



**SPECIAL PROVISIONS  
FOR  
TRAFFIC SIGNALIZATION**

**Black Hawk County  
STP-A-8155(757)--86-07**

**Effective Date  
March 17, 2020**

**THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**157120.01 GENERAL.**

**A. Scope.**

These Special Provisions cover the work described in the contract documents. It covers furnishing all labor, equipment and materials, and performing all required operations to complete the work as per contract documents and to provide a completely operational and working signal system. Unless otherwise modified by these Special Provisions, all work including equipment, material and installation shall be in accordance with the appropriate Iowa DOT Standard Specifications. Where reference is made to the codes, Standard Specifications, the safety orders, the general orders, the standards, laws, and ordinances, it shall mean the version of the reference that is in effect on the bid advertising date.

**B. Definitions.**

Terms used in this document shall have the meanings defined below:

- City means City of Waterloo, Iowa, or its representatives.
- WOTD means City of Waterloo Traffic Operations Department.
- Punch List means a list of items that need to be corrected by the Contractor on the project before the final acceptance can be made.
- Response Time means the elapsed time from when the Contractor is given a notice to take certain actions to the time the Contractor actually starts the action.
- LED means light emitting diode.
- IP means Internet Protocol.
- APS means Accessible Pedestrian Signals.

**C. Related Specifications and Standards.**

1. The Contractor shall comply with all of the standards listed below unless otherwise modified by contract documents or Special Provisions:
  - ANSI (American National Standards Institute) Standards.

- ASTM (American Society for Testing Materials) Standards.
  - EIA (Electronics Industries Associations) Standards
  - IMSA (International Municipal Signal Association) Standards.
  - ITE (Institute of Transportation Engineers) Standards.
  - MUTCD - Manual on Uniform Traffic Control Devices.
  - National Electrical Code.
  - National Electrical Safety Code.
  - NEMA (National Electrical Manufacturers Association) Standards.
  - Specifications of the Underwriters Laboratories, Inc.
  - TIA (Telecommunications Industries Association) Standards.
  - TIA/EIA (Telecommunications Industry Association/Electronic Industries Alliance) 568
  - NTCIP (The National Transportation Communications for Intelligent Transportation System Protocol).
  - ATC (Advanced Transportation Controllers)
  - All pertinent local, state and federal laws and regulations covering installation, material, design, construction, and operation.
2. The Contractor shall notify WTOD in writing of any discrepancy or ambiguity as to the intent or meaning of the Contract Documents or Signalization Specification before starting to work on that area. WTOD will supply the Contractor in writing with the intent. The decision of WTOD will be final and conclusive.

#### **157120.02 MATERIALS AND CONSTRUCTION.**

##### **A. General.**

1. The contract work shall comply with the applicable requirements of the Standard Specifications, in particular the following parts:
  - Section 2423: Support Structures for Highway Signs, Luminaires, and Traffic Signals
  - Section 2525: Traffic Signalization
  - Section 4189: Traffic Signal Equipment
  - Division 26: Roadside Development
2. Materials shall be of new stock unless the plans provide for the relocation or the use of materials furnished by others. New materials shall be the products of approved suppliers and manufacturers, approved by the Engineer. Miscellaneous electrical equipment and materials shall be UL approved.

##### **B. Solid State ATC (and NEMA) Actuated Traffic Signal Controller.**

1. Contractor shall furnish and install an Intelight X-3 controller. Included with each of these controllers shall be a license to fully communicate with the MaxView central management software. Contractor shall install the controller in the existing cabinet and supply and install all associated cabinet equipment needed to connect the controller to the existing fiber optic network at the cabinet.
2. The controller shall be fully compatible with Waterloo's Intelight traffic adaptive system MaxAdapt and shall function in traffic adaptive mode. Unless otherwise specified elsewhere in the contract documents, controller shall meet the requirements below.
3. The controller shall comply with NEMA TS-2 Type1, ATC, and NTCIP standards. All electronic components, quality, and functionality of the traffic signal controller shall conform to the applicable standards for TS-2 Type 1 traffic signal controllers mandated by the current edition of NEMA Standards Publication TS2-2003 v02.06 for Traffic Controller Assemblies, and conform to NTCIP Requirements. Controller engine board and operating system shall support open

