

SP-090062  
(New)



**Iowa Department of Transportation**

**SPECIAL PROVISIONS**

for

**TRAFFIC SIGNALIZATION**

**Johnson County**

IM-080-6(278)243--13-52

**Effective Date**

April 20, 2010

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

**PART 1            GENERAL**

**1.01 - Section Includes**

- A. Electrical
- B. Conduit
- C. Concrete Bases and Handholes
- D. Poles
- E. Signals
- F. Mast Arms
- G. Controller
- H. Fiber Optic Cable
- I. Video Traffic Detection System

**1.02 - Description of Work**

- A. Electrical  
This item includes furnishing and installing all electrical components in accordance with the Contract Documents.
- B. Conduit  
This item includes furnishing and installing conduit fittings associated with traffic signals in accordance with the Contract Documents.
- C. Concrete Bases and Handholes  
This item includes furnishing and installing bases and handholes associated with traffic signals in accordance with the Contract Documents.
- D. Poles  
This item includes furnishing and installing the poles associated with traffic signals in accordance with the Contract Documents.
- E. Signals  
This item includes furnishing and installing the signals in accordance with the Contract Documents.
- F. Mast Arms  
This item includes furnishing and installing the Mast Arms in accordance with the Contract Documents.
- G. Controller  
This item includes furnishing and installing controllers in accordance with the Contract Documents.
- I. Fiber Optic Cable  
This item includes installation, termination, and testing fibers.
- H. Video Traffic Detection System  
This work shall consist of furnishing and installing a system that detects vehicles on a roadway using only video images of vehicle traffic and includes all hardware, software, equipment, labor, and materials necessary to complete the fully functioning system in place.

**1.03 - Submittals**

- A. Submit test results as set forth in the Contract Documents.
- B. Submit certificate of compliance indicating the materials incorporated into the Work comply with the Contract Documents.
- C. The substitution of materials is allowed as set forth in General Conditions.
- D. Supplier shall submit five (5) 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.

- E. Submit catalog cuts of each component incorporated into the project, showing the selected equipment meets the specifications.

#### **1.04 - Delivery, Storage and Handling**

- A. 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.
- B. 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.
- C. Remove and dispose of unacceptable materials from the site in accordance with the Contract Documents.

#### **1.05 - Scheduling and Conflicts**

- A. Schedule Work to minimize disruption of public streets and facilities.
- B. Discontinue Work which will be affected by any conflicts discovered or any changes needed to accommodate unknown or changed conditions and notify the ENGINEER.

#### **1.06 - Special Requirements**

- A. The use of explosives is not permitted unless provided for in the special provisions of the Contract Documents.
- B. All work and materials incorporated into this Project shall conform to all applicable local, state, and Federal requirements.
- C. The CONTRACTOR shall be prepared to furnish, upon request from the ENGINEER, a sample for evaluation, of any item or material which he proposes to furnish for this Project.
- D. Any modifications of the installation are subject to the approval of the ENGINEER.
- E. 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).
- F. The painted surface of any equipment damaged in shipping or installation shall be retouched or repainted in a manner satisfactory to the ENGINEER.

## **PART 2 PRODUCTS**

### **2.01 - Electrical**

- A. Service Conductor (Power Cable) shall be 600 volt, single conductor cable shall comply with Article 4185.12 of 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.
- B. Signal cable shall be solid 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.
- C. Loop detector lead-in cable shall conform to the requirements of IMSA 50-2, latest revision thereof.
- D. Detector loop wire shall conform to the requirements of IMSA 51-5, latest revision thereof. The encasing tube shall be polyvinyl chloride. Detector loop sealant in pavement saw cuts and holes shall be a flexible embedding sealer.

- E. 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.  
Connectors shall be approved by the ENGINEER prior to incorporation in the Work.
- F. Communication and Interconnect Cable (For Underground Installation)
  - 1. Fiber Optic Cable shall be 1 hybrid cable with 6 strands of Multi-mode/ 6 strands of single-mode
  - 2. Jacket. The overall jacket shall be made of virgin, black, low density, high molecular weight polyethylene.
- G. Self-Supporting (Figure 8) Communication Cable
  - 1. Self-Supporting (Figure 8) communication cable shall meet all requirements of Paragraph 2.01F for communication and interconnect cable except that the cable assembly is not required to be packed with petroleum jelly.
  - 2. Self-Supporting (Figure 8) communication cable shall contain a messenger cable made of extra high strength, 1/4 inch, 7 strand, Class A galvanized, steel of 6600 pound breaking strength.
- H. Tracer wire shall be a #10 AWG wire single conductor, stranded copper, Type THHN, with UL approval and orange jacket.
- I. 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 and shall have a nominal diameter of five-eighths inch unless otherwise specified. Ground rods shall conform to the requirements of IMSA specification No. 62-1956.
- J. All ground wires shall be #6 AWG, bare, solid annealed copper wire unless otherwise specified on the plans.
- K. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). All Work shall conform with the requirements of the National Electrical Code. All miscellaneous electrical equipment shall be approved.
- L. Circuit breakers shall conform to manufacturer's requirements.
- M. Video Traffic Detection System: Iteris system is preferable
  - 1. Cameras shall have color video.
  - 2. As an option, programming the system shall be available with the computer. Using a RS-232 communication link, the following capabilities shall be available as a minimum:
    - a. Continuous or single video snapshots. The user shall be able to select both the resolution and quality of the image.
    - b. Remote detection zone setup.
    - c. Detector File upload/download
    - d. Ability to store the snapshot image.
    - e. Security Protection to Prevent Unauthorized Remote Access.
  - 3. The system shall detect vehicles in real time as they travel across each detector zone.
  - 4. The system shall have an RS-232 port for communications with an external computer.
  - 5. The system shall accept new detector patterns from an external computer through the RS-232 port when that computer uses the correct communications protocol for downloading detector patterns.
  - 6. The system shall send its detector patterns to an external computer through the RS-232 port when requested when that computer uses the correct communications protocol for uploading detector patterns.
  - 7. Up to 144 detection zones shall be supported and each detection zone can be sized to suit the site and the desired vehicle detection region.
  - 8. Detection zones may be ANDed or ORed together to indicate vehicle presence on a single detector output channel.
  - 9. When a vehicle is detected crossing a detection zone, the detection zone will flash a symbol on the video overlay display to confirm the detection of the vehicle.

10. Detection shall be at least 99% accurate in good weather conditions, with slight degradation possible under adverse weather conditions (e.g. rain, snow, or fog) which reduce visibility. Detection accuracy is dependent upon camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.
11. The system shall provide 32 channels of detection through either a NEMA TS1 port or a NEMA TS2 port.
12. The system shall provide dynamic zone reconfiguration (DZR) to enable normal director operation of existing zones except the one being added or modified during the setup process. The system shall output a constant call on any detection channel corresponding to a zone being modified.
13. Detection zones shall be directional to reduce false detections from objects traveling in directions other than the desired direction of travel in the detection area.
14. The system shall process the video input from each camera at 30 frames per second.
15. The system shall output a constant call for each enabled detector output channel if a loss of video signal occurs. The system shall output a constant call during the background learning period.
16. The system shall operate satisfactorily in a temperate range from  $-34^{\circ}\text{C}$  to  $+74^{\circ}\text{C}$  and a humidity range from 0%RH to 95%RH, non-condensing as set forth in NEMA specifications.
17. The system shall include an RS-232 port or serial communications with a remote computer. This port shall be a 9 pin female "D" subminiature connector on the front of the system.
18. The system shall include a ports for transmitting TS1 and TS2 detections to a traffic controller. The TS1 port shall be a 37 pin female "D" connector on the front of the system. The TS2 port shall be a 15 pin female "D" connector on the front of the system.
19. The video inputs to the system shall include transient voltage suppression and isolation. Amplification that shall assure the 1 volt peak to peak video signal integrity is maintained despite vide cabling losses and externally induced transients. The amplifier shall have a minimum common mode rejection at 60 Hz of 90 dB.
20. The system enclosure shall be bonded to a good earth ground.
21. The front face of the system shall contain indications to enable the user to view real time detections for up to 8 detector output channels at a time.
22. The video cameras used for traffic detection shall be furnished by the system supplier and shall be qualified by the supplier to ensure proper video detection system operation.
23. The camera shall produce a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from night time to day time, but not less than the range 0.1 lux to 10,000 lux.
24. The camera shall include auto-iris control based upon average scene luminance and shall be equipped with an auto-iris lens.
25. The camera shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry.
26. The camera electronics shall include AGC to produce a satisfactory image at night.
27. The camera shall be housed in an environmentally sealed enclosure pressurized with dry gas to minimize the formation of condensate and extend the life of the camera and lens. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface.
28. The camera enclosure shall be equipped with a sun shield. The sunshield shall include a provision for water diversion to prevent water from flowing in the cameras field of view. The camera enclosure with sunshield shall be less than 6 inch diameter, less than 26

inches long, and shall weigh less than 12 pounds when the camera and lens are mounted inside the enclosure.

