



**SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION**

**Linn County
NHSX-100-1(79)--3H-57**

**Effective Date
March 18, 2014**

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

120137.01 DESCRIPTION.

A. Section Includes.

Electrical
Conduit
Concrete Bases and Handholes
Poles and Mast Arms
Signals
Controllers and Cabinets

B. Description of Work.

All work shall be in accordance with the contract documents.
Electrical: includes furnishing and installing all electrical components.
Conduit: includes furnishing and installing conduit fittings associated with traffic signals.
Concrete Bases and Handholes: includes furnishing and installing bases and handholes associated with traffic signals.
Poles and Mast Arms: includes furnishing and installing the poles associated with traffic signals.
Traffic Signal Structure: includes furnishing and installing the items associated with the traffic signal structure.
Signals: includes furnishing and installing the signals.
Controllers and Cabinets: includes furnishing and installing controllers, cabinets and accessories.

C. Submittals.

Submit test results as set forth in the contract documents.
Submit certificate of compliance indicating the materials incorporated into the Work comply with the contract documents.
The substitution of materials is allowed as set forth in the Traffic Signal General Notes on sheet N.01 of the plans.

Supplier shall submit five copies of Shop Drawings of Signal Poles and Mast Arms to the Engineer for review prior to manufacture of the mast arm assemblies. Manufacture shall not begin until the Shop Drawings have been approved by the Engineer. The intent of the Engineer's review and approval is to assist the supplier in interpreting the Specifications. Shop Drawing approval shall not relieve the supplier of the responsibility for errors in the Shop Drawing or the requirements of the Specifications.

D. Delivery, Storage and Handling.

Deliver only materials that fully conform to these Specifications, or for which substitution has been approved as set forth in General Conditions.

1. The Bidder awarded the Contract shall complete the equipment list by writing in the name of the equipment manufacturer and catalog number of each item listed which he proposes to install. Before beginning Work on the Project, the Contractor shall submit three copies of the equipment list, and three copies of catalog cuts for all materials supplied by the Contractor.

2. Prior to ordering any materials the Contractor shall provide certification from the manufacturers of all electrical equipment, conduit, and cable stating said material complies with the Specifications.

Store material in accordance with the manufacturers' recommendations and in locations which will minimize the interference with operations, minimize environmental damage, and protect adjacent areas.

Remove and dispose of unacceptable materials in accordance with the contract documents.

E. Scheduling and Conflicts.

Schedule Work to minimize disruption of public streets and facilities.

Discontinue Work which will be affected by any conflicts discovered or any changes needed to accommodate unknown or changed conditions and notify the Engineer.

F. Special Requirements.

All work and materials incorporated into this Project shall conform to all applicable local, state, and Federal requirements.

Furnish upon request from the Engineer, a sample of any item or material proposed for use on for this Project.

Any modifications of the installation are subject to the approval of the Engineer.

Unless otherwise specified in the contract documents, the installation of all signal equipment shall be in accordance with the Traffic Signal Manual of the International Municipal Signal Association (IMSA).

The painted surface of any equipment damaged in shipping or installation shall be retouched or repainted in a manner satisfactory to the Engineer.

The Standard Specifications for Highway and Bridge Construction, current series, Iowa DOT, shall apply to these specifications as noted, and shall be referenced as the Standard Specifications.

120137.02 MATERIALS.

A. Electrical.

Service Conductor (Power Cable) shall be 600 volt, single conductor cable shall comply with the Standard Specifications and shall be U.L. listed for type "USE." The sheath shall be black for the positive cable and white for the negative cables.

Signal cable shall be stranded and conform to the requirements of IMSA 19-1 or 20-1, or latest revision thereof. The number and size of conductors shall be as specified on the plans.

Loop detector lead-in cable shall conform to the requirements of IMSA 50-2, latest revision thereof.

Detector loop wire shall conform to the requirements of IMSA 51-5, latest revision thereof. The encasing tube shall be polyvinyl chloride.

Connectors shall be either insulated spring steel connectors or insulated set screw connectors.

The spring shall have sharp edges, round edges will not be approved.

The set screw connectors shall be Ideal, Series 30-200; Holub, Catalog No. 10-307, Model SS-2 or approved equal.

Connectors shall be approved by the Engineer prior to incorporation in the Work.

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

Ground rods shall be high strength steel rods with chemically bonded copper coverings to provide high conductivity and to prevent electrolytic action. Rods shall be full length as shown on the plans with nominal diameter of 5/8 inch unless otherwise specified. Ground rods shall conform to the requirements of IMSA specification No. 62-1956, latest revision.

All ground wires shall be No. 6 AWG, bare, solid annealed copper wire unless otherwise specified on the plans.

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). All Work shall conform to the requirements of the National Electrical Code. All miscellaneous electrical equipment shall be approved.

Circuit breakers shall conform to manufacturer's requirements. Breakers shall be housed in approved enclosure, such as Square D model QO2L0RB or equivalent.

B. Conduit.

Galvanized rigid steel conduit (RSC) shall meet the requirements of ANSI Standard Specification C 80.1, latest revision. The number and size of conduits shall be as called for on the plans.

Conduit shall be of standard length with each length bearing the UL approved label.

Polyvinyl Chloride (PVC) conduit shall be Schedule 80. Conduit shall be of standard length with each length bearing the UL approved label.

Conduit fittings shall conform to the requirements of ANSI Standard Specification C 80.4, latest revision. All fittings used with rigid steel conduit shall be galvanized steel. Fittings of aluminum or zinc alloys are not acceptable.

Unless otherwise specified in the contract documents, all conduit used for the electrical service system shall be galvanized rigid steel having the Underwriters Laboratories approval.

Conduit couplers shall be threaded-type.

High density polyethylene (HDPE) conduit, where specified in the Plan Documents, shall meet or exceed the requirements of ASTM F 2160 "Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)". Joints and couplings shall meet or exceed ASTM F 2176 "Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct". Orange conduit will be required for underground fiber optic cable installation. Manufacturer's certification may be required for HDPE conduit.

C. Concrete Bases and Handholes.

Concrete for bases shall be Class "C" structural concrete, C-4 mix.

Reinforcement for bases shall meet the requirements of Section 2404 of the Standard Specifications.

Precast concrete pipe used in constructing handhole shall be Type 2000-D.

Lid for precast concrete handhole shall be cast-iron Neenah R5900E or approved equal. Cover shall be Type 'C' (checkered top), with minimum weight 165 pounds. Manufacturer's name and "TRAFFIC SIGNAL" legend shall be cast on top of the cover.

Unless otherwise listed in the Plan Documents, precast polymer concrete handholes shall stackable, have bolted covers (PG style), and be sized 24 inch by 36 inch depth. The polymer concrete material shall meet or exceed all appropriate ANSI/ SCTE 77 tests and requirements. The bottom shall be "open" unless otherwise specified in the Plans. The lid shall be imprinted with the legend "TRAFFIC SIGNAL" and satisfy loading requirements of

ANSI Tier 8. A minimum of four cable hooks will be installed in each junction box to support cables.

Handhole cable hooks shall be galvanized according to ASTM A 153.

Handholes shall be placed on course aggregate base, Iowa DOT Gradation No. 5.

Plastic loop handholes shall be Pencil PE-10 or an approved equal.

D. Final Traffic Signal Pole and Mast Arm Assembly.

General.

1. The mast arms, support poles, and luminaire arms shall be continuous tapered, round steel poles of the anchor base type. The poles and mast arms shall be a minimum of 7 gauge fabricated from one length of steel sheet with one continuous arc welded vertical seam, unless otherwise approved by the Engineer. The poles and mast arms shall be fabricated from corrosion resistant steel meeting requirements of ASTM A572 or A1011 GRADE 50 and the base and flange plates shall be fabricated from A36 structural steel. After manufacture, poles and mast arms shall have minimum yield strength of 48,000 psi. The base plate shall be attached to the lower end of the shaft by a continuous arc weld on both the inside and outside of the shaft.
2. It may be permissible to fabricate poles and mast arms by welding two sections together.
3. Welding, fabrication, and inspection shall conform to Section 2525 of the Standard Specifications, a separate Specification. Pole manufacturers shall certify that only certified welding operators in accordance with the Standard Specifications are used. The welding consumables used shall be in accordance with the approved list furnished by the Iowa DOT.
4. 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 found satisfactory. The cost of all nondestructive testing shall be paid by the supplier and will be considered incidental.

Mast Arms.