- architecture and be compliant with current ITE, AASHTO, and NEMA Standard Publication for ATC 5201.
4. All major components shall meet the environmental, design, and operating standards outlined in NEMA Standards Publication TS2-2003 v02.06, Section 2.
  5. Only the connector needed for a NEMA TS-2 Type 1 cabinet is required.
  6. Direct human interface shall be through menus or graphics user interface.
  7. Engine Board and CPU shall be compliant with the ATC 5201 Standard and shall meet the following minimum specifications:
    8. Processor: 32 bit; 750 MIPS at 400 MHz;
    9. Memory: 1 MB SRAM; 64 MB SDRAM; 64 MB DRAM
  10. On-board 5-Pin USB Motherboard Connector
  11. No batteries or moving parts such as fans or memory storage devices with rotating parts on the controller unit
  12. Display a 16 line by 40 character LCD
  13. All keypads to be mounted on the controller front panel and are to be weather resistant and backlit
  14. Readily be installed and operate in TS-2 Type 1 traffic signal control cabinets.
  15. Each local controller shall have a USB slot for copying controller data for either backup or for transferring to another controller.
  16. The Traffic Signal Controller shall use a Linux operating system (O/S) with kernel version 3.14 or later and shall include standard POSIX libraries for application support including real-time extensions of POSIX 1003.1b. To facilitate application level access to the ATC hardware, a Board Support Package (BSP) shall be provided by the controller manufacturer for access to hardware-specific drivers.
  17. The operating system shall include enabled support for cgroups (control groups) for the purpose of limiting, accounting for, and isolating resource usage (CPU, Memory, etc.) of all running processes to ensure the reliability and stability of the traffic signal control application.
  18. The Linux operating system shall include an application programming interface in compliance with the ITE, AASHTO, and NEMA Application Programming Interface (API) Standard for the ATC v2.0.
  19. In addition to the front panel screen, the traffic signal controller shall have an on-board web server which hosts a graphical user interface for monitoring and configuring the intersection control software. The web server interface shall provide access from any internet enabled device with a web browser. No additional or proprietary software shall be needed to use the graphical user interface.
  20. In addition to standard operations specified in the NEMA TS-2 for NTCIP v02.06 Standard, the intersection control software shall have a logic processor where the user can develop advanced logic statements and operations to be used as custom solutions or for feature development. In addition to standard Boolean logic, the user shall be able to specify conditions using all input and output functions including but not limited to phase indications and intervals, detector calls,

preempt status, interval/service times, and greater than/less than relationships. For example, the processor shall provide a way for the user to program the following condition in the controller front panel: "Call preempts 5 if phase 2 is green for more than 25 seconds. Also send a message to the downstream controller to start preempt 2 in 15 seconds if the coordinator is currently in transition."

21. One copy of a Microsoft Windows<sup>®</sup> based traffic signal controller emulation software package shall be supplied. This program would allow the user to program a traffic signal controller on a Windows based computer, and shall be compatible with the latest version of the Windows operating system. The program supplied shall be the same version as the firmware version supplied with the controller. This program would allow the user to program a complete traffic signal controller and can be saved on a USB memory drive for transfer to a controller. This program shall be updated and supplied to the City at the same time as the Linux firmware for the controller and shall be supplied no charge for any updates.
22. The Contractor shall provide all NTCIP Management Information Base (MIBs) files associated with the controller software including manufacturer specific and extended objects. There shall be no limitations on the re-distribution and re-use of the MIBs associated with the controller software.
23. The vendor's current software development tool kit including tool-chain and other necessary Linux Libraries for the ATC engine board shall be publicly available for the lifetime of the product. Once standard ATC API Software has been developed per the ATC API 2.06a specification and released by the ITE, AASHTO, and NEMA Joint Committee on ATCs, the new industry standard API and toolkit should be provided on all engine boards provided with no extra cost. The controller shall be compatible with City's existing MaxView Advanced Traffic management System including full communications and monitoring capabilities.