29. The camera enclosure shall include a thermostatically controlled heater to assure proper operation of the lens iris at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure.
30. When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperate range from  $-34^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  and a humidity range from 0% RH to 100% RH.

## 2.02 - Conduit

- A. Galvanized rigid steel conduit (R.S.) 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.
- B. Polyvinyl Chloride (PVC) conduit shall be Schedule 80. Conduit shall be of standard length with each length bearing the UL approved label.
- C. 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.
- D. Unless otherwise specified, all conduit used for the electrical system shall be galvanized rigid steel having the Underwriters Laboratories approval.
- E. Conduit couplers shall be threaded-type.

## 2.03 - Concrete Bases and Handholes

- A. Concrete for bases shall be Class "C" structural concrete, C-4 mix.
- B. Reinforcement for bases shall meet the requirements of Section 2404 of the IDOT Standard Specifications for Highway and Bridge Construction, Current Series.
- C. Plastic loop handholes shall be Pencil PE-10, FiberProTek FC1800, Strongwell(Quazite) PT/LT, or an approved equal.
- D. Precast concrete handholes shall be placed on course aggregate base, Iowa DOT Specification 4109, Gradation No. 5.
- E. Lid for precast concrete handhole shall be cast-iron. Cover shall be Type 'C' (checkered top), with minimum weight 165 pounds. Manufacturer's name and "TRAFFIC SIGNALS" lettering shall be cast on top of the cover
- F. Precast concrete pipe used in constructing handhole shall be Type 2000-D.
- G. Handhole cable hooks shall be galvanized according to ASTM A 153.

## 2.04 - Pole and Mast Arm Assembly

- A. General
  1. The mast arms, support poles, and luminaire arms shall be continuous tapered, round or octagon 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 A595, Grade C, and A606, Type 4 sheets (with minimum chemical requirements of A588, Grade D), and the base and flange plates shall be fabricated from A588 structural steel. After manufacture, poles and mast arms shall have a minimum yield strength of 48,000 p.s.i. 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.

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 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.

Welding, fabrication, and inspection shall conform to the Iowa Department of Transportation Supplemental 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 supplier and will be considered incidental.

2. Pole manufacturers shall certify that only certified welding operators in accordance with Iowa Department of Transportation Supplemental Specification for Structural Steel were used. The welding consumables used shall be in accordance with the approved list furnished by the Iowa Department of Transportation.

#### B. Mast Arms

1. The mast arms shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and designed to support traffic signals and/or signs as shown on the attached tabulation. They shall be certified by the Fabricator that the mast arms are capable of withstanding winds up to 100 miles per hour without failure. The length of the mast arms shall be as specified on the Schedule of Prices.
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 4 degrees, unless approved by the ENGINEER.

#### C. 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 15.0 feet and a maximum of 19.0 feet 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. A lug shall be provided in the pole base near the handhole to permit connection of a #6 AWG grounding wire.

#### D. Signal Pole and Mast Arm Loading

1. Traffic signal poles and mast arms shall be fabricated according to the standard Specifications assuming the following signal head and signing loads:
  - a. Maximum Loading for Arms 36 to 47 Feet Long
 

5-section head on end, 24 inch by 30 inch sign centered 2 feet inboard, 3-section head 12 feet inboard, 3-section head 24 feet inboard, 18 inch by 60 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.
  - b. Maximum Loading for Arms greater than 47 Feet Long

5-section head on end, 24 inch by 30 inch sign centered 2 feet inboard, 3-section head 12 feet inboard, 24 inch by 30 inch sign centered 14 feet inboard, 3-section head 24 feet inboard, 3-section head 36 feet inboard, 18 inch by 60 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.

E. Pole and Mast Arm Mounted Signs

1. The CONTRACTOR shall furnish and install all mast arm mounted and pole mounted signs shown on the traffic signal plans. All signs shall conform to the Manual on Uniform Traffic Control Devices. Prior to fabricating the street name signs, the CONTRACTOR shall submit Shop Drawings to the ENGINEER for review, detailing the legend, sign dimensions, and sign colors, and materials.
2. Sign mounting may be either a manufactured mounting bracket from a vendor or support bracketry assembled by the CONTRACTOR. All steel support bracketry shall be galvanized and the banding shall be stainless steel. Either method shall hold the sign firmly in place in winds up to 100 mph. The above Work shall include furnishing and installing all necessary signs, mounting brackets, stainless steel banding, and miscellaneous hardware to complete the sign installation in place.
3. A J-hook wire support shall be provided 6 inches to 12 inches above and 90 degrees with respect to the opening for each mast arm and luminaire arm. The J-hook shall be a curved 3/8 inch diameter steel bar.

F. Finish

1. Where called for on the plans, the poles and mast arms shall be weathering steel.
2. Where called for on the plans, the poles and mast arms shall be galvanized steel 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, all weld flux shall be removed.

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-dipped galvanized to the requirements of either ASTM A123 (fabricated products) or ASTM A153 (hardware items) by immersion in a molten bath of prime western grade zinc maintained between 810-850°F. Maximum aluminum content of the bath shall be controlled to 0.01% and Flux ash shall be skimmed from the bath surface prior to immersion and extraction of the assemblies to assure a debris free from coating.
3. Where called for on the plans, 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, all weld flux shall be removed.

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-dipped galvanized to the requirements of either ASTM A123 (fabricated products) or ASTM A153 (hardware items) by immersion in a molten bath of prime western grade zinc maintained between 810-850°F. Maximum aluminum content of the bath shall be controlled to 0.01% and Flux ash shall be skimmed from the bath surface prior to immersion and extraction of the assemblies to assure a debris free coating.

c. Top Coat

All galvanized exterior surfaces visually exposed shall be coated with a Urethane or Triglycidyl Isocyanurate Polyester Powder to minimum film thickness of 2.0 mils. The coating is to be electrostatically applied and cured in an oven by heating the steel substrate to between 350°F and 400°F.

d. Color

The finished color shall be a Green closely matching other poles in use in the City which are Valmont's Green pitts 74-gf75.

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.

G. 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 ASTM A36 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 for a minimum of 12 inches on the threaded end. The anchor bolts shall be threaded a minimum of 6 inches at one end and have a 4 inch long 90 degree bend at the other end. The Fabricator shall 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. Items supplied with weathering steel poles shall be painted to match the weathering steel poles. Items supplied with powder coated galvanized poles shall be powder coated to match the poles.

H. Luminaire Extension

1. All mast arm assemblies will require luminaire extensions as noted in the plans. 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, unless approved by the ENGINEER. Luminaire arm shall be a single curved arm, unless otherwise noted on the plans.
3. The end of the luminaire arm shall provide a 30 foot luminaire mounting height, unless otherwise noted on the plans.

## 2.05 - Signals

### A. 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 last 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. Said gasket to be engaged by the rim of the reflector holder when the door is closed to render the union between the reflector holder and the door assembly dust tight.
  - c. The reflector shall be parabolic in design and made a 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.
6. 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.