1. The mast arms and poles shall be designed in accordance with the 1994 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and designed to support greater traffic signals and/or signs load as listed in these documents. Fabricator shall certify that the mast arms are capable of withstanding winds in the most critical direction up to 80 miles per hour, plus 1.3 gusting factor (104 mph maximum gusted wind) without failure. The length of the mast arms shall be as specified on the Plan Documents.
2. When loaded with the signals and signs the mast arms shall have a slight rise. Unloaded the maximum angle between the mast arm and horizontal shall be 2 degrees to 5 degrees depending on the length of the mast arm, unless approved by the Engineer.

Poles.

1. The pole shall be designed to support the mast arm so when it is equipped with the traffic signals and/or signs it will provide a minimum of 15 feet 6 inches and a maximum of 18 feet 6 inches clearance from the street surface to the bottom of the signal heads or signs.
2. The pole shall be equipped with two reinforced handholes with covers (4 inch by 6 1/2 inch minimum). One handhole shall be located 18 inches above the base and 180 degrees with respect to the mast arm. The second handhole shall be located directly opposite the traffic signal mast arm. Securing the cover to the pole shall be done with the use of simple tools.
3. Provide a lug in the pole base near the handhole to permit connection of a No. 6 AWG grounding wire.
4. Provide a J-hook wire support (a curved 3/8 inch diameter steel bar) 6 inch to 12 inch above and 90 degrees with respect to the opening for each mast arm and luminaire arm.

Signal Pole and Mast Arm Loading. Traffic signal poles and mast arms shall be fabricated to the greater of the loading listed in the Plans and the following signal head and signing loads:

1. Maximum Loading for Arms less than 36 Feet Long: 5-section head on end, 24 inch by 30 inch sign centered 2 feet inboard, video detection camera with 4 foot extension mounting 6 feet inboard, 3-section head 12 feet inboard, 21 inch by 120 inch metro sign centered 16 feet inboard, 2 3-section pole-mounted heads, 2 2-section pole-mounted pedestrian heads, luminaire, 6 inch backplates on all signal heads.
2. Maximum Loading for Arms 36 to 47 Feet Long: 5-section head on end, 24 inch by 30 inch sign centered 2 feet inboard, video detection camera with 4 foot extension mounting 6 feet inboard, 3-section head 12 feet inboard, 3-section head 24 feet inboard, 21 inch by 120 inch metro sign centered 28 feet inboard, 2 3-section pole-mounted heads, 2 2-section pole-mounted pedestrian heads, luminaire, 6 inch backplates on all signal heads.
3. Maximum Loading for Arms greater than 47 Feet Long: 5-section head on end, 24 inch by 30 inch sign centered 2 feet inboard, video detection camera with 4 foot extension mounting 6 feet inboard, 3-section head 12 feet inboard, 24 inch x30 inch sign centered 14 feet inboard, 3-section head 24 feet inboard, 3-section head 36 feet inboard, 21 inch by 120 inch metro sign centered 28 feet inboard, 2 3-section pole-mounted heads, 2 2-section pole-mounted pedestrian heads, luminaire, 6 inch backplates on all signal heads.

Finish.

1. Unless otherwise called for on the Schedule of Prices, the poles and mast arms shall be powder coated over galvanized per the following:
 - a. Surface Preparation:

Steel plates shall be blast cleaned as necessary to remove rolled-in mill scale, impurities, and non-metallic foreign materials. After assembly, remove all weld flux.

The iron or steel shall be degreased by immersion in caustic solution, pickled by immersion in sulfuric acid, and rinsed clean from any residual effects of the caustic or acid solutions by immersion in a fresh water bath.

Final preparation shall be done by immersion in a concentrated zinc ammonium chloride flux solution with an acidity maintained between 4.5-5.0 pH. The assembly shall then be air dried to remove any moisture remaining in the flux coat and/or trapped within the product.
 - b. Zinc Coating:

The assemblies shall be hot-dip galvanized to the requirements of either the current revision of ASTM A123 (Specification for Zinc Coatings on Iron and Steel Products) or the current revision of ASTM A153 (Specification for Zinc Coating on Iron and Steel Hardware). AASHTO, MILSPEC or International specifications can be accommodated when requested in advance. If repairs are required, they are done so in accordance with the current revision of ASTM A780 (Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings).
 - c. Powder Coating:
 1. General:

The specified powder coat finish consists of a Progressive Epoxy Technology (PET) primer with Polyester Urethane, TGIC (Triglycidyl Isocyanurate) Polyester, or Super Durable Powder top coat.
 2. Surface Preparation:

The galvanized surface is prepared for painting by sweep blasting to the current revision of ASTM D6386 requirements utilizing cast steel abrasives conforming to the Society of Automotive Engineers (SAE) Recommended Practice J827. The blast method used is a recirculating, closed cycle centrifugal wheel system with abrasive conforming to SAE Shot Number S280.
 3. Prime Coat:

All exterior surfaces are coated with a PET primer powder to a minimum dry film thickness (DFT) of 3.0 mils, with the bottom 8 feet of the pole shaft having a minimum dry film thickness (DFT) of 5.0 mils. The prime coat must be energy absorptive, chip resistant and capable of achieving a rating of 10A under testing

per ASTM Procedure D3170 which is based on the SAE J400 test. The PET powder is electrostatically applied and partially cured in a gas fired convection oven.

4. Top Coat:

The primed surface is coated with Polyester Urethane, TGIC (Triglycidyl Isocyanurate) Polyester or Super Durable Powder top coat to a minimum dry film thickness (DFT) of 3.0 mils. The top coat powder is electrostatically applied and cured in a gas fired convection oven. Thermosetting powder resin provides both intercoat as well as substrate adhesion that meets 5A or 5B classifications of ASTM D3359.

5. Color:

The finished color shall be a dark bronze closely matching other poles in use in the City which are Valmont's Dark Bronze #333.

e. Packaging:

All parts shall be packaged, wrapped, or cradled in a manner which will insure arrival at the destination without damage to the surface. Prior to shipment, small poles are wrapped in a protective polypropylene woven material, laminated to 3/32 inch microfoam. Larger poles are protected at dunnage points on the truck or trailer.

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 F1554 Grade 105 or approved equal.
3. Bolts attaching the arms to the pole shall meet the requirements of ASTM A325 or approved equal.
4. The anchor bolts shall be hot dip galvanized and have a 4 inch long 90 degree bend at the other end. The Fabricator shall submit drawings for the anchor bolts and base plate design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A153, Class D, or shall have an electrodeposited coating of the same coating thickness, and so designed for this purpose.
5. Anchor bolt covers, pole top covers, and mast arm end covers shall be gray cast iron castings conforming to ASTM Designation: A48 Class 30 or fabricated from ASTM A36 Steel.

Luminaire Extension.

1. Traffic signal pole assemblies which require luminaire extensions are indicated on the Plan Documents. The pole for the luminaire extension shall provide a continuous shaft as required for the mast arm.
2. The pole for the luminaire extension shall be vertical and shall provide a 38 foot luminaire mounting height, unless approved by the Engineer. Luminaire arm shall be a single curved arm, unless otherwise noted on the Plan Documents.
3. The length of the luminaire arm shall be 15 feet, and the orientation of the luminaire arm shall be 10 degrees counterclockwise from the mast arm, unless otherwise noted on the contract documents.
4. A 1 1/8 inch minimum diameter hole shall be drilled in the pole directly opposite the luminaire arm attachment point and in line with the hole leading into the luminaire arm.

Future Luminaire Arm.

1. The traffic signal assemblies without luminaire extensions shall be designed to support a future luminaire extension.
2. The pole shall have a 1 inch thick steel plate welded in the top of the pole to receive the future luminaire extension. The steel plate shall be tapped unless otherwise specified on the contract documents.
3. The future luminaire will be installed 38 feet above the pavement surface and the luminaire arm will extend 15 feet from the pole, unless otherwise specified on the contract documents.