### **C. Vehicular Signal Heads.**

1. Signal head doors should open so the light assembly can be changed without removing the door or loosening the head.
2. Signal indications shall be 12 inches in diameter and sectional in construction requiring one section for each light indication.
3. All traffic signal light sources shall be LED. LED and LED assemblies shall meet all pertinent NEMA, IEEE, and ITE standards.
4. Signal head lenses can be made of glass or ultraviolet (UV) stabilized synthetic materials. Non-polycarbonate synthetic lenses shall meet the ITE color standards and 3 1/2 foot drop test. Lenses shall be capable of withstanding ultraviolet exposure from direct sunlight for a minimum period of 36 months without exhibiting evidence of deterioration. Lenses may be tinted or may use transparent film or materials with similar characteristics to enhance "ON/OFF" contrasts. If a polymeric lens is used, a surface coating or chemical surface treatment shall be used to provide front surface abrasion resistance.
5. The housing for the individual sections shall be made of UV stabilized polycarbonate or a die-cast aluminum. The top and bottom of each section shall have an integral locking ring with separations to permit rotation of the signal head in 5 degree or smaller increments. Openings in the top and bottom of the signal shall accommodate standard 1 1/2 inch bracket arms. All joints between sections shall be waterproof. Locknuts or other means approved by the Engineer shall hold the section firmly together.
6. Each section shall be complete with a one-piece, hinged door with watertight gaskets and two

- stainless steel locking devices. The hinged pins shall be designed so that the doors may be easily removed and reinstalled without use of special tools.
7. One section of a three or more section assembly shall be equipped with terminal block for termination of field wiring.
  8. The lamp socket shall be equipped with color-coded wire, red, yellow, or green, depending upon the lens color of the section.
  9. The socket wires shall be a minimum of 26 inches long, composed of wire with insulation designated to withstand 105°C. The wiring leads shall be terminated with spade lugs for ease of connection to terminal block. The socket shall be equipped with a gasket to insure a dust-tight fit.
  10. A coupling washer assembly comprised of two washers, three cadmium-plated bolts, nuts and lock washers shall lock the individual sections together. The hole in the coupling washer assembly shall be large enough to accommodate three 3/4 inch cables.
  11. Certification: The City shall be furnished with a certification from the manufacturer of the signal head that the equipment furnished under the contract documents complies with all provisions of these Special Provisions. If there are any items which do not comply with the contract documents, a list of those exceptions must be detailed on the certification.
  12. All screws, latching bolts and hinge pins shall be according to manufacturers' recommendations. One section of the three-section signal shall be equipped with a six-position terminal block for termination of field wiring. Each five-indication signal shall be equipped with an eight-position terminal block.
  13. All surfaces of metal signal housing doors and visor shall be oven baked, black, enamel, except the doors and visors shall be flat black.
  14. During the course of construction and until the new signals are placed in operation, signal faces shall be covered or turned away from approaching traffic. When ready for operation, they shall be securely fastened in position facing toward approaching traffic. All traffic signal displays shall be installed as indicated on the plans and aligned and leveled per MUTCD on all axes. All optically programmable signal heads shall be properly programmed to limit their field of view as directed by the Engineer. Three-section overhead displays located on mast arms should have the red indication above the mast arm and five-section displays shall have two sections above the mast arm
  15. Visors: Each lens shall have an aluminum or UV stabilized polycarbonate cut-off tunnel visor not less than 8 inches in length and designed to shield each lens. Visors shall have a minimum thickness of 0.05 inch and be painted flat black.

#### **D. Pedestrian Signal Heads.**

1. Signal head doors should open so the light assembly can be changed without removing the door or loosening the head.
2. All pedestrian signal heads shall include all the necessary fittings and adjustable cable tie type brackets and shall use LED.
3. The pedestrian signal shall be 16 inches, with a universal don't walk "HAND" symbol indication and a universal walk "MAN" symbol indication in one section head, and countdown timers.
4. Other properties shall be the same as defined for vehicular traffic signal heads defined earlier.

**E. Backplates.**

1. Backplates shall be UV stabilized polycarbonate or aluminum and louvered. Backplates shall be 5 inch border in size and shall be at least 0.05 inch thick. A 1 inch radius shall be provided on all corners. Each backplate shall be furnished with all the necessary mounting hardware for attachment according to manufacturers' instructions.
2. The size of each backplate shall be suitable for mounting on three-section and five-section, 12 inch signal heads, including space for plumbizers, when called for. All mounting hardware shall be rustproof and corrosion resistant.

