.** Provide a 120/240 volt, 200 amp, single phase, three wire, underground electric service dedicated to the street lighting and receptacle control system. Provide a 200 amp MidAmerican Energy approved lever by-pass meter socket and 2 inch Schedule 80 service conduit with No. 3/0 AWG conductors to the utility transformer, as required by the utility. Allow for 200 feet of horizontal run. The electric utility will furnish and install the meter, and will connect the service conductors to the utility transformer. Work related to the service installation shall be coordinated with the electric utility. The installation shall meet all utility requirements and be in accordance with Article 230 of the NEC. Service equipment, including but not limited to the service conduit, and liquid-tight flexible metallic conduit, shall be bonded in accordance with NEC 250.92.
- C.** Provide a 200 amp, 22 KAIC rated, twenty-four space load center with 200 amp main circuit breaker, equipment ground bar, and flush cover. The panel at the James Street intersection shall be designated "Panel PB". The panel at the Main Street intersection shall be designated "Panel PC". Provide branch circuit breakers as indicated on the Schedules on Sheet P.06. The neutral bus of the panel shall be bonded to the grounding system. Connect the panel ground bar to the control cabinet grounding system. Provide a typed schedule for the panel.
- D.** Provide a twelve-pole, NEMA rated, 30 amp, electrically held lighting contactor with 120 volt operating coil for controlling the lighting circuits.
- E.** Provide a twelve-pole, NEMA rated, 30 amp, electrically held contactor with 120 volt operating coil for controlling the receptacle circuits.
- F.** Provide a NEMA twist-lock photo cell mounted to the top of the cabinet and aimed north.
- G.** Provide two (2) Hand-Off-Auto control switches for controlling the lighting and receptacle contactors. In Hand, each switch shall connect control power directly to its respective contactor

coil. In Auto, control power shall be routed through the photo cell to the respective contactor coil. The control switches shall be 30.5 mm with knob-lever operators.

- H.** Provide two (2) indicator lights to indicate when each contactor coil is energized. The indicator lights shall be 30.5 mm, 120 vac, of the press-to-test transformer type and shall be provided with LED light sources. Color shall be red.
- I.** Disconnects, control switches, contactors, load centers, etc. shall be labeled with engraved plastic nameplates. The nameplates shall have white letters on a black background and shall be provided with beveled edges and adhesive backs.
- J.** After the electrical system is complete, and at such time as approved by the Engineer, conduct an operating test. Demonstrate equipment to operate in accordance with requirements of the Specifications and Drawings. Furnish instruments and personnel required for tests.