E. Final Traffic Signal Structure.**General.**

1. The horizontal chords, support poles, and luminaire arms shall be continuous tapered, round steel poles of the anchor base type. The poles and horizontal chords shall be a minimum of 7 gauge fabricated from one length of steel sheet with one continuous arc welded vertical seam, unless otherwise approved by the Engineer. The poles and horizontal chords shall be fabricated from corrosion resistant steel meeting requirements of ASTM A572 or A1011 GRADE 50 and the base and flange plates shall be fabricated from A36 structural steel. After manufacture, poles and horizontal chords shall have minimum yield strength of 48,000 psi. The base plate shall be attached to the lower end of the shaft by a continuous arc weld on both the inside and outside of the shaft.
2. It may be permissible to fabricate poles and horizontal chords by welding two sections together.
3. Welding, fabrication, and inspection shall conform to Section 2525 of the Standard Specifications.. Pole manufacturers shall certify that only certified welding operators in accordance with the Standard Specifications are used. The welding consumables used shall be in accordance with the approved list furnished by the Iowa DOT.
4. 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 found satisfactory. The cost of all nondestructive testing shall be paid by the supplier and will be considered incidental.

Horizontal Chords.

1. The horizontal chords and poles shall be designed in accordance with the 1994 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and designed to support greater traffic signals and/or signs load as listed in these documents. Fabricator shall certify that the horizontal chords are capable of withstanding winds in the most critical direction up to 80 miles per hour, plus 1.3 gusting factor (104 mph maximum gusted wind) without failure. The length of the horizontal chords shall be as specified on the Plan Documents.

Poles.

1. The pole shall be designed to support the horizontal chords so when it is equipped with the traffic signals and/or signs it will provide a minimum of 17 feet and a maximum of 19 feet clearance from the street surface to the bottom of the signal heads or signs.
2. Each pole upright shall be equipped with three reinforced handholes with covers (4 inch by 6 1/2 inch minimum). One handhole shall be located 18 inches above the base and 180 degrees with respect to the horizontal chord. The second handhole shall be located directly opposite the traffic signal horizontal chord. The third handhole shall be located directly opposite the luminaire mast arm. Securing the cover to the pole shall be done with the use of simple tools.
3. Provide a lug in the pole base near the handhole to permit connection of a No. 6 AWG grounding wire.
4. Provide a J-hook wire support (a curved 3/8 inch diameter steel bar) 6 inch to 12 inch above and 90 degrees with respect to the opening for each horizontal chord and luminaire arm.

Signal Pole and Horizontal Chord Loading. Traffic signal poles and horizontal chords shall be fabricated to the loading listed in the Plans on the Signal Structure Detail.

Finish.

1. Unless otherwise called for on the Schedule of Prices, the poles and horizontal chords shall be powder coated over galvanized per the following:
 - a. Surface Preparation:

Steel plates shall be blast cleaned as necessary to remove rolled-in mill scale, impurities, and non-metallic foreign materials. After assembly, remove all weld flux.

The iron or steel shall be degreased by immersion in caustic solution, pickled by immersion in sulfuric acid, and rinsed clean from any residual effects of the caustic or acid solutions by immersion in a fresh water bath.

Final preparation shall be done by immersion in a concentrated zinc ammonium chloride flux solution with an acidity maintained between 4.5-5.0 pH. The assembly shall then be air dried to remove any moisture remaining in the flux coat and/or trapped within the product.

b. Zinc Coating:

The assemblies shall be hot-dip galvanized to the requirements of either the current revision of ASTM A123 (Specification for Zinc Coatings on Iron and Steel Products) or the current revision of ASTM A153 (Specification for Zinc Coating on Iron and Steel Hardware). AASHTO, MILSPEC or International specifications can be accommodated when requested in advance. If repairs are required, they are done so in accordance with the current revision of ASTM A780 (Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings).

c. Powder Coating:

1. General:

The specified powder coat finish consists of a Progressive Epoxy Technology (PET) primer with Polyester Urethane, TGIC (Triglycidyl Isocyanurate) Polyester, or Super Durable Powder top coat.

2. Surface Preparation:

The galvanized surface is prepared for painting by sweep blasting to the current revision of ASTM D6386 requirements utilizing cast steel abrasives conforming to the Society of Automotive Engineers (SAE) Recommended Practice J827. The blast method used is a recirculating, closed cycle centrifugal wheel system with abrasive conforming to SAE Shot Number S280.

3. Prime Coat:

All exterior surfaces are coated with a PET primer powder to a minimum dry film thickness (DFT) of 3.0 mils, with the bottom 8 feet of the pole shaft having a minimum dry film thickness (DFT) of 5.0 mils. The prime coat must be energy absorptive, chip resistant and capable of achieving a rating of 10A under testing per ASTM Procedure D3170 which is based on the SAE J400 test. The PET powder is electrostatically applied and partially cured in a gas fired convection oven.

4. Top Coat:

The primed surface is coated with Polyester Urethane, TGIC (Triglycidyl Isocyanurate) Polyester or Super Durable Powder top coat to a minimum dry film thickness (DFT) of 3.0 mils. The top coat powder is electrostatically applied and cured in a gas fired convection oven. Thermosetting powder resin provides both intercoat as well as substrate adhesion that meets 5A or 5B classifications of ASTM D3359.

5. Color:

The finished color shall be a dark bronze closely matching other poles in use in the City which are Valmont's Dark Bronze #333.

e. Packaging:

All parts shall be packaged, wrapped, or cradled in a manner which will insure arrival at the destination without damage to the surface. Prior to shipment, small poles are wrapped in a protective polypropylene woven material, laminated to 3/32 inch microfoam. Larger poles are protected at dunnage points on the truck or trailer.

Hardware.

1. The horizontal chords 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 F1554 Grade 105 or approved equal.
3. Bolts attaching the horizontal chords to the pole shall meet the requirements of ASTM A325 or approved equal.

4. The anchor bolts shall be hot dip galvanized and have a 4 inch long 90 degree bend at the other end. The Fabricator shall submit drawings for the anchor bolts and base plate design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A153, Class D, or shall have an electrodeposited coating of the same coating thickness, and so designed for this purpose. Coordinate with the bridge contractor regarding installation of anchor bolts.

5. Anchor bolt covers, pole top covers, and mast arm end covers shall be gray cast iron castings conforming to ASTM Designation: A48 Class 30 or fabricated from ASTM A36 Steel.

Luminaire Extension.

1. The pole for the luminaire extension shall provide a continuous shaft as required for the mast arm.
2. The pole for the luminaire extension shall be vertical and shall provide a 38 foot luminaire mounting height, unless approved by the Engineer. Luminaire arm shall be a single curved arm, unless otherwise noted on the contract documents.
3. The length of the luminaire arm shall be 15 feet, and the orientation of the luminaire arm shall be 10 degrees counterclockwise from the mast arm, unless otherwise noted on the contract documents.

F. Signals.

General.

1. The signal heads shall be complete with all fittings and brackets for a complete installation. Each signal shall consist of a main body assembly, optical units, necessary screws, wing nuts, eyebolts, etc., and shall be delivered completely assembled. All hardware including hinge pins, wing nuts, eye bolts or latch bolts shall be made of a solid non-corrosive metallic material to prevent seizure or corrosion by the elements. Each signal shall be smooth both inside and outside and shall contain no sharp fins or projections of any kind. The doors and visors shall be flat black. All metal parts shall be painted with one coat of primer and two coats of a high grade Federal Black enamel. All parts of the vehicle signals shall be in compliance with the latest ITE Report on Adjustable Face Vehicle Traffic Control Signal Heads.
2. The electrical and optical system of the signal head shall be designed to operate on 115 volt, single phase, 60-Hertz alternating current.
3. All exterior surfaces shall be black.
4. Main Body Assembly of the signal unit shall consist of one or more polycarbonate sections have integral cast serrations so when assembled with the proper brackets they may be adjusted in increments and locked securely to prevent moving. The sections shall be designed so that when assembled they interlock with one another. All joints between sections shall be waterproof. The sections shall be held firmly together by locknuts or other means approved by the Engineer. Any open end on an assembled signal face housing shall be plugged with an ornament cap and gasket.
5. Doors and Optical Units
 - a. The doors shall be made of polycarbonate. Each door shall be of the hinged type and shall be held closed by a wing nut or other approved means. The hinge pins shall be designed so that the doors may be easily removed and reinstalled without the use of special tools. Each door shall have a polycarbonate visor designed to shield each lens. The inside of each visor shall be flat black.
 - b. 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. 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 dust tight. Between the door and the lens, there shall be a neoprene gasket securely fastened around the outer surface of the lens. The gasket shall 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.
 - c. The reflector shall be parabolic in design and made of specular Alzak aluminum.