**F. Foundations.**

1. A screw-in metal foundation can be used in lieu of a concrete base for pedestal installations. If used, it shall conform to manufacturer's specification for use as traffic signal pedestal pole as per plans.
2. The concrete bases shall conform to the dimensions shown on the plans. The bottom of all foundations shall rest securely on firm undisturbed ground. Forms shall be used for the above ground portion of all foundations. Whenever the excavation for a foundation is irregular in shape, forms shall be used to provide the proper dimensions of the foundations below grade. The material for the forms shall be of sufficient thickness to prevent warping or other deflections from the specified pattern. The forms shall be leveled and a means shall be provided for holding them rigidly in place while the concrete is being deposited.
3. The Contractor shall be responsible for the proper elevation, offset and level of each foundation. Where the foundation cannot be constructed as shown on the plans because of an obstruction, the Contractor shall relocate the foundation or use other effective methods of supporting the pole after securing the Engineer's approval.
4. Anchor bolts and reinforcement shall be held rigidly in-place before the concrete is poured. Anchor bolts shall be held in-place by means of a template constructed to space the anchor bolts uniformly in accordance with the pattern shown on the plans, and not to protrude excessively after installation of equipment.
5. Two conduit inlets shall be installed as a minimum per foundation. Inlets not used shall be capped below grade. A ground rod shall be placed external to each foundation. All ground rods shall be a minimum of 5/8 inch in diameter, 8 foot long copper clad and shall be external to the concrete foundation, driven 4 inches below ground surface. Anchor bolts, conduits and reinforcement shall be held rigidly in place before the concrete is poured.
6. The center of the template and the center of the concrete base shall coincide unless otherwise directed by the Engineer. High-frequency vibrator shall consolidate concrete after it is placed in the form. The top of the base shall be rounded with an edger having a radius of 1/2 inch. The exposed surface of the base shall have a rubbed surface finish.
7. Should the Contractor find that it is necessary to alter or reconfigure any portion of the installation or there would be a conflict with the design versus the site grade, ditches, utilities, etc., or the elevation appears to be too high or too low, the City shall be notified in writing of the portions that are in conflict. Immediate response will be given by the City or its representative to avoid delays.
8. After the foundation or base has been poured, no modification of any sort shall be made. If 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 the Contractor shall install a new foundation or base at no extra cost to the City.

9. Prior to installing the structures, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury.
10. The foundation must be given 7 days to cure before the structures are erected.
11. New bases shall be constructed and finished to the dimensions shown on the plans. Concrete shall be as specified in Article 2403.03 of the Standard Specifications for Class C, Mix No. C-4, air-entrained P.C. concrete, and shall be placed in accordance with Section 2403 of the Standard Specifications.
12. Reinforcement shall be in accordance with Section 2404 of the Standard Specifications. The top of the signal base shall be at a minimum of 2 inches and a maximum of 3 inches above the finished grade.
13. Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original grade and the grade involved shall be left in a neat and presentable condition.
14. Concrete sidewalks, pavements, base courses and bituminous surfaces shall be replaced with new materials.
15. The backfill shall be mechanically compacted in 6 inch layers to a density equal to that of the surrounding material.

#### **G. Traffic Signal Pedestal Poles.**

1. All traffic signal pedestals shall be Schedule 80 galvanized steel or Schedule 80 spun aluminum and shall be in conformance with Section 2525 of the Standard Specifications.
2. The length of the pedestal, from the bottom of the base to the top of the shaft, shall be 10 feet, unless otherwise specified on the plans. For galvanized poles, the pedestal shaft shall be fabricated of tubing with a wall thickness of at least 1/8 inch. It shall have a satin brush or spun finish. The top of the shaft shall have an outer diameter to receive a pole-top mounting bracket of a traffic signal or a pedestal-mounted traffic signal controller.
3. All hardware shall be of hot dipped galvanized steel in accordance with the latest revision of ASTM A123.
4. The pedestal base shall be cast-aluminum, breakaway, with a handhole. The size of the handhole shall be at least 4 inches by 6 inches and equipped with a cover, which can be securely fastened to the shaft with the use of simple tools. The surface of the base shall be prepared for painting in accordance with the manufacturer's recommendations and coated to match the pedestals.
5. Bases shall have a minimum weight of 20 pounds and shall have a four-bolt pattern uniformly spaced on a 13 3/4 inch diameter bolt circle.
6. Anchor Bolts. Galvanized, hot rolled steel anchor bolts, sizes as determined by the pole manufacturer, shall be supplied, complete with all the hardware required for installation. The anchor bolts shall have a right-angle bend at the bottom end and threaded at the top end.