#### B. Vehicle Signals

1. In addition to meeting the requirements of Section A., Vehicle Signals shall meet the following requirements:
  - a. All signal indications shall use Light Emitting Diode (LED) Vehicle Signal Modules. All lenses shall be prismatic and long range. The lenses shall be 12 inches in diameter. All lenses shall be made of vandal resistant polycarbonate or acrylic plastic free from bubbles and flaws. The lenses shall meet the light transmittivity and chromaticity standards established by the ITE Standard for Adjustable Face Vehicle Traffic Control Signal Heads.
  - 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.

#### C. Pedestrian Signals

1. In addition to meeting the requirements of Section A., Pedestrian Signals shall meet the following requirements:
  - a. Pedestrian signals shall consist of two signal sections with rectangular lenses and mounting attachments. The upper section shall display a "Hand" symbol and shall display a "Walking Person" symbol. The lower section shall be a count down timer. The two sections shall be of such design and construction as to fit rigidly and securely together with or without a spacer. No spacer shall be more than 1/2 inch thick. The signals shall operate with LED.
  - b. The lenses shall be either sanded or prismatic lenses. The lenses shall be made of vandal resistant polycarbonate or acrylic plastic. The symbols on these lenses shall be at least 9 inches high and shall be designed to produce a maximum visibility both day and night. The Walk symbol shall be White LED modules and the Don't Walk symbol shall be Portland Orange LED. Both messages shall be screened on the lenses with a material which will not crack or peel. The background or field around both messages shall be black.
  - c. Each signal lens shall be equipped with a visor not less than seven inches in length, which encloses the top and both sides of the lens.

#### D. Optically Limiting Signal Heads

1. Optically limiting signal heads shall meet all of the applicable requirements of Section A through Section B except as hereafter provided:
  - a. Optically limiting signal heads shall permit the visibility zone of the indication to be determined optically. The field of light coverage vertically, laterally, and longitudinally shall be controllable within one degree of any axis, without the use of tunnel visors or louvers. The projected signal indication shall be visible or selectively veiled anywhere within 15 degrees of the optical axis.
  - b. The signal section shall be provided with a rigid connection that permits tilting from at least nine degrees above to nine degrees below the horizontal while maintaining a common vertical line through couplers and conduit. Head assemblies shall be adaptable for mounting on conventional mounting fixtures or in combination with conventional signal sections. The signal section shall be capable of mounting and servicing with ordinary tools.

- c. The optical system shall include 120 volts, 150 watt, three prong sealed beam lamp with an average rated life of 6,000 hours with an integral reflector, and optical limiter-diffuser, an objective lens, and optical masking tape.
  - i. The optical limiter-diffuser combination shall provide an imaging surface, at focus on the optical axis for objects 900 to 1,200 feet distance, and permit an effective veiling system to be selectively applied as determined by the desired visibility zone. The optical limiter shall be composed of heat resistant glass and provided with positive indexing means.
  - ii. The objective lens shall be a high resolution, planar incremental lens hermetically sealed with a flat laminate of weather resistant acrylic plastic. The visible signal indication shall be at least 10 3/4 inches in diameter for circular indications, and the visible arrow indication shall conform to the requirements of the Institute of Transportation Engineer's Standards.
- d. A voltage reducer shall be supplied to provide dimming of all the optically limiting signal lamps as the ambient light intensity drops below approximately three foot-candles.
- e. Each signal housing shall be constructed of die-cast aluminum conforming to the Institute of Transportation Engineer's alloy and tensile requirements and shall have a chromate preparatory treatment. The exterior of the signal housing, lamp housing and mounting flange shall be finished with a high quality baked enamel prime and finished painted flat black. The lens holder and interior of the signal housing shall be optically flat black.
- f. 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.

**E. 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 furnished with a completely adjustable stainless steel strap around arm, malleable clamp casting, vertical support tube, top and bottom signal head support with set screws, bolts, hole with rubber grommet in mast arm, and 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.
- F. 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.

**2.05.1 – Traffic Signal LED's**

**A. LED Vehicle Signal Module**

- A. LED Vehicle Traffic 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 (Interim)"

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.

#### 2.05.2 - Backplates

- A. 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.
- B. Backplates shall be supplied with attaching bolts or screws in sufficient quantity to securely hold the backplates to the signal heads.

#### 2.05.3 – Aluminum traffic Signal Pedestal

- A. 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.
- B. The shaft shall be attached to a square cast-aluminum base with a handhole. The size of the handhole shall be at least 8.5 inches by 8.5 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 #6 AWG grounding wire.
- C. The length of the pedestal, from the bottom of the base to the top of the shaft, shall be 10 feet. The top of the shaft shall have an outer diameter of 4 1/2 inches and shall be designed to receive a pole top mounting bracket to a traffic signal.
- D. Pedestals shall be equipped with all necessary hardware, shims and anchor bolts to provide for a complete installation without additional parts.
- E. 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.

#### 2.05.4 – Pedestrian Push Button Detectors

- A. Pedestrian push button detectors shall be of the direct push contact type without levers, handles or toggle switches. Each detector shall consist of a pressure activated non-moving button mounted in a durable case. The button shall have a two tone audible and visible momentary LED light. The button 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. 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.
- B. A saddle shall be provided if necessary to secure a rigid installation and neat fit.
- C. Push button detectors shall be given one prime coat of metal primer and two coats of high quality black exterior enamel.

#### 2.06 - Controllers

- A. General Design Requirements
  1. Purpose. It is the purpose of Section A of these specifications to set forth minimum design and functional requirements for all actuated controllers included in this specification.
  2. Electrical Requirement
    - a. Power
      - i. Nominal Voltage and Current. The controller shall be designed to operate from a nominal 120 volt alternating current, 60 hertz power source.
      - ii. Voltage and Current Ranges. The controller shall operate satisfactorily within a voltage range of 95 to 135 volts alternating current and a frequency range of 57 to 63 hertz.
    - b. Controller Connections. NEMA Connection Requirement. The controller shall contain a circular twist lock type connector meeting the requirements of Part 3,

Section TS 1-3.05 "Pin Connections", paragraph A. NEMA Traffic Control Systems Standard TSI-1983.

- c. Overcurrent Protection. The controller shall contain a front panel mounted AC power input fuse of suitable size to provide over-current protection.
  - d. Automatic Reorientation. 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.
3. Constancy of Intervals. Minimum Requirements. The length of any interval or timing setting shall not change by more than  $\pm 100$  milliseconds from its set value, so long as the voltage and frequency of the power supply and the ambient temperature inside the controller cabinet remain within the tolerances specified in these specifications.
  4. Interval Sequence
    - a. General. The controller shall provide the proper intervals and interval sequence as required in the following section of these specifications.
    - b. Required Interval Sequence. The phase and interval sequence shall be programmable to provide from two through eight phase dual ring operation with 4 overlaps as described in the latest revision of the NEMA Standards for traffic control systems.
    - c. Skipping of Actuated Phases. If, prior to the end of the green interval of the terminating phase, neither vehicle nor pedestrian memory indicates a need for the next traffic phase, the intervals which comprise that phase shall be omitted from the interval sequence. However, once the green interval has been terminated, the phase causing the termination may not be omitted.

This does not, however, preclude the use of recall switches which when in the "on" position, shall cause the phase to be displayed even though no detector actuations have been received.

5. Interval Setting and Functions
  - a. Provision for Setting. The controller shall provide for the setting of each interval, portion of interval, or function by means of a positive setting on a keyboard.
    - i. Keyboard entry shall have a user friendly interface such that in every case the meaning of a number being displayed shall be clearly evident without reference to the sequence of key strokes preceding the display and without reference to a manual or instruction sheet. The method of finding current data and of changing data shall be intuitive to the extent that little or no training is required and keystroke sequences do not need to be memorized except for security access codes.
  - b. Location of Controls. The interval and function controls shall be located on the front of the controller and shall be properly designated as to the function each control performs.
  - c. Required Intervals/Functions and Ranges. The required intervals, portions of intervals, and functions for each phase of operation are listed in Table 1.