- d. The reflector holder shall be of non-ferrous or rust proofed metal and designed to separately support the reflector and socket in proper relation to the lens. The reflector holder shall be hinged to the left-hand side of the signal body when viewed from the front. On the right-hand side, the reflector holder shall be held in place by a spring catch or other quickly releasable means.
- e. 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 one-sixteenth of an inch and to align itself correctly with the lens when the door of the optical unit is closed and pressed against the rim of the reflector holder. By such means, the joint between the reflector holder and the lens shall be rendered dust-tight. 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.
- f. The socket shall be arranged with a lamp grip so it will be impossible for the lamp to be loosened by vibration.
- g. The wire entrance fitting shall be made of malleable iron or other approved material equipped with a standard 1 1/2 inch pipe fitting for attachment to the signal head. It shall be provided with weatherproofing means so that when it is attached to the top of the signal a weatherproof assembly results. Positive locking means shall be provided so that the signal cannot loosen from the fitting. The fitting shall be provided with an insulation bushing at the point where wires enter. The fitting shall be provided with self-locking features to prevent the signal head from turning out of directional adjustment in a strong wind. It shall be painted in color to match that of the signal.

Vehicle Signals.

1. Vehicle Signals shall meet the following requirements:
 - a. All signal indications shall be Light Emitting Diode (LED) Signal Modules.
 - b. Visors shall be of the tunnel type not less than eight inches in length and shall be designed in a manner such that the visor may be easily installed or removed from the signal head.
 - c. A terminal block shall be mounted in the back of the second section of the signal head. The terminal blocks shall be secured at both ends.
 - d. Signals shall be shipped completely assembled with tunnel visors attached to the signal door.

Pedestrian Signals. Pedestrian Signals shall meet the following requirements:

1. Pedestrian signals shall consist of a single unit, nominal 16 inch by 18 inch, with "egg crate" housing and mounting attachments. The left half shall display a "HAND" symbol and a "WALKING PERSON" symbol. The right half shall display clearance interval countdown numerals.
2. The signals shall operate with LED lamps that meet or exceed ITE PTCSI-2 LED Pedestrian Signal Specifications.
3. The lenses shall be made of vandal resistant polycarbonate or acrylic plastic. Unless otherwise specified on the Plan Documents, the symbols on these lenses shall be at least 9 inches high and shall be designed to produce a maximum legibility both day and night. The "HAND" symbol shall be Lunar White and the "WALKING PERSON" symbol and numerals shall be Portland Orange. The background or field around both messages shall be black.

Optically Programmable Signal Heads.

1. Optically programmable signal heads shall meet the following requirements:
 - a. Optically programmable signal heads shall permit the visibility zone of the indication to be controllable without the use of tunnel visors, louvers or tape. Fresnel and/ or refractive lenses are acceptable.
 - b. Signal illumination shall be remotely programmable to the desired area of visibility by alignment of the LED array per section. If three or more optically programmable units are identified on the Plan documents, a programming unit must be furnished.
 - c. Each signal lens shall be equipped with a visor, which encloses the top and both sides of the lens. The interior and exterior color shall be optical black.

Mounting Assemblies.

1. Mounting assemblies shall consist of 1 1/2 inch standard pipe and fittings. All members shall be so fabricated such that they provide plumb, symmetrical arrangement, and securely fabricated assemblies. Construction shall be such that all conductors are concealed within assemblies. Cable guides shall be used to support and protect conductors entering assembly through poles. All threads shall be coated with rust preventive paint during assembly.
2. Support brackets, trunnions, and fittings shall be made of cast aluminum, steel, or cast iron. Bracket parts except for stainless steel parts shall be given one prime coat of metal primer and two coats of high quality black exterior enamel.
3. Mounting assemblies shall be watertight and all open segments of the fittings shall be plugged with an ornamental plug and a gasket.
4. Mast arm mounting brackets shall be Astro-brac cable-mount or approved equal and shall be furnished with all incidentals necessary for complete installation.
5. Brackets for mounting the signal head on top of a pedestal shall provide support for both the top and bottom of the signal head.

Each signal shall be packed or crated separate and complete by itself. The outside of each package or crate shall clearly show the manufacturer, type, catalog number, Purchaser purchase order number and project. Mounting attachments may be shipped separate from the signals, but the boxes or crates shall be marked clearly with the same information as the signals. Mounting attachments of different types shall not be mixed in one box or crate.

G. Traffic Signal Lamps.

LED Vehicle Signal Modules shall comply with the latest revision of the "Equipment and Material Standards of the Institute of Transportation Engineers: Chapter 2a: VTCSH Part 2: Light Emitting Diode (LED) Vehicle Signal Modules" Note the following: Section 5.5 Dimming (Optional) is not required. Section 5.8 Failed State Impedance (Optional) is required. Compliance with all other sections of this standard is required.

H. Backplates.

Backplates shall be 0.125 inch thick thermoplastic and provide a minimum of a 5 inch black field around the assembly. Corners of the backplates shall be rounded with a 2 1/2 inch radius. Backplates shall be supplied with attaching bolts or screws in sufficient quantity to securely hold the backplates to the signal heads. Backplates will be installed with all vehicle signal heads, unless otherwise directed by the Traffic Engineering Division.

I. Aluminum Traffic Signal Pedestal.

The pedestal shaft shall be fabricated of aluminum tubing with a wall thickness of not less than 0.125 inches. Shaft shall have a brushed aluminum finish.

The shaft shall be attached to a square cast-aluminum base with a handhole. The size of the handhole shall be at least 8 1/2 inches by 8 1/2 inches and equipped with a cover, which can be securely fastened to the base with the use of simple tools. A lug shall be provided near the handhole to permit connection of a N0. 6 AWG grounding wire.

The length of the pedestal, from the bottom of the base to the top of the shaft, shall be 10 feet, unless otherwise noted in the Plans. The top of the shaft shall have an outer diameter of 4 1/2 inches.

Signal head mounting assemblies shall be approved by the Engineer prior to installation. Pedestals shall be equipped with all necessary hardware, shims and anchor bolts to provide for a complete installation without additional parts.

The pedestal base shall be designed to mount on four 3/4 inch anchor bolts spaced evenly around a 12 3/4 inch diameter bolt circle.

The finished color shall be a dark bronze closely matching other poles in use in the City which are Valmont's Dark Bronze #333.

J. Pedestrian Pushbutton Detectors.

Pedestrian pushbutton detectors shall be Bulldog BDLM2 (Momentary LED Model) manufactured by Polara, or approved equal. Each detector shall consist of a removable contact assembly mounted in a durable metal case. The contacts shall be entirely insulated from the case and operating button with terminals for making connections. The case shall have one outlet for 1/2 inch pipe. The operating button shall be made of brass or other non-rusting metal alloy and shall be of sturdy design. This button shall be weatherproof and shall not protrude out from the case. The entire assembly shall be weathertight, secure against electrical shock and of such construction as to withstand continuous hard usage. The contacts shall be normally open and no current flowing except at the moment of actuation.

A saddle shall be provided if necessary to secure a rigid installation and neat fit.

Pushbutton housing shall be black.

K. Controllers.

General Design Requirements

1. Traffic signal controllers shall be EPAC M52 manufactured by Siemens, unless otherwise specified in the Plan Documents. Controllers shall be new, NTCIP compliant, Ethernet-ready, and fully compatible with existing controllers on CITY's the interconnected traffic signal system, The CITY's system is ACTRA (latest revision) by Siemens.

a. General. The controller shall be provided with suitable load switches, external to the controller, for closing and opening signal light circuits. A load switch and a flash transfer relay shall be provided for each socket in the cabinet.

b. Closing and Opening of Circuits/Minimum Capacity. 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.

c. NEMA Triple Signal Load Switch(s). External jack mounted load switches shall be provided in accordance with Part 5, "Solid-State Load Switches", Sec. TS 1-5.01, NEMA Traffic Control Systems Standards, TS1-1983.

2. HAWK traffic signal controllers shall be EPAC M52, manufactured by Siemens, with factory programming to support a HAWK signal defined by the MUTCD.

3. Conflict Monitor Minimum Requirements. For actuated controllers of solid state design and construction or actuated controllers utilizing solid state load switches, a separate external signal monitoring device shall be provided to monitor the occurrence of conflicting Green or Walk indications and shall cause the signals to go into flashing operation should such conflicts be sensed. This shall conform to Part 6, NEMA TS1-1983.

4. Flashing of Signals

a. Minimum Requirements. Means external to the controller shall be provided to permit the substitution of flashing signal indications for the normal specified interval sequence. The indications to be flashed shall be as specified here or in the included interval sequence chart on the plans.

1) Flashing Rate: Flashing shall be at the rate of not less than 50 nor 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.