#### **H. Galvanized Steel Traffic Signal Supports and Light Poles.**

1. The signal mast arms, support poles and light poles shall be continuous steel poles of the anchor base type as shown on the plans. The pole shall be fabricated from low carbon (maximum carbon 0.30%) steel of U.S. Standard Gauge and shall be manufactured from steel

sheet with one continuous welded vertical seam.

2. After manufactured, they shall have minimum yield strength of 48,000 psi. The base shall be of heavy cast or rolled steel attached to the lower end of the shaft by a continuous weld on both the inside and outside of the shaft. The diameter of the bolt circle shall be as specified by the manufacturer.
3. It is permissible to fabricate poles and mast arms by welding two sections together by vendor only. Welding and fabrication shall conform to the Structural Welding Code AWS, as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.
4. The pole shall be designed to support the traffic signals, lights and/or signs with the clearance as shown on the plans. Where called for on the plans, the poles shall be designed to assume high-rise design luminaire arms for streetlights. The luminaire riser may be manufactured and designed a separate add-on piece.
5. The pole shall be equipped with an approximately minimum 2 foot by 1 foot 10 inch transformer base or as specified on the plans.
6. Securing of the cover of the shaft shall be possible with the use of simple tools.
7. The mast arms and poles shall be equipped with all necessary hardware, shims, and anchor bolts to provide a complete installation without additional parts.
8. In addition to what is shown on the plans, all signal poles and mast arms shall be designed to carry a 5-section traffic signal head and a 24 inch by 36 inch sign at the end of each mast arm.
9. All hardware shall be of hot dipped galvanized steel in accordance with the latest revision of ASTM A123. All mast arms and support poles shall be galvanized steel and shall be in conformance with Section 2525 of the Standard Specifications.
10. All luminaire extensions shall provide for 40 foot mounting height and 12 foot overhang, unless otherwise specified on the plans.
11. All signal supports shall contain the anchor bolts. The anchor bolts shall be constructed from A36 steel with minimum yield strength of 50,000 psi. The anchor bolts shall be hot dipped galvanized for a minimum of 12 inches on the threaded end and shall be threaded a minimum of 6 inches at one end and have a 4 inch long, 90 degree bend at the other end.
12. Certification: The fabricator shall certify that the mast arms are capable of withstanding winds of at least 100 mph without failure; that only certified welding operators in accordance with AWS D1.1-75 or latest revisions were used; and that only electrodes as modified by the current version of AASHTO Standard Specifications for Welding of Structural Steel for Highway Bridges were used.
13. Pole Erection: All poles are to be erected vertically with the mast arm at a right angle to the centerline of the street, unless otherwise specified, and securely bolted to the cast-in- place concrete foundations at the locations indicated on the plans.
14. Leveling shall be accomplished by the use of nuts on each anchor bolt. One nut shall be placed 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 and final tightening of top nut to expose a maximum of three full threads.
15. All threaded pedestal poles shall be drilled and tapped and a ¼ inch diameter by ¾ inch long



galvanized or stainless steel bolt shall be installed through the base and the pole to prevent turning of the pole.

16. The Location of All Signal Standards: The locations of all signal standards shown on the plans are subject to adjustment depending on the actual locations of existing underground utilities and overhead utilities. Actual locations of standards will be selected at the time of construction upon location of existing utilities.