TABLE 1  
 Functions and Timing to be Provided On Each Phase of Operation

	<u>Minimum Range</u> <u>(Sec.)</u>	<u>Increment (Sec.)</u>
Minimum Initial	1 – 99	1.0
Maximum Initial *	0 – 99	1.0
Added initial Per Actuation	0 – 9	0.1
Passage Time	0 – 9	0.1
Minimum Gap	0 – 9	0.1
Time To Reduce to Minimum Gap	0 – 9	0.1
Time Before Reduction	0 – 99	1.0
Time Before Reduction	0 – 99	1.0
Maximum 1	1 – 99	1.0
Maximum 2	1 – 99	1.0
Yellow Change	0 – 9	0.1
Red Clearance	0 – 9	0.1
Walk	0 – 99	1.0
Pedestrian Clearance	0 – 99	1.0
Red Revert (One Per Controller)	3 – 9	1.0

\* Maximum Initial may have fixed value of 30 Sec.

d. Interval and Function Indication

i. Indication. Long life light emitting diode indications or approved equal shall be provided and appropriately labeled on the controller to facilitate the determination of operation and termination of the intervals and functions contained therein. Indication shall include but not necessarily be limited to the following:

- |                         |                |
|-------------------------|----------------|
| .Phase(s) next          | .Dwell         |
| .Phase(s) in service    | .Walk          |
| .Initial interval       | .Ped clear     |
| .Vehicle interval       | .Force off     |
| .Yellow change interval | .Hold          |
| .Maximum termination    | .Red clearance |
| .Gap termination        |                |

ii. Call Indication. Indication shall be provided on the controller to display presence of vehicle call including memory and detector actuations and presence of a pedestrian call when pedestrian timing functions are included.

- e. Vehicle Recall Switch(s). A recall switch shall be provided for each actuated vehicle phase which, when asserted, shall cause the automatic return of the right-of-way to that phase in accordance with the specified interval sequence.
- f. Maximum Recall Switch(s). The recall switch(s) shall provide a maximum recall position which when asserted for a phase, shall cause the automatic return of the right-of-way to that phase for the duration of the maximum green interval in accordance with the specified interval sequence.
- g. Vehicle Detector Non-Lock Memory Switch(s). A switch shall be provided for each actuated vehicle phase which, when placed in the non-lock position, shall cause the vehicle detector memory circuit for that phase to be disabled.
- h. Pedestrian Recall Switch(s). A recall switch shall be provided for each actuated phase that includes pedestrian interval timing function, which when asserted, shall

cause the automatic return of the controller to that phase and related pedestrian interval(s).

- i. Flashing of Pedestrian Clearance Interval Functions. Means shall be provided to control the flashing of pedestrian signals during the pedestrian clearance interval(s).
6. Signal Circuits.
  - a. General. The controller shall be provided with suitable load switches, external to the controller, for closing and opening signal light circuits. Such shall be sufficient in quantity to provide the interval sequence as described in Subsection A.4.2 of this specification. Solid state load switches will be required for solid state controllers.
  - 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.
7. 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. The monitor shall have an LCD Screen.
8. 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. All signals shall flash red.
    - i. 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.
    - ii. 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.
    - i. Police panel switch. Operation of flash mode from police panel shall put operation of controller into Stop Time Mode.
    - ii. 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 utilize zero point switching. This shall conform to Part 8, NEMA Traffic Control Systems Standards, TS1-1983.
9. 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.
- b. Operation Without Pedestrian Timing. When concurrent pedestrian timing is not provided, one actuation of the interval advance input shall advance the controller to Green rest, from which it will immediately select a phase next and advance to the Yellow Vehicle Clearance, subject to the constraints of concurrent timing
  - c. Operation With Pedestrian Timing. When concurrent pedestrian service is provided, two sequential activations of the interval advance input shall be required to advance through a Green interval, the first actuation shall terminate the WALK interval, and the second shall terminate the GREEN interval including the Pedestrian Clearance Interval.
  - d. Automatic Timing of Vehicle Change/Clearance Intervals. All Vehicle Change/Clearance Intervals shall be timed internally by the controller. Actuations of the interval advance input during Vehicle Change/Clearance intervals shall have no effect on the controller.
10. Stop Timing. Suitable input from auxiliary equipment or other external sources, shall cause cessation of controller timing during assertion of such input. Upon removal of such input assertion, the interrupted interval, which was timing, shall resume normal timing. Provisions shall be made to insure that there is no conflict between the various inputs to this function which would result in a stop time signal for one ring affecting the condition of the other ring.
11. Coordination
- a. Minimum Requirements. Means shall be provided within the controller to permit its interconnection into a coordinated traffic signal system when coordinating devices are added. As a minimum, this should include the provision of Yield circuit or Hold circuit, accessible to interruption by commands external to the controller.
  - b. Hold Feature. The controller shall contain a Hold Feature which when asserted for a particular phase shall hold that phase in a rest condition. Upon release from the Hold, the phase shall immediately advance into the appropriate clearance interval or other unexpired portion of the green, provided there is an actuation on an opposing phase.
  - c. Force-Off Feature. The controller shall contain a Force-off Feature which, when asserted shall cause termination of the current phase provided that phase is in the extension portion. In no case shall assertion of force-off cause termination in a clearance interval or during a minimum green for vehicles or pedestrians.
  - d. NEMA Coordination Requirements. In addition to the minimum coordination requirements specified above, the controller shall contain the coordination features for the applicable configuration included in NEMA Traffic Control Systems Standard TS1-1983.
  - e. Closed loop Compatibility. The controller shall be fully compatible with an Eagle Signal Company computer controlled signal system. It shall allow full use of all optional functions of that computer system.
12. Environmental and Testing.
- a. Minimum Requirements.
    - i. General. The controller shall maintain all of its programmed functions and timing intervals when the ambient temperature and humidity are within the specified limits of this specification.
    - ii. Ambient Temperature. The operating ambient temperature range shall be from -30°F to +165°F.
    - iii. Cooling/Heating Devices. No heating or cooling devices other than standard vent fan(s) shall be required for proper operation of the controller.
    - iv. Humidity. The controller shall be designed to operate properly within a relative humidity range of 0 to 95% up to 110°F.

b. NEMA Requirements.

- i. Environmental and Operating. The controller shall fulfill the environmental and operating requirements as described in Part 2, Section 1, "Environmental and Operating Standards", NEMA Standards TS1-1983.
- ii. Testing. The controller shall fulfill the testing requirements as described in Part 2, Section 3, "Test Procedures", NEMA Traffic Control Systems Standard TS1-1983.

13. Cabinet.

a. Basic Construction. The controller and all associated equipment shall be provided in weatherproof metal cabinet of clean-cut design and appearance. The controller cabinet must be large enough to accommodate a future master control unit (under separate contract, unless specified in the plans). The cabinet must be fiber ready.

i. Construction Material. The cabinet shall be constructed of sheet or cast aluminum.

ii. 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.

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.

iii. 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.

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.

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.

iv. 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,  $\pm 10$  degrees.

v. 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.

vi. Mounting Screws. Screws used for mounting shelves or other mounting purposes shall not protrude beyond the outside wall of the cabinet.

vii. 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 LED cabinet lighting mounted in the cabinet in a manner which will provide adequate light to service all parts of the cabinet interior during nighttime hours Size, Type and Mounting.

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

ii. Mounting. The cabinet shall be arranged and equipped for concrete base mounting. Base should be flush with the ground and a riser installed. Sufficient

galvanized anchor bolts, clamps, nuts, hardware, etc., as required for the specified mounting type shall be furnished with each cabinet.

b. Ventilation.

Two thermostatically controlled duct fan units 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 fans 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 fans 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 retention on all sides to prevent warpage and entry of foreign matter around the edges.

c. Connecting Cables, Wiring and Panels.