2) Capacity: The operation of the flashing circuit shall be accomplished in such a manner as to avoid undue pitting or burning or other damage to load switches at 10 amperes of tungsten lamp load at 120 volts, 60 hertz AC for 50 million times.

b. Control of Flasher Mode.

1) Police panel switch. Operation of flash mode from police panel shall put operation of controller into Stop Time Mode.

2) Inside switch. An "auto-off-flash" mode switch shall be provided inside cabinet.

c. Flashing of Vehicular Signals. 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 the flashing is provided by

- two flashers, they shall be wired to assure that the flashing of all lenses on the same approach is simultaneous.
- d. Flashing of Pedestrian Signals (Pedestrian Clearance). When pedestrian interval timing functions are included, means shall be provided to permit flashing of the DON'T WALK pedestrian signals during the pedestrian clearance interval.
 - e. Solid State Flasher. A solid state flasher with no contact points or moving parts shall be provided. The solid state flasher shall use zero point switching. This shall conform to Part 8, NEMA Traffic Control Systems Standards, TS1-1983.
5. Manual Control.
- a. Manual control enable: When specified, manual commands shall place vehicle calls and pedestrian calls (when pedestrian timing is included in the controller's sequence of operation) on all phases, stop controller timing in all intervals except vehicle clearances, and inhibit the operation of the external advance input during vehicle clearance.
6. Cabinet.
- a. Basic Construction. The controller and all associated equipment shall be provided in weatherproof metal cabinet of clean-cut design and appearance.
 - b. Construction Material. The cabinet shall be constructed of sheet or cast aluminum.
 - 1) The cabinet and riser shall be natural, unfinished aluminum. All mounting attachments shall be natural, unfinished aluminum or finished with two coats of high grade aluminum colored paint.
 - 2) Door. A hinged door shall be provided permitting complete access to the interior of cabinet. When closed, the door shall fit closely to gasketing material, making the cabinet weather and dust resistant. The door shall be provided with a strong lock and key.
 - a) The door shall be designed to be opened only with the standard controller cabinet key currently used by the City of Cedar Rapids. A sample key will be made available to the successful bidder.
 - 3) Auxiliary Door. A small, hinged and gasketed "door-in-door" shall be included on the outside of the main controller door. The auxiliary door shall not allow access to the controller, its associated equipment, or exposed electrical terminals but shall allow access to a small switch panel and compartment containing a signal shutdown switch, a flash control switch, and other specified functions.
 - a) The auxiliary door lock shall be equipped with a strong lock utilizing keys of a different design from those provided for the main cabinet door.
 - b) The auxiliary door lock shall be designed to be opened only with the standard auxiliary door key used by the City of Cedar Rapids. A sample key will be made available to the successful bidder.
 - 4) Door Stop. The controller cabinet door shall be provided with a stop and catch arrangement to hold the door open at angles of both 90 degrees and 180 degrees, ± 10 degrees.
 - 5) Mounting Shelves. The cabinet shall contain strong mounting table(s) or sliding way(s) to accommodate the mounting of the controller and all included auxiliary equipment. The mounting facilities shall permit the controller and/or auxiliary equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connections or interrupting operation of the controller. Refer to Fiber Optic Cable specification for additional requirements.
 - 6) Mounting Screws. Screws used for mounting shelves or other mounting purposes shall not protrude beyond the outside wall of the cabinet.
 - 7) Outlet and Lamp. An electrical outlet shall be furnished and located in an accessible place near the front of the cabinet and each cabinet shall be provided with a light mounted in the cabinet in a manner which will provide

adequate light to service all parts of the cabinet interior during nighttime hours and controlled by a toggle switch mounted on the inside control panel.

c. Size, Type and Mounting.

1) Size. The cabinet shall be of such size to adequately house the controller, all associated electrical devices and hardware, splice trays, and other auxiliary equipment herein specified.

2) Mounting. The cabinet shall be arranged and equipped for concrete base mounting. An aluminum cabinet riser, compatible in size, shape and material with the controller cabinet specified in the Plan Documents, shall be provided. The depth of the riser shall be 15 inches. Sufficient galvanized anchor bolts, clamps, nuts, hardware, etc., as required for the specified mounting type shall be furnished with each cabinet.

d. Ventilation. A thermostatically controlled duct fan unit with a minimum rating of 100 CFM in free air shall be installed in the cabinet to provide forced air ventilation through the cabinet. The fan unit shall be mounted to the inside top of the cabinet and shall be easily removed and replaced without having to dismantle any part of the cabinet or exhaust duct system. The thermostat controlling the fan shall be manually adjustable to turn on between 90°F and 150°F with a differential of not more than 10°F between automatic turn-on and turn-off. The fan shall intake air through filtered vents located near the bottom of the cabinet or cabinet door and exhaust it through a weather-proof, screened duct located near the top of the cabinet. Fiberglass type dry filters shall be used to cover the air intakes into the cabinet. These filters shall be easily removed and replaced and be of standard dimensions commercially available. The filters shall be provided with positive retainment on all sides to prevent warpage and entry of foreign matter around the edges.

e. Connecting Cables, Wiring and Panels.

1) Connecting cables. Electrical connections from the controller (and auxiliary devices when included) 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 leading therefrom.

2) In addition to the above, a mating plug/cable assembly shall be provided for all connectors on the controller (or auxiliary device).

3) Panels and Wiring. Each cabinet shall be furnished with suitable, easily accessible wiring panel(s). All panel wiring shall be neatly arranged and firm.

a) Wiring terminals. Terminals shall be provided, as a minimum, for the following:

i. Terminal with N.E.C. cartridge fuse receptacle, fuse, power line switch or magnetic circuit breaker, with integral power line switch, for the incoming power line.

ii. Terminal, unfused, for the neutral side of the incoming power line.

iii. Terminals and bases for signal load switches, outgoing signal field circuits, signal flasher, and outgoing signal field circuits.

iv. Terminals for detector cables for all required auxiliary equipment.

v. Terminals for all conflict monitor inputs and outputs, for all NEMA defined inputs and outputs, and for all inputs and outputs defined by the controller manufacturer which may be in addition to the NEMA defined inputs and outputs.

b) Clearance between terminals. Provide adequate electrical clearance between terminals. Arrange controller, auxiliary equipment, panel(s), terminals and other accessories to facilitate entrance and connection of incoming conductors.

c) Signal circuit polarity. The outgoing signal circuits shall be of the same polarity as the line side of the power service; the common

return of the same polarity as the grounded side of the power service.

- d) Grounding conductor bus. An equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet in an approved manner.
- f. Fusing and Surge Protection.
 - 1) Incoming AC Line. Suitable overcurrent protection shall be provided.
 - 2) Branch AC Circuits. Suitable overcurrent protection devices shall be provided for each of the following AC power line input circuits:
 - a) Controller mechanism
 - b) Cabinet fan
 - c) Conflict monitor
 - d) Detector amplifiers
 - e) Flash transfer
 - 3) Light & Outlet Fuse. A 15 ampere fuse and indicating type of fuse holder, wired in advance of the main circuit breaker for protection of the AC power input circuits to the cabinet light and the convenience duplex receptacle shall be provided.
 - 4) Surge Protection. High energy transient surge protection shall be provided on the incoming AC power lines in order to minimize potential controller damage. This shall be a gas discharge lightning arrester - 200-400 volts. A second such device shall be provided on the AC power line to the controller unit. This device shall be EDCO SHP 300-10 and FIL 300 combination filtering surge protection or approved equal.
- g. Plastic Envelope. Secure a heavy-duty clear plastic envelope (min. dimensions 9 inches wide x 11 inches deep) to the inside wall of the cabinet door.
- 7. Guarantee. The 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 purchaser any part that fails in any manner by reason of defective material or workmanship within a period of 18 months from date of shipment from the supplier's factory, but not to exceed one year from the date that the equipment was placed in operation after installation.
- 8. Wiring Diagrams and Documentation: One documentation package shall be supplied in each controller cabinet and three additional copies will be supplied for office use. Each package will consist of the following list of items for the cabinet and load facility and for each model of controller, conflict monitor, load switch, and flasher.
 - a. Complete schematic diagram, accurate and current for unit supplied.
 - b. Complete physical description of unit.
 - c. Complete installation procedure for unit.
 - d. Specifications and assembly procedure for any attached or associated equipment required for operation.
 - e. Complete maintenance and troubleshooting procedures.
 - f. Warranty and guarantee on unit, if any.
 - g. Complete performance specifications (both electrical and mechanical) on unit.
 - h. Complete parts list - listing full names of vendors and parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.
 - i. Pictorial of components layout on chassis or circuit boards.
 - j. Complete stage-by-stage explanation of circuit theory and operation.