#### I. Galvanized Finish.

1. Both liquid finish and powder top coat galvanization are acceptable. All light poles, light pole mast arms, light pole bases, signal poles, pedestal poles, push button posts and signal pole mast arms shall come with a 5-year warranty against fading, cracking, peeling and corrosion. They shall be finished using an electrostatically-applied liquid finish consisting of an organic, zinc-rich, moisture cure urethane primer and high quality fast-cure polyurea topcoat (MillerBond or similar) or using a galvanized-powder topcoat finishing system, in accordance with the following:
2. **Surface Preparations.** Prior to being incorporated into an assembled product, steel plates 3/4 inch or more in thickness shall be blast cleaned to remove rolled-in mill scale, impurities and non-metallic foreign materials. After assembly, all weld flux shall be mechanically removed. The iron or steel product shall be prepared for zinc coating in accordance with ASTM 232.
3. **Zinc Coating.** The product shall be hot-dip galvanized to the requirements of ASTM A123 (fabricated products). The entire product shall be totally immersed, with no part of it protruding out of the zinc (no double dipping). This is to limit a risk of trapped contaminants containing chlorides and reduce the risk of bare spots. Maximum aluminum content of the bath shall be 0.01%. Flux ash shall be skimmed from the bath surface prior to immersion and extraction of the product to assure a debris-free zinc coating.
4. **Exterior Coating.** All galvanized exterior surfaces shall be coated with a Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. Prior to application, the surfaces to be powder coated shall be mechanically etched by brush blasting (Ref. Society for Protective Coatings [SSPC] SP-7) and the zinc-coated substrate preheated to 450°F for a minimum of 1 hour in a gas-fired convection oven by heating the zinc-coated substrate to a minimum of 350°F and a maximum of 400°F. The thermosetting powder resin shall provide both intercoat as well as substrate fusion adhesion that meets 5A or 5B classifications of ASTM D3359. Color shall be a semi-gloss black elected from the manufacturer's standard color table and shall be readily matchable for future repair.
5. **Packaging.** Prior to shipment, all items shall be protected to prevent damage during shipment and handling at project site.
6. **Field Repair Procedures.** Where factory applied coatings have become damaged or abraded due to handling, transport, installation, welding or other circumstances, they shall be repaired in accordance with manufacturer's recommendations. All damaged areas shall be thoroughly wire brushed. All dirt, oil, grease or other contaminants shall be removed in accordance with SSPC-SP1 and SP5. Touch-up paint shall be supplied by the galvanizer or steel fabricator and shall be identical in color and composition to that used in the plant. Touch-up paint shall be applied to all prepared surfaces to a dry film thickness of at least 4.0 mils.

#### J. Electrical.

1. Weather proof connectors shall be used.
2. All termination shall offer a secure connection and be secure to the cable conductors. It shall

not pull off of the cable when gently tugged. The connection shall not rely on tape to secure it to the cable jacket to prevent it from coming apart.

3. The correct tools shall be used to crimp the terminal connections. Using the wrong size of crimping die which produces a weak, non-uniform crimp which produces a short-term installation is not acceptable.
4. Service Installation. (Traffic Signal and Lighting): The Contractor shall supply and install a 2 inch Schedule 80 PVC conduit to the source of power either to the transformer or up the power pole with a weather head connector as required by the power company supplied by the Contractor. The size of the service conductors shall be 3/c No. 3 AWG stranded conductor. The Contractor shall be responsible for coordination of this work with the power company and for payment of connection fees, if any. The address of the source of power will be provided at the time of construction.
5. Pole: There shall be one conductor for each optical unit or set of optical units operating identically through the same cycle and one conductor for common return. Each overhead red, yellow, green signal head shall be wired with a separate cable from a splice in the pole base according to the conductor combination specified on the plans.
6. An electrical splice in each wire servicing traffic signal heads on a pole shall be made in the handhole compartment of that pole. All wiring, except loop and magnetic detector wire, shall be one continuous length of cable from the splice in the handhole compartment of the signal pole to the terminal compartment in the controller cabinet. Splices for detectors will be permitted between the detector wire and the detector lead-in cable only at the first handhole provided adjacent to the detector and will be done by City personnel.
7. All splices in the handhole compartment of a signal pole shall be made using gel filled twist wire connectors. Signal cable splices shall be made using gel-filled wire nuts. Cable connections in signal heads and controller cabinets shall be made at the terminal blocks with a mechanical attachment device attached to each wire end by terminal connectors specified elsewhere in this Special Provision.
8. Slack for each cable shall be provided by a 4 foot length in each handhole and a 2 foot length in each signal and controller base (measured from the handhole compartment to the end of the cable). In those handholes where detector splices are made, a 4 foot length of cable slack shall be provided in both the loop wire and the shielded lead-in cable.
9. 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 rollers and other suitable devices. A suitable wire lubricant shall be used to reduce friction and strain on wires or cables.
10. Service cable runs shall be continuous from the power line located on the service pole to the meter located on the controller cabinet or from the meter located on the service pole to the terminal compartment in the controller, whichever is applicable. The service riser shall be topped by standard weather head or otherwise replaced with "U" Guard.
11. Clearances to the overhead utilities shall be specified by the serving utility. The power company will furnish the electrical meter. The Contractor shall supply the service cabinet. All work shall be in accordance with Section 2525 of the Standard Specifications and the MUTCD.
12. A uniform systematic color code shall be used.