- i. 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. This can be accomplished by means of a multiple plug, a spring-connected mounting or approved equivalent arrangement. Correlation shall be made with connecting cable plug and controller jack as described in Subsection 2.2., Section A of this specification.

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

- ii. 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:

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.

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

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

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

Terminals for detector cables.

Terminals for all required auxiliary equipment.

Terminals for all conflict monitor inputs and outputs.

Terminals for all NEMA defined inputs and outputs

Terminals 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. 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.
- 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.

- d. Fusing and Surge Protection.
    - i) Incoming AC Line. Suitable overcurrent protection, utilizing one of the methods described in Subsection A.13.4.2.1, shall be provided.
    - ii) Branch AC Circuits. Suitable overcurrent protection devices shall be provided for each of the following AC power line input circuits:
      - 1. Controller mechanism
      - 2. Cabinet fan
      - 3. Conflict monitor
      - 4. Detector amplifiers
      - 5. Flash transfer
    - iii) 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. The Cabinet light shall be a goose neck type.
    - iv) 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.
  - e. Painting. The cabinet shall be natural, unfinished aluminum. All mounting attachments shall be natural, unfinished aluminum or finished with two coats of high grade aluminum colored paint.
  - f. Plastic Envelope. A heavy-duty clear plastic envelope shall be securely attached to the inside wall of the cabinet door. Minimum dimensions shall be 11 inches wide by 14 inches deep.
  - g. Cabinet shall have a battery back system with an automatic transfer switch. The unit shall run or flash the signals. Batteries and UPS shall be mounted in a small side mount cabinet.
14. 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.
15. 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.
- B. Multi-Phase Traffic Actuated Controllers
- 1. Purpose. It is the purpose of this section of the specifications to set forth minimum design and operating requirements for multi-phase (two through eight phase) traffic actuated traffic signal controllers.

2. General Design Requirements. The General Design Requirements in Section A of this specification shall apply in addition to certain design, operational and functional requirements hereinafter described.
  - a. NEMA Design Requirements. The controller shall be designed in accordance with the applicable requirements, included in NEMA Traffic Control System Standard TS1-1983.
  - b. Controller Interchangeability. Interchangeability of controllers furnished under this specification shall be achieved by connector plug interchangeability as designated in Part 3, NEMA Traffic Control Systems Standard TS1-1983.
  - c. Maximum Controller Dimensions. The controller shall be no more than 19 inches wide, 13 inches high and 11 inches deep.
3. Operational Requirements.
  - a. Mode of Operation. The controller shall provide the multi-phase operation described in Subsections 1 and 2 of this section of the specification and shall be fully actuated with means of receiving actuations on all phases. The traffic signal controller shall be capable of Volume Density operation. The controller shall have variable initial and time waiting gap reduction features. The controller shall also have dual maximum extension capability.
  - b. The controller shall also permit a non-actuated mode of operation on any of its phases by assertion of the vehicle recall function (or pedestrian recall function when such function is present) on the desired phase.
  - c. Call to Non-Actuated Mode. The controller shall feature an input which, when asserted, shall permit the selection of non-actuated mode of operation on any of its phases.
  - d. Operation With Auxiliary Functions/Devices. The controller shall be capable of having its basic operation expanded or augmented by the addition of auxiliary functions or devices.
  - e. Minimum Green
    - i. Actuated Phase. The minimum green shall consist of an initial portion Only, or a separately set Minimum Green function.  
If pedestrian functions are provided and a pedestrian actuation is received, the Minimum Green shall consist of a WALK interval plus a Pedestrian Clearance interval.
    - ii. Non-Actuated Phase. In the non-actuated mode of operation, the Minimum Green on the non- actuated phase shall be equal to the values described for Actuated Phases in the preceding paragraphs or shall be equal to a separately set Minimum Green function.
  - f. Unit Extension. 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 that traffic phase for one Unit Extension portion from the end of the actuation but subject to the Maximum (extension limit).
  - g. Maximum (Extension Limit). The Maximum or extension limit shall determine the maximum duration of time the right-of-way can be extended for a phase having successive detector actuations spaced less than a Unit Extension portion apart.
  - h. Initiation of Maximum (Extension Limit). The timing of the Maximum or extension limit shall commence (1) with the first actuation or other demand for right-of-way on a traffic phase not having the right-of-way or (2) at the beginning of the Green interval if an actuation or other demand for right-of-way has been previously registered on a traffic phase not having the right-of-way or, alternatively, the Maximum may commence at the end of the initial portion of the Green interval if an actuation or other demand has been previously registered on a traffic phase not having the right-of-way.

- i. Transfer of Right-of-Way. 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 provided that there has been an expiration of a Unit Extension portion with no continuing actuation or an expiration of the Maximum (extension limit) timing on the preceding phase having the right-of-way.
- j. Change Clearance Interval(s) Prior to Transfer. The transfer of right-of-way to any conflicting phase shall occur only after the display of the appropriate change clearance interval(s).
- k. Rest in Absence of Actuation.
  - i. Minimum Rest. In the absence of detector actuation or assertion of recall switch(s), the right-of-way indication shall remain (rest) on the traffic phase on which the last actuation occurred.
  - ii. Rest in All-Red. In the absence of detector actuation or assertion of recall switch(s), the controller, after display of the appropriate clearance interval(s) on the last phase having the right-of-way, shall rest in Red (and associated Pedestrian DON'T WALK indications) on all phases until detector actuations are received.
- l. Memory Feature. Unless precluded by the operation of non-memory feature, the following memory retention shall be provided in the controller.
  - i. Memory Change During Clearance Interval(s). 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.
  - ii. Memory If Phase Terminated by Maximum (Extension Limit). 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.
- m. Pedestrian Timing Operation. When pedestrian timing functions are specified in the General Design Requirements, Section A of this specification, the following pedestrian function operation shall be provided.
  - i. Pedestrian Timing With Non-Actuated Phase. In the non-actuated mode of operation, a WALK interval shall be provided simultaneously with the associated Minimum Green interval of the non-actuated phase. A flashing DON'T WALK Pedestrian Clearance Interval shall follow the WALK interval, during which the Green traffic phase continues to be displayed.
  - ii. Pedestrian Timing With Actuated Phase. 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.
  - iii. Condition in Absence of Pedestrian Call. In absence of pedestrian actuation or assertion of pedestrian recall function, pedestrian signals shall remain in a DON'T WALK condition.
  - iv. Recycle of Pedestrian Functions. In the absence of opposing phase demand, it shall be possible to recycle the pedestrian interval functions to succeeding pedestrian actuations without change in vehicle indications.
  - v. Pedestrian Actuation Memory. 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.
  - vi. Non-extension of Pedestrian Intervals. Successive pedestrian actuations shall not cause extension of the pedestrian intervals.