L. Radar Vehicle Detection.

This specification sets forth the minimum requirements for a Wavetronix Radar Vehicle Detection System that provides the required vehicle detection as indicated in the plans. All work, equipment and materials to provide a properly functioning Radar Vehicle Detection System is included.

The system shall be comprised of these principal items:

1. Intersection Preassembled Backplate (AC): The backplate provides communications, power conversions and surge protection for the Matrix (stop bar detection) or Advance (advance detection) radar units.
2. Radar Detector Rack Cards: To receive input from the radar devices and plug into any standard detector rack card slot.
3. SmartSensor Matrix: Stop bar presence radar detector designed for use at signalized intersections.
4. SmartSensor Advance: Advance zone radar detector designed for use at signalized intersections.

M. Dome Style Pan/Tilt/Zoom CCTV Camera.

This specification sets forth the minimum requirements for an Axis Dome Style Pan/Tilt/Zoom CCTV Camera that provides the required functionality of viewing the intersection through the City's Central Traffic Signal System. All work, equipment and materials to provide a properly functioning Axis Dome Style Pan/Tilt/Zoom CCTV Camera is included.

N. Fiber Optic Cable.

The work installing fiber between the trunk line fiber and the proposed traffic signal controller cabinets is to be completed by a third party Contractor specified from the City of Cedar Rapids IT division. The traffic signal Contractor shall coordinate work with the City and the City specified fiber Contractor. The fiber is to be installed and the Ethernet communication system is to be operational prior to the turn on of the permanent signals so that they can be managed from the City's central traffic signal system.

O. Ethernet Communication System.

This specification sets forth the minimum requirements for an Ethernet based traffic signal interconnect and communications system. All work, equipment, and materials to provide a properly functioning Ethernet communications system is included.

1. The fiber optic Ethernet communications equipment shall include:
 - a. Heavy Duty Field Switch shall be GarrettCom Magnum 6KL
 - 1) Fully managed layer two switch with six 10/100 MB Ethernet ports with RJ45 connectors, plus two 1GB SFP ports using SM duplex transceivers with LC connector(LX10), plus two 100FX built-in transceivers with LC connectors

The system shall be primarily fiber optic cable based, but may include interface equipment to change from fiber optic communication to twisted pair copper wire communication as shown in the plans. The system shall also include interface equipment and cabling for CAT-5 communications.

All equipment, terminations, connectors, terminal blocks, and any other hardware to construct the system shall be designed for outdoor use in typical traffic signal system conditions. All equipment shall include mounting brackets to secure the equipment in the cabinet.

P. Service Pedestal and Back-to-Back Battery Back-up System.

The Contractor shall supply and install a combination battery back-up, electrical service with meter and lighting controller (Model All-Metered Option 1) to be manufactured by Tesco, Inc. Additional features must include metered disconnect for traffic signal, and street lighting. Dedicated conduits shall connect the unit with the adjacent quazite handhole (for street lighting) and the designated traffic signal cabinet. The service pedestal shall be part of the continuously grounded traffic signal system discussed in this specification.

The underground service distribution and control pedestals shall be constructed of anodized aluminum. The system shall provide uninterrupted, conditioned power (true pure sine wave) for the Traffic Controller Cabinet to eliminate Black-outs, Brown-outs, and Spikes on the signals and the control equipment. A typical intersection with a power outage, will operate as normal for 2 hours of run time and 8 hours of flash. Upon normal power resumption, the system shall recharge to 95% within 6 hours. Batteries shall be quick, hot swap replacement

with no exposed terminals. The system shall monitor and record transient events and self-test the batteries, and provide local and remote data.

Service pedestal will include:

1. Small and low profile with no exposed fasteners.
2. Fabricated from anodized aluminum.
3. Durable all welded construction.
4. Vandal proof doors with hasp stress rated to 2000 lbs.
5. The cabinet shall be factory wired and tested before shipment.
6. UL approved copper cable busing and control wiring.
7. Meets EUSERC requirements.
8. Shall provide both unmetereed and metered circuits up to 200 Amps.

Cabinets and power specifications:

1. Dual Cabinets external dimensions: 20.5 inches wide by 50 inches high by 19.25 inches deep, excluding door handles.
2. Cabinet shall be fabricated from 1/8 inch anodized aluminum.
3. Internal parts shall be fabricated from 14 gauge cold rolled steel.
4. Cabinet shall be all welded construction with welding materials specifically designed for the material used.
5. All fasteners, latches, and hardware shall be of stainless steel and all hinges shall be continuous piano style.
6. There shall be no exposed nuts, bolts, screws, rivets, or other fasteners on the exterior.
7. Removable backpan shall be mounted on four welded 1/4 inch studs.
8. Cabinet doors shall have 2000 pound stress rated hasp, welded to the cabinet and door.
9. Cabinets shall have fully framed side hinged outer doors with swagged close tolerance sides for flush fit with top drip lip and closed cell neoprene flange compressed gaskets.
10. Base mounting detail shall be identical to existing cabinets for emergency replacement.

Deadfront Safety Door

1. Distribution and control panel shall have a hinged deadfront panel with 1/4 turn latch and knurled knobs.
2. Deadfront shall be hinged on the same side as the front door and shall open a minimum of 120 degrees.

Power Distribution Panel

1. Main breakers shall be 1 pole, 2 pole, 3 pole, or 4 pole, as appropriate for this installation, and in accordance with the local utility.
2. Provide metered main circuit breaker and disconnects as shown on wiring diagram on the N Sheets.
3. There shall be no plug-in circuit breakers. Circuit breakers shall be industrial grade.
4. All branch circuit breakers shall be installed in a vertical position, handle up for 'On', handle down for 'Off'.
5. All busing shall be U.L. approved copper THHN cable busing, fully rated.

Battery Back-Up System

1. Vandal-resistant construction.
2. 1400 VA, 950 Watts, Industry Standard run time 3 hours - all LED Intersection.
3. Typical Intersection (700 watts) run time 2 hours, with 6-8 hours of selected flash.
4. Inverter Tilt-out housing for easy maintenance.
5. No tools required for inverter 110 contact connections and simple slide-in installation, weights 28 pounds
6. Full power bypass and isolation switches.
7. Transient voltage protection.
8. Power Analyzer with triple redundant Bypass
9. Conditioned power
10. Power Conflict Monitor with isolation and transfer module
11. Watchdog timer with redundant 5 ms delay and hard transfer to utility power
12. Smart slot communications I/O module.
13. RS 232 and USB ports for local or remote monitoring.

14. Intelligent battery management system with microprocessor controlled smart battery charger, automatic self test, cell guard for longer life and faster recharge times.
15. 24V 18AH batteries AGM/VRLA (absorbed glass mat/valve regulated lead acid), compact, lightweight only 25 pounds
16. Seismically rated fixed position framed battery trays.
17. Quick swap hot battery replacement system.
18. Heavy duty smart safety battery connection system, 30A silver plated plugs.
19. Battery Manufacturer's 2 year warranty.

Control Compartment

1. All components shall match existing components in use for maintenance of spare parts and known reliability.
2. The cabinet shall be completely prewired in the factory.
3. All control wiring is 19 strand No. 14 AWG THHN.
4. All terminals shall be permanently labeled.

Nameplates and Drawings

1. The function of circuit breakers, switches and other components as required shall be identified by laminated engraved plastic nameplates fastened with minimum of two 1/4 inch, #4-40 machine screws.

Q. Equipment and Materials.

Equipment and materials shall be of new stock unless the contract documents provide for the use of existing equipment, or equipment 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.

120137.03 CONSTRUCTION.

A. General.

The Contractor shall furnish and install all equipment and materials necessary for a complete and operative signal installation as shown on the plans and described in the contract documents. The Contractor shall perform all work required and furnish all labor, materials, equipment, tools, transportation and supplies necessary to complete the work in accordance with the contract documents.

The Contractor shall be a licensed electrical Contractor in accordance with City Ordinance and adherence to local Building Code shall be met.

The Contractor will be responsible for incidental sidewalk removal and replacement necessary to complete the signal construction. All waste material and debris shall be disposed of at a sanitary landfill at the Contractor's expense.