- n. Advanced Operational Features. When certain advanced operational features are specified in the General Design Requirements, Section A of this specification, the controller shall provide the following operation.
    - i. Volume Density Operation.
      - a) Variable Initial. Utilizing the specified mode selected to provide this function, the controller shall enable an increase in timing of the Initial portion of the Green interval of a phase based upon the number of traffic actuations stored on that phase during its YELLOW and RED interval.
      - b) Time Waiting Gap Reduction. Utilizing the functions specified, the controller shall enable a reduction in the Extension portion of the Green interval of the phase having the right-of-way in proportion to the time elapsed from the registration of an actuation on an opposing phase or from the beginning of the Green interval, whichever occurs later.
    - ii. Dual Maximum (Extension Limit) Operation. Assertion by external command for the operation of a Maximum II function for a phase shall cause the controller to provide the timing value for that function in lieu of the normal maximum value.
  - o. NEMA Operational Requirements. In addition to the basic operational requirements specified above, the controller shall provide the operational features for the applicable configuration included in the NEMA Traffic Control Systems Standard TS1- 1983.
4. Functional Requirements.
- a. Basic Functional Requirements. Functional requirements for the multi-phase traffic actuated controller shall be as specified in the General Design Requirements in Section A of these specifications.
  - b. NEMA Functional Requirements. In addition to the basic functional requirements specified above, the controller shall provide the functional features for the applicable configuration, included in the NEMA Traffic Control Systems Standard TS1-1983.
  - c. Overlaps. When required by the interval sequence chart in the General Design Requirements section of these specifications, overlap(s) shall be provided by the controller and may be implemented via internal or external logic.
5. Enhanced operation.
- a. Preemption. A minimum of two preemption inputs shall be provided. These shall be designed for railroad or emergency vehicle preemption and shall provide the ability to set the delay before start of preempt sequence and the duration of the preempt sequence. It shall also be possible to define the status of each phase as red, green, flashing yellow, or flashing red during the preemption period and to provide an orderly transition into and out of the preemption period.
  - b. Coordination. The controller shall be capable of emulating a 3 dial/3 split/3 offset pretimed controller coordinated with a 9 wire interconnect system.
  - c. Time Base Functions. The controller shall have the capability to provide internal time based coordination. In addition it must provide a minimum of two auxiliary outputs controlled by the time base coordination which can be fully programmed on a time basis to control external devices on a cycle by cycle, time of day, day of week, and/or holiday schedule on an annual basis.
6. Remote Flash. A remote flash input is required which will provide for the remote implementation of flashing operation consistent with the requirements of the MUTCD. This shall include a means of programming a "Flash Entry Phase" and a "Flash Exit Phase."

## **2.07 - Inductive Loop Vehicle Detector**

### **A. Design Requirements**

- 1. Operation
  - a. General

The detectors shall be designed to operate with loop and lead-in wire combinations having a wide variation in electrical characteristics. The electrical characteristics are a function of the length and width of the loop, the length and type of lead-in wires, and other factors. The detector shall operate with the usual configurations of loops and lead-in wires, standard with the Department, which have a 40 to 700 microhenry total inductance.

The detector shall provide reliable detection and maintain an output indication for a period of not less than three minutes for a vehicle that causes a 0.02% change in the total inductance of the loop and lead-in system as measured at the detector loop input terminals. The detector shall provide operation as above with a loop system having any or all of the following characteristics:

- 1) A shunting resistance of 10,000 ohms or greater to a common or circuit ground bus.
- 2) A loop system quality factor (Q) of not less than 5.0, when connected to the detector being tested. Q is defined as the ratio of the resonant operating frequency over the half-power bandwidth.
- 3) A total or equivalent inductance within the range of 40 to 700 microhenries at the detector loop input terminals.

A sensitivity adjustment or selector shall be provided to allow selection of a high, medium or low sensitivity adjustment.

- b. Loop Energizing and Detector Sensing Circuits. The detector shall provide reliable detection of licensed motor vehicles. The detector shall provide an input (switch closure) only when vehicles are passing or stopped over the loop and shall detect all vehicles passing over the loop at speeds up to 80 miles per hour.
    - i) Turn on. When first turned on, while tuning or being tuned, the detector shall provide a continuous output pulse (switch closure), plus a visual indication, in both the presence and pulse modes of operation. On power failure, or loop failure that would cause the inductance to exceed the tuning range, the detector must place a continuous call.
    - ii) Frequency. To prevent mutual interference "crosstalk", the detectors shall be provided with a three position frequency mode switch on the front panel.
    - iii) Automatic Tuning. The detector shall be designed to be initially tuned to the loop and provide for automatic drift compensation.
    - iv) Weather. The operation of the detector shall not be affected by changes in the inductance of the loop caused by environmental changes, such as rain, hail, snow, temperature humidity, nor shall the sensitivity be markedly affected.
  - c. Accuracy. The detector shall be able to detect all licensed vehicles, including motorcycles, accurately.
2. Detector Output. The detector output (switch closure) to the associated traffic control equipment shall be provided by means of a relay. The relay shall have a mechanical life of at least 1,000,000 operations. The contacts shall have a rating of at least 1.0 ampere at 120 volts AC or DC.
  3. Power Supply. The detector shall be designed to operate on a 110 commercial 60-hertz power line over a voltage range of 100-125 volts. The primary of the power supply transformer shall be fused with a 1/4 inch diameter, 1 1/4 inches long, 250 volt fuse of suitable current rating. An extractor-post fuse- holder shall be provided. The fuse rating shall be marked by the fuse-holder.
  4. Visual Indicator. A long life light emitting diode shall be used to provide a visual indication of each vehicle detection. Lamps shall be easily replaceable without the use of tools. The indication must be readily visible in the indirect sunlight.

All indicator lights shall have a minimum design life of 20,000 hours at rated voltage unless an ON-OFF switch is provided to control the lights. If an ON-OFF switch is provided, the design of the lights need be only 1,000 hours at rated voltage.



5. Dielectric Strength. The detector shall withstand a dielectric strength test of 1,250 volts, 60 hertz per second, AC applied between the 120 VAC line-supply circuit and the terminals for the external loop for a period of one minute
6. Interchangeability and Design Life. All modules and components of the same type shall be interchangeable. The design life of all components, under conditions of normal operation, shall not be less than five years.
7. Delay Call. The detector, when specified on the bid form, to have a "Delayed Call" feature, shall be capable of ignoring a vehicle actuation unless it persists for more than a predetermined period of time. The predetermined time shall be adjustable from 0 to 25 second minimum on the front panel. The "Delayed Call" feature shall be inoperative during the green interval for the phase related to the amplifier.

**B. Enclosure**

1. General. A dustproof, metal enclosure shall be provided to enclose all electrical parts of the detector. The enclosure shall be designed for placement on a shelf in a weatherproof field cabinet. The detector shall not be position sensitive.
2. Detector Units. Detector units shall be designed for use with loop combinations (two to four loops) in series or parallel or series-parallel). The detector model shall have a visual indication of a call and will not require external equipment for tuning or adjustment.
3. Size. A small size enclosure and the ability to stack the enclosures, one on top of another, is desirable. Single detector units shall not be larger than 6 inches by 3 inches by 8 inches deep.
4. Marking. Each detector shall be marked with the manufacturer's name, model, catalog, or type number, and serial number. The electrical input rating (voltage, frequency, and wattage) shall be included in the marking.

**C. Input/Output Receptacle**

1. Function Assignment. Input and output connections for the detector shall be made to a type MS-3102-A18-1P box receptacle with 10 male contacts. A plastic cover shall be provided on the receptacle. The pin positions of the input/output connector shall be assigned as follows:

<u>Pin No.</u>	<u>Function</u>
A	120 VAC (-)
B	Output Relay Common
C	120 VAC (+)
D	Input from Loop
E	Input from Loop
F	Output Relay N.O.
G	Output Relay N.C.
H	Chassis Ground
I	Spare
J	Spare

2. Plug and Cable. A plug, type MS-3108-B with type 18-1S insert, with 10 female contacts shall be furnished, wired, leads of leads of #18 AWG stranded, color-coded wire with 300 volt insulation. A type MS-3057-10 cable clamp and boot shall be provided for strain relief. The leads shall be 5 feet in length, the first 16 inches of leads, from the plug, shall be enclosed in cotton braiding. No terminals are required on the leads.

**D. Components**

1. Inductors and Transformers. All inductors and transformers shall have their windings insulated and shall be impregnated to exclude moisture. All wire leads shall be color coded.
2. Resistors and Capacitors. All resistors and capacitors shall be insulated and shall be marked with their resistance or capacitance value. Resistance and capacitance values

may be indicated by the Radio Electronics Television Manufacturer's Association (RETMA) color codes. All electrolytic capacitors shall be marked to indicate polarity and voltage.