All incidental parts which are not shown on the plans or specified herein, and which are necessary to complete the traffic signal, or electrical systems, shall be furnished and installed as though such parts were shown on the plans or specified herein. All systems shall be complete and in operation to the satisfaction of the Contracting Authority at the time of completion of the work.

The Engineer or his representative shall have full freedom to observe all phases of the work performed by the Contractor and to discuss all matters dealing with the quality and progress of the work.

The Standard Specifications as modified by these contract documents shall apply to this specification.

The installation of the signals and signs shall be in conformance with the MUTCD.

B. Qualifications, Service Calls, and Warranty.

Contractor's personnel are required to be knowledgeable of the traffic signal controller operation and wiring. Controller manuals and wiring schematics will be provided to the Contractor for his use on the project. These documents must be returned undamaged at the end of the project.

The Public Works Department Traffic Engineering Division will provide part-time observation of the Contractor's work. The Division's representative will be available during normal working hours (7:00 A.M.-3:30 P.M.) to review the Contractor's work. Contractor shall provide four hours advance notice to the Division for review of the work. Any service calls or review of the Contractor's work outside of the Department's normal working hours will be billed to the Contractor.

The Traffic Engineering Division will continue to provide service call maintenance during the project. If it is determined that the malfunction was caused by the Contractor's work, then the Contractor will be billed for the materials, labor, and equipment required to correct the malfunction and/or damage.

The Contractor shall guarantee all his work against defects due to poor workmanship or materials as specified in the Contract Documents.

C. Concrete Bases for Poles and Controller.

Conform to Article 2525.03 of the Standard Specifications.

Excavations for bases shall be made in a neat and workmanlike manner. Whenever the excavation is irregular, forms shall be used to provide the proper dimensions of the foundations below grade. Construction of the bases may require hand excavation to verify location of utilities.

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 placed. When located within or adjacent to a continuous sidewalk area, the top of the pole bases shall be set flush with the sidewalk or pavement surface.

All reinforcing bars, conduits, ground rods, and anchor bolts shall be installed rigidly in place before concrete is placed in the forms. Cap and protect conduit ends before placing concrete.

Anchor bolts for the signal poles or the controller shall be set in place by means of a template constructed to space the anchor rods in accordance with the manufacturer's requirements. At locations on the Highway 100 bridge structure, Contractor shall coordinate anchor bolt and mounting details with Bridge Contractor. See bridge plans for additional information. The top of the bolts shall not vary more than 1/4 inch. The center of the template and the center of the concrete base shall coincide unless the Engineer directs otherwise.

The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of 1/2 inch. The exposed surface of the base shall have a wood floated surface finish. Exposed concrete surfaces shall be cured using white-pigmented curing compound or plastic film meeting the requirements of the Standard Specifications.

The bottom of the foundations and bases shall rest securely on firm undisturbed ground. Where the foundation or base cannot be constructed as shown on the plans because of an obstruction, the Contractor shall use other effective methods of supporting the pole as may be designated by the Engineer.

After the concrete is placed in the form, it shall be vibrated with a high-frequency vibrator to eliminate all voids.

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. The Contractor shall bear all costs of replacing work deemed unsatisfactory by the Engineer.

Unless otherwise specified, anchor bolts for poles where arms are to be perpendicular to the centerline of the street shall be installed so that a line through the center of one anchor bolt farthest from the curb and extended through the center of the adjacent anchor bolt closest to the curb will be perpendicular to the centerline of the street to within two degrees of arc unless otherwise specified.

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.

Each base location shall be approved by the Engineer prior to construction. Base dimensions shown on the plans are minimum dimensions and based on stable soil conditions. Should

extremely loose or sandy soil be encountered, the Contractor shall contact the Engineer for necessary base alterations.

Where shown/indicated on the plans, the Contractor shall remove the top of existing mast arm footings, anchor bolts, and conduits to 36 inches below the existing top of curb or edge of pavement elevation. Waste materials shall be removed from the site and disposed in accordance with local regulations. Backfilling for the removal shall be performed with mechanical compaction equipment meeting the requirements for backfilling conduit. The upper 6 inches of the removal area, if outside the proposed pavement, shall be backfilled with black dirt and seeded.

Where shown/indicated on the plans, the Contractor shall remove the top of existing controller cabinet footing, anchor bolts, and conduits to 36 inches below the existing top of curb or edge of pavement elevation. Waste materials shall be removed from the site and disposed in accordance with local regulations. Backfilling for the removal shall be performed with mechanical compaction equipment meeting the requirements for backfilling conduit. The upper 6 inches of the removal area, if outside the proposed pavement, shall be backfilled with black dirt and seeded.

D. Handholes.

Handholes shall be a precast unit conforming to the requirements of the plans.

The ends of all conduit leading into the handhole shall fit approximately 2 inches beyond the inside wall. A drain conforming to the dimensions shown on the Plans shall be constructed in the bottom of the handhole unless otherwise specified.

Frames and covers for handholes shall be set flush with the sidewalk or pavement surface. When installed in an earth shoulder away from the pavement edge, the top surface of the handhole shall be approximately 1 inch above the surface of ground. When constructed in unpaved driveways, the top surface of the handhole shall be level with the surface of the driveway.

Openings for conduit access shall be drilled to match the outside diameter of the conduit.

Each handhole shall be grounded by a No. 6 AWG bare copper ground wire as per the plan details.

Grout conduit access after installing conduit.

Install galvanized cable hooks if not precast with the handhole.

Plastic loop and polymer concrete handhole construction shall meet the requirements for precast handholes except that cable hooks will not be required in plastic handholes.

E. Conduit.

Conduit shall be placed between structures as identified on the plans.

Conduit shall be installed without change in direction directly from one structure to another, unless approved by the Engineer. Change in direction may be considered for physical restrictions such as right-of-way restrictions, utilities, location of roadway slopes, retrofitting existing conduit stubs, and certain short sections of conduits.

Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where it is necessary to cut and thread steel conduit, exposed threads will be field galvanized.

All conduit and fittings shall be free from burrs and rough places. Standard manufactured elbows, nipples, tees, reducers, bends, couplings, union, etc. of the same materials and treatment as the straight conduit pipe shall be tightly connected to the conduit.

Prior to installation of cable, all conduit ends shall be provided with a bushing to protect the cable from abrasion, except for open ends of conduit being placed for future use. Bushings shall have grounding fittings which shall be connected to the grounding system by a #6 ground wire as contained in these specifications.

All conduit placed for future use shall be threaded and capped with threaded metal pipe caps.

All conduits shall drain, except for specific locations approved by the Engineer. Contractor will not be allowed to bend conduits upward to accomplish the conduit clearances shown on the handhole details.

All conduit openings shall be sealed with an approved sealing compound after the cables are in place. This compound shall be a 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.

F. Trenching and Backfilling for Traffic Signals.

Secure written approval of the City Forester/ Arborist prior to any trenching or excavation within the drip line of any tree.

Trenches shall be excavated to such depth as necessary to provide 12 inch to 18 inch cover over the conduit. All cinders, broken concrete or other hard abrasive materials shall be removed and shall not be used for backfill. The trench shall be free of such materials before the conduit is placed. No conduit shall be placed prior to inspection of the trench by the Engineer.

All trenches shall be backfilled as soon as possible after installation of conduit. Backfill material shall be deposited in the trench in layers not to exceed 6 inches in depth and each layer shall be thoroughly compacted before the next layer is placed. Hard materials shall not be placed within 6 inches of the conduit.

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

G. Pushed Conduit.

It is intended that all conduit be placed without disturbing the existing pavement, and the term "pushed" is used. "Pushed" conduit shall be placed by jacking, pushing, boring or any other means necessary to place the conduit without cutting or removing pavement.

Removal of pavement will require prior approval of the Engineer. Replacement of removed pavement will be done according to plan details and no additional payment will be made.

Plan quantities for pushed conduit include at least two feet of pushed conduit behind each curb.

The maximum conduit depth at handholes for all conduits, including pushed conduit, is as shown on the plans. Contractor must push a mole (without conduit) at least four times before consideration will be given to allowing an upward bend in the conduit.

H. Electrical.

All conductor cable combinations shall be shown on the plans. No substitutions will be permitted.

Each signal head shall be wired separately from the handhole compartment in the pole base to the signal head.