3. Printed-Circuit boards. All printed-circuit boards shall be at least 1/16 inch thick and shall be made of glass-cloth silicone. National Electric Manufacturer's Association (NEMA) type G-10 glass epoxy or equivalent. The conductor material shall be copper, 0.0027 inch thick, having a weight of 2.0 ounces per square foot, with a protective solder coating. All printed-circuit board connectors (male and female) shall be gold plated over the copper base. The printed circuit-boards shall be securely mounted in such a way as to prevent flexing or bending of the boards, and shall be easily removable for servicing or replacement.
  4. Wiring. All interconnecting wire shall be insulated #22 AWG or larger, suitable for 180°F operation.
  5. Solid State Circuitry
    - a. Components. Transistors, integrated circuits, or semi-conductor diodes shall be used for all amplifying, detecting, rectifying, counting logic, and regulator circuits. No vacuum or gas tubes shall be used except for pilot lights. Transistors, integrated circuits, and diodes shall be marked with their type number and shall be types listed by the Radio Electronics Television Manufacturer's Association (RETMA). No electromechanical timers, synchronous motors, or relays shall be employed, except as specified in Section 1-B.
    - b. Proprietary parts. All electronic and electrical components must be of standard manufacture and available from a source other than the manufacturer of the loop detector unit.
  6. Temperature. The temperature of components shall not cause any appreciable reduction in component life when the detector is operated in an ambient temperature from 20°F to 180°F.
- E. Workmanship
1. The enclosure and all modules shall be fabricated, assembled, and wired in a workmanlike manner.
- F. Documentation
1. Contents. A documentation package shall be supplied in each controller cabinet for the inductive loop vehicle detectors which shall consist of the following:
    - a) Complete schematic diagram, accurate and current for unit supplied.
    - b) Complete physical description of unit.
    - c) Complete installation procedure for unit.
    - d) Loop specifications and loop assembly procedure.
    - 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.
  2. Number of copies. At least three full documentation packages for each detector sensing unit model shall be supplied to the ENGINEER.

## **2.08 - Equipment And Materials**

- A. Equipment and materials shall be of new stock unless the plans 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.

## **PART 3 EXECUTION**

### **3.01 - General**

- A. 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.
- B. The CONTRACTOR shall be a licensed electrical contractor in accordance with City Ordinance and adherence to local Building Code shall be met.
- C. **CONTRACTOR Qualifications**  
Trained and experienced personnel shall supervise the fiber optic cable installation. Qualified technicians shall make the cable terminations and splices. The CONTRACTOR upon request of the ENGINEER shall provide documentation of qualifications and experience for fiber optic equipment installations. The ENGINEER shall determine if the CONTRACTOR is qualified to perform this work. The CONTRACTOR shall have attended a certified fiber optic training class mandated by the specifications prior to starting work.
- D. 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.
- E. 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 OWNER at the time of completion of the work.
- F. 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 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.
- G. The Standard Specifications for Highway and Bridge Construction, Series 2009, Iowa Department of Transportation, as modified by these contract documents shall apply to this Special Provision.  
The above specifications are referred to as the Standard Specifications.  
The installation of the signals and signs shall be in conformance with the "Manual of Uniform Traffic Control Devices for Streets and Highways", 2003 edition, latest revision.
- H. The video detection system shall be installed as recommended by the supplier and as documented in installation materials provided by the supplier.
- I. **Miscellaneous Equipment**  
The CONTRACTOR shall furnish and install all necessary miscellaneous connectors and equipment to make a complete and operating installation in accordance with the plans, standard sheets, standard specifications, special provisions, and accepted good practice of the industry.

### **3.02 - Qualifications, Service Calls, And Warranty**

- A. 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.
- B. The ENGINEER will provide part-time observation of the CONTRACTOR's work. The ENGINEER'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 Department for review of the work. Any service calls or review of the CONTRACTOR's work outside of the ENGINEER's normal working hours will be billed to the CONTRACTOR.

- C. The ENGINEER 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.
- D. The CONTRACTOR shall guarantee all his work against defects due to poor workmanship or materials as specified in the Contract Documents.

### **3.03 - Concrete Bases For Poles And Controller**

- A. Concrete bases for poles and controllers shall conform to the plans and Section 2403 of the Iowa DOT Standard Specifications.
- B. 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.
- C. 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 in a continuous sidewalk area, the top of the pole bases shall be set flush with the sidewalk or pavement surface.
- D. 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.
- E. 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. 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.
- F. 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 Section 4106 of the Iowa DOT Standard Specifications.
- G. 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.
- H. After the concrete is placed in the form, it shall be vibrated with a high-frequency vibrator to eliminate all voids.
- I. 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.
- J. 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.
- K. 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.
- L. 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.

- M. Where shown 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.

### **3.04 - Handholes**

- A. Handholes shall be either built in place in an excavation made in a neat workmanlike manner or shall be a precast unit conforming to the requirements of the plans.
- B. 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 them rigidly in place while the concrete is being placed.
- C. 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.
- D. 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 one 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.
- E. All conduit openings in the handholes 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. Plastic loop handhole construction shall meet the requirements for the precast handhole detail in the plans except that cable hooks will not be required. Openings for conduit access shall be drilled to match the outside diameter of the conduit.
- F. Grout conduit access after installing conduit.
- G. Install galvanized cable hooks if not precast with the handhole.

### **3.05 - Conduit**

- A. Conduit shall be placed as shown on the plans.
- B. Unless approved by the ENGINEER, conduit shall be installed without change in direction directly from one structure to another. Change in direction may be allowed for physical restrictions such as right-of-way restrictions, utilities, location of roadway slopes, retrofitting existing conduit stubs, and certain short sections of conduits.
- C. 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.
- D. 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.
- E. 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.
- F. All conduit placed for future use shall be threaded and capped with threaded metal pipe caps.
- G. 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.

### 3.06 - Trenching And Backfilling For Traffic Signals

- A. Secure written approval of the City prior to any trenching or excavation within the drip line of any tree.
- B. 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.
- C. 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.
- D. 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.

### 3.07 - Pushed Conduit

- A. 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.
- B. 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.
- C. Plan quantities for pushed conduit include at least two feet of pushed conduit behind each curb.
- D. 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.

### 3.08 - Electrical

- A. 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.
- B. The signal cable color codes shall be as follows:

#### Iowa City Color Codes

1 tape = Left turn signal; 2 tape = Through signals; 3 tape = Right turn signal.

Tapes shall be color coded as follows:

Blue = NE Corner;

Orange = Southeast Corner;

Yellow = Southwest Corner;

Green = Northwest Corner.

Video cable tapes shall be similarly color coded.

4 conductor cable

Green Ball - Green

Yellow Ball - Black

Red Ball - Red

Sig. Common - White

7 conductor cable

Green Ball - Green

Yellow Ball -	Orange
Red Ball -	Red
Green Arrow -	Blue
Yellow Arrow -	Black
Sig. Common -	White & W/BK

9 Conductor Cables

Pedestrian Signals

Walk – main st	Green
Don't Walk – main st	Red
Walk - side st	Green\Blk
Don't walk - side st	Red\Blk
Sig. Common -	White
Pushbutton - main st	Orange
Pushbutton – side st	Black
PB Common -	W/BK

- C. 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. Street lights will be fused with a 5 amp fuse in each pole base using a Type HEB-AA Fuseholder.
- D. Conductor groupings and splicings may be made in the terminal compartment in the controller cabinet.
- E. The loop detector lead-in cable shall be one continuous length of cable from the terminal compartment of the controller cabinet to a splice made with the loop detector wires in the first handhole or pole base handhole compartment provided adjacent to the loop detector. Details of the loop detector splices are shown on the plans.
- F. 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. Contractor shall leave a pull string in each conduit.
- G. 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. Ties shall be of an opaque nylon material arranged to include a marker board, non-releasing holding device, and cable fastening tail. The marking board shall be not less than 3/8 inch wide by 3/4 inch long, and 25 mils thick, roughened on one side to hold permanent black nylon marking ink from a pen. 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
Loops	Loop number, direction and location (stop lines, advance, or left turn loop)
Pedestrian, Push Button	Location, street crossing

In addition, the cables shall be identified in each handhole and at the pole bases using colored tape as follows:

1 tape = Left turn signal; 2 tape = Through signals; 3 tape = Right turn signal. Tapes shall be color coded as follows: Blue = NE Corner; Orange = Southeast Corner; Yellow = Southwest Corner; Green = Northwest Corner. Video cable tapes shall be similarly color coded.