The signal cable color codes shall be as follows:

<u>Pedestrian Signals</u>		<u>5-Section Traffic Signals</u>		<u>3-Section Traffic Signals</u>	
Walk -	Green	Green Ball -	Green	Green Ball -	Green
Don't Walk -	Red	Yellow Ball -	Orange	Yellow Ball -	Orange
Sig. Common -	White	Red Ball -	Red	Red Ball -	Red
		Green Arrow -	Black	Sig. Common -	White
		Yellow Arrow -	W/Bk	Spare -	Black
		Sig. Common -	White		
		Spare -	Blue		

4-Section Traffic Signals

Red Arrow -	Red
Yellow Arrow -	Orange
Flashing	W/Bk
Yellow Arrow -	
Green Arrow -	Green
Sig. Common -	White
Spare -	Blue
Spare -	Black

One electrical splice in the handhole compartment of the pole base will be allowed for the signal circuit wiring. All signal circuit cable runs shall be one continuous length of cable from the connections made in the handhole compartment of the signal pole bases to the terminal compartment in the controller base.

Conductor groupings and splicings may be made in the terminal compartment in the controller cabinet.

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 cable out of conduits into handholes. Only vegetable lubricants may be used to facilitate the pulling of cable.

Each signal cable shall be identified with an identification tie in the controller cabinet, handholes, pole base handhole, pedestal handhole and at any splice or junction location. Identification ties shall be provided both on the cable from the controller and the cables leading to the heads for a splice in a pole base handhole. Identification shall be permanent and water-proof. Once installed, the tie shall not be removable except by cutting it loose from the cable.

Identification ties shall be marked as follows:

Heads: Head number, number of sections

Radar: Device number, direction and location (stop line, advance)

Pedestrian push button: Location, street crossing

Cable slack shall be 4 feet in handholes, 2 feet in signal bases and in the terminal compartment of the controller base.

Connectors shall be of the proper size for the number and size of the wires being connected.

Clean wire ends thoroughly after the insulation is stripped off to insure complete contact with another wire or the connector. Discard section of cable if strands are damaged when insulation is removed. Nicked or damaged conductor strands will not be permitted inside of connectors. Loose wire ends shall not be used as "shims" to make a connection.

Do not apply electrical tape to the finished connections. Extend signal cable insulation beneath the insulated portion of the connector. Redo any connection with exposed bare wire.

Arrange covered connections so they will not be in contact with the metal poles. Connections in the poles shall be pointed up to prevent accumulation of moisture in the connection.

Cable connections in signal heads and controller cabinets shall be made at the terminal blocks provided for this purpose. All stranded wires inserted under a binder head screw shall be equipped with a solderless pressure type spade connector with a pre-insulated shank. All solid wire shall have an eye and shall not have a terminal connector.

Service cable shall be continuous from the disconnect switch located on the service pole to the terminal compartment of the controller cabinet.

Interconnect cable shall be continuous from controller to controller.

A tracer wire shall be installed as incidental in all conduits with signal cables, vehicle detection cables, or communication cables. The tracer wire shall be identified in the controller cabinet, handholes, and poles by means of identification tags. The tracer wire shall be spliced in the handholes to form a continuous network.

If approval is granted by the Engineer for use of PVC or HDPE conduit carrying signal cable, ground wire shall be installed in all such conduit, and shall be incidental.

I. Pole Erection.

All poles are to be erected vertically and securely bolted to the cast-in-place concrete foundations at the locations shown on the plans.

Leveling shall be accomplished by the use of nuts on each anchor bolt. One nut shall be turned on each anchor bolt and the pole placed in position on these nuts. The top nuts shall then be placed loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts.

After the pole is securely fastened, install stainless steel mesh in the area between the pole and the base. The material and the method of attachment shall be approved by the Engineer.

Each pole shall be grounded from the pole to the foundation ground rod by a No. 6 AWG bare copper ground wire.

Poles shall be placed so that modifications and/or attachments are correctly oriented, as indicated on the plans.

The foundations must be given seven days to cure before poles are erected. The centers of the poles are to be set back from the curb by distance shown on the plans. Poles shall be erected so that they are plumb with traffic signals installed, in line, and all the same relative height above the centerline of the street and with the mast arms correctly oriented as shown on the plans.

Poles must be erected so that they are plumb with traffic signal heads. The manufacturer recommendation for raking should be observed when setting the pole to assure that it is plumb when the load is applied.

Mast arm assemblies shall be furnished and installed by the Contractor, unless otherwise stated in the contract documents.

J. Signals.

All signal faces and indicators shall be furnished by the Contractor and installed as shown on the plans. Pole mounted signal heads and pedestrian push buttons are shown on the plans and schematic drawings in schematic form only. Pole mounted signal heads are generally intended to be mounted on the face of pole with respect to oncoming traffic. Modifications are required when the view of the pole mounted signal indication is blocked. Pedestrian pushbuttons shall be installed on the face of the pole in 90 degree increments with respect to the mast arm. The pushbutton shall be located on the pole face so the arrow on the pushbutton sign directs pedestrians to the appropriate crosswalk.

All optically limited signal heads shall be properly masked or programmed to limit their field of view as directed by the Engineer.

Backplates shall be installed and properly secured for the traffic signal heads.

All signal heads shall be kept securely covered until such time as the signals are put into operation.

The location of signal heads in which the view of the indications is blocked or partially blocked by utility poles, trees or other physical obstructions shall be adjusted to a location approved by the Engineer. Standard heights and locations shown on the plans are typical for unobstructed locations. Signal heads installed without approval of the Engineer, which in the opinion of the Engineer are obstructed, shall be relocated at the Contractor's expense. Holes in the poles due to this signal relocation shall be plugged in a manner acceptable to the Engineer.

K. Controller Cabinet.

The controller cabinet shall be mounted with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the Traffic Engineering Division.

All field wiring must be directly attached to the wiring lugs. Attachment of wiring shall be in a neat and workmanlike manner.

All conduit openings in the controller cabinet shall be sealed with an approved sealing compound. This compound shall be a readily workable at temperatures as low as 30°F and shall not melt or run at temperatures as high as 300°F.

All wiring diagrams, service manuals, instructions for installing and maintaining the equipment and advice as to timing and operation shall be delivered to the Engineer in good condition.

The Engineer or his representative shall inspect the installation before activation and shall be present at the time the controller is activated to assure that the controller is installed in accordance with the manufacturer's recommendations.

L. Ground Rods.

Ground wires shall be connected to ground rods with one piece nonferrous clamps which employ set screws as tightening devices. Connections to ground rods need not be taped.

Each steel pole or pedestal shall be firmly connected to the ground rod provided, by means of the grounding terminal as specified. Placing the ground wire under an anchor bolt nut, anchor bolt cover, or similar device will not be permitted.

M. Equipment Testing.

When work is complete and the project is open to normal traffic, notify the Engineer in writing the date the signal will be ready for testing. City procedure for operation of new traffic signal installations will apply, unless expressly modified by the Engineer.

Initial traffic signal timings and timing adjustments will be provided by the Engineer. Deliver the controller and cabinet to the Traffic Engineering Department for testing and programming at least 10 working days prior to planned installation.

Upon concurrence of the Engineer, place the signal in operation for a consecutive 30 day test period. Any failure or malfunction of the equipment supplied or installation performed shall be corrected and the signal tested for an additional 30 consecutive day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.

If the signal is to operate independently of other signals or signal systems, it shall be tested as a single installation.

If the signal is part of a system, the test period shall not be started until all signals in the system are ready to be tested. The system shall be tested as a unit.

Initiate correction of any failure malfunction of the signal installation within 24 hours of notification by the Engineer. The Engineer will correct any failure or malfunction of the signal installation not investigated within the above time period, and will deduct its expenses from the final payment.

Ground testing shall conform to Article 2523.03 of the Standard Specifications.

N. Clean-Up.

Upon completion of the work in this specifications, remove from the site all rubbish, trash, and debris resulting from operations. Leave the site in a neat and orderly condition.

120137.04 METHOD OF MEASUREMENT.BASIS OF PAYMENT

Measurement for Traffic Signalization will be lump sum.

120137.05 BASIS OF PAYMENT.

Payment for Traffic Signalization shall be full compensation for supplying all equipment, labor, and materials necessary to install, erect, and operate a complete, fully functional traffic signal system, including but not limited to traffic signal poles, mast arms, bases, signal heads, luminaires on combination street light/signal poles, wiring, conduits, handholes, controllers, cabinets, coordination with utilities, wireless detection system, battery back-up system, any Ethernet communication equipment, testing, and all other miscellaneous hardware, software or any other items necessary to complete the traffic signal system in place.