- H. Cable slack shall be as follows:
  - 4 feet in handholes
  - 2 feet in signal bases
  - 2 feet in the terminal compartment of the controller baseNo slack will be allowed in the loop detector lead-in cable after the initial splice.
- I. Connectors shall be of the proper size for the number and size of the wires being connected.
- J. Wire ends must be thoroughly cleaned after the insulation is stripped off to insure complete contact with another wire, or the connector. If strands are damaged when the insulation is removed, the section of the cable must be discarded. 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.
- K. Electrical tape shall not be applied to the finished connections. Signal cable insulation shall extend beneath the insulated portion of the connector. Any connection with exposed bare wire shall be redone by the CONTRACTOR.
- L. Covered connections must be arranged so that 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.
- M. Loop detector splices shall be capable of satisfactory operations under continuous immersion in water.
- N. 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.
- O. Service cable shall be continuous from the disconnect switch located on the service pole to the terminal compartment of the controller cabinet.
- P. Interconnect cable or fiber shall be continuous from controller to controller. A tracer wire shall be installed in all conduits with signal cables, detector lead-in 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. The tracer wire shall have an orange jacket.

### **3.09 - Pole Erection**

- A. All poles are to be erected vertically and securely bolted to the cast-in-place concrete foundations at the locations shown on the plans.
- B. 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.
- C. After the pole is securely fastened, install metal strips in the area between the pole and the base. The metal strips and the method of attachment shall be approved by the ENGINEER.
- D. Each pole shall be grounded from the pole to the foundation ground rod by a No. 6 AWG bare copper ground wire.
- E. Poles shall be placed so that modifications and/or attachments are correctly oriented, as indicated on the plans.
- F. The foundations must be given seven days to cure before poles are erected. The center of the poles are to be set back from the curb, a 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.
- G. 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.
  - H. Mast arm assemblies shall be furnished and installed by the CONTRACTOR. When pre-used painted mast arm assemblies are specified, the CONTRACTOR shall prime and paint the mast arm assemblies with the following method:
    1. Remove all rust, scale, and loose paint from the surface by sanding or power tool cleaning (SSPC-SP-3). CONTRACTOR to use care when power tool cleaning to avoid burning, polishing, or grinding surface dirt into the existing paint surface. Hand tool cleaning (SSPC-SP-2) will be allowed only in areas accessible to power tool cleaning.
    2. Remove all chalking, dirt, and other foreign material from the entire surface by application of petroleum solvent (i.e. paint thinner, mineral spirits, etc.) and wiping the entire surface with clean rags.
    3. All bare metal surfaces exposed by the cleaning operation shall be spot primed the same day to avoid flash rusting.
    4. After the primed areas have dried, apply one coat of finish paint.
    5. Primer and paint must be approved by the ENGINEER.

### 3.10 - Loop Detectors

- A. Loop detectors shall be installed in accordance with the plans. Adjustments in the locations shall be made to minimize the location of the loop wire across construction joints. Locations of the loops shall be subject to the approval of the ENGINEER. The cabinet end of the cable shall be clearly tagged identifying the loop.
- B. The slot for the loop shall be constructed as per plan. The slot shall be completely clean of all loose debris and have a smooth bottom.
- C. New PCC pavement shall not be sawed until seven days after pour unless approved by ENGINEER.
- D. Loop detectors shall be connected to the controller with shielded cable. No splices will be allowed in this cable.
- E. Upon completing the loop installation in the field cabinet and prior to sealing the loop in the pavement, the CONTRACTOR shall notify the ENGINEER who may meter the loops by test instruments capable of measuring electrical values of installed loop wires and lead-ins to measure induced AC voltage, inductance in microhenries, high-low "Q" indication, leakage resistance in megaohms, and the resistance of the conductors in ohms.
  1. An acceptable load installation shall be defined as follows:
    - a) Induced voltage test:  
No deflection on the pointer of a volt meter
    - b) Inductance:  
The inductance reading on the loop tester is approximately the calculated value or with approval of the ENGINEER is between 100 mh and 200 mh.
    - c) Loop Q:  
Deflection of the pointer to the upper side of the scale.
    - d) Leakage to Ground:  
Deflection of the pointer to above 100 megaohms.
    - e) Loop Resistance:  
The resistance reading on an ohm meter is approximately the calculated value.
  2. An unacceptable loop installation shall be defined as follows:
    - a) Inductance:

The inductance reading is below 90 mh or above 250 mh.

- b) Leakage to Ground:  
Deflection of the pointer to below 100 megaohms.
- c) Loop Resistance:  
The resistance reading is 50% more than calculated.

### **3.11 - Signals**

- A. 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. (See Signal Head Mounting Details.) Modifications to this are required when the view of the pole mounted signal indication is blocked. (See Paragraph 3.11E). Pedestrian push buttons shall be installed on the face of the pole in 90 degree increments with respect to the mast arm. The push button shall be located on the pole face so the arrow on the R10-4 sign directs pedestrians to the appropriate crosswalk.
- B. All optically limited signal heads shall be properly masked to limit their field of view as directed by the ENGINEER.
- C. Backplates shall be installed and properly secured for the traffic signal heads.
- D. All signal heads shall be kept securely covered until such time as the signals are put into operation.
- E. 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.

### **3.12 - Controller**

- A. 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.
- B. All field wiring must be directly attached to the wiring lugs. Attachment of wiring shall be in a neat and workmanlike manner. All connections at the controller shall be done by City Traffic Engineering personnel.
- C. 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.
- D. 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.
- E. 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.

### **3.13 - Ground Rods**

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

### **3.14 - Equipment Testing**

- A. The result of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data.
- B. When the CONTRACTOR's work is complete and the project is open to normal traffic, the CONTRACTOR shall notify the ENGINEER in writing the date the signal will be ready for testing.
- C. Initial traffic signal timings and timing adjustments will be performed by the ENGINEER.
- D. Upon concurrence of the ENGINEER, the CONTRACTOR shall place any signal in operation for a consecutive 30-day test period. Any failure or malfunction of the equipment supplied or installation performed by the CONTRACTOR shall be corrected at the CONTRACTOR's expense 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.
- E. If the signal is to operate independently of other signals or signal systems, it shall be tested as a single installation.
- F. 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.
- G. The CONTRACTOR shall 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 by the CONTRACTOR within the above time period, and will deduct its expenses from the CONTRACTOR's final payment.
- H. Ground testing shall conform to Article 2523.03, U of the Iowa DOT Standard Specifications.

### **3.15 - Clean-Up**

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

## **PART 4 – METHOD OF MEASUREMENT AND BASIS OF PAYMENT**

### **4.01 – Method of Measurement**

Payment for Traffic Signalization and for Advance Detection System will be as follows:

- A. This item will be the lump sum for Traffic Signalization.
- B. Advance Loop Detection System. This item will be lump sum for the advance detection system.

### **4.02 – Basis of Payment**

- A. 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 lights, luminaires on combination street light/signal poles, wiring, conduits, handholes, controllers, cabinets, coordination with utilities, video detection system, testing, and all other miscellaneous hardware, software or any other items necessary to complete the traffic signal system in place. This item specifically excludes the Advance Loop Detection system described in the following item.
- B. Payment for Advance Loop Detection System shall be full compensation for supplying all equipment, labor, and materials necessary to install all conduit and handholes required for the advance loop detectors shown in the plans. This system includes inductive loops installed in the pavement, loop wiring, loop conduit, PVC handholes, loop sealant, loop detector units in the traffic signal cabinet, system testing, and all other materials and hardware necessary for a fully functional Advance Loop Detection system in place.