13. All wiring shall comply with the National Electrical Code and City Ordinance and shall be subject to the inspection of WTOD.
14. All wire shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.

#### **K. Bonding and Grounding.**

1. Metal conduit, service equipment, anchor bolts, metal poles, pedestals, controller cabinets, and all other electrical equipment shall be made mechanically and electrically secure to from a continuous system, and shall be effectively grounded. The grounding conductor shall be a No. 6 AWG stranded green copper wire.
2. Grounding bar shall be accomplished by bonding the grounding circuits to copper clad metal, driven electrodes. All electrodes shall be, as a minimum, 5/8 inches in diameter and 8 foot long copper clad. The electrodes shall be driven vertically until the top of the rod is a minimum of 4 inches below grade. Bonding to the ground rod shall be made by means of suitable screw type positive ground rod clamps. Grounding to waterlines will not be permitted.
3. Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or to 1 3/16 inch, or longer, brass or bronze bolt installed in the pole base.
4. The service meter and socket shall be bonded to a ground electrode by use of a ground clamp and a No. 6 AWG copper wire and shall be by means of cadmium plated grounding bushing and bonding jumpers. Where there is a change at a pull box or manhole for non- metallic conduit to metallic conduit, the grounding wire in the non-metallic conduit shall be bonded to the metallic conduit.
5. Existing ungrounded metal poles shall be grounded by means of a driven ground rod.

#### **L. Cables and Wires.**

1. The number of conductors and size of all traffic signal cable shall be as specified on the plans. All wire shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.
2. Service Conductors: Power cable shall be a 600 volt, stranded, insulated, single conductor, No. 3 AWG (black and white) unless otherwise stated in the plans. Ground wire shall be No. 6 AWG green stranded copper wire.
3. Signal Pole Base to Signal Pole Base: This shall be composed of either 5-conductor No. 16 AWG or 12-conductor No. 16 AWG cable IMSA Spec 20-1 Signal Cable – PE insulations, PE Jacket or otherwise specified on project plans. The color code should be NEMA K-1 method 1 with 600 volts rating. The signal cable conductors shall pedestal mounted) and mast arms to signal heads shall be No. 16 AWG cable (the number of conductors shall be specified on plans) and composed of stranded wire.
4. Luminaire Conductors: Conductors shall consist of type THWN, 600 volt, and single conductor copper stranded wires, which run continuously between poles. Conductors shall meet the requirements of Article 4185.12 of the Standards Specifications and shall be of the size and number shown on the plans.
5. Detector Lead-In Cable: Detector lead-in cable shall be No. 16 AWG, meeting the requirements of IMSA Specification 50-2 or latest revision thereof.
6. Tracer Wire: Tracer wire shall be a No. 10 AWG wire single conductor, stranded copper, Type

THWN, with UL approval and orange jacket. Provide in conduit runs that contain fiber optic cable but the conduit does not contain built-in tracer wire. Tracer wire shall be electrically continuous. Splices are permitted in hand-holes and pull-boxes provided the connection of two or more wires is made using a gel-filled wire connector. An additional 10 foot long "tail" shall be bonded to the tracer to be used for locating purposes.

**M. Handholes.**

1. Unless otherwise indicated on the plans, handholes shall be constructed as per these Special Provisions.
2. Except for fiber optics handholes, the Contractor may furnish a poured-in-place concrete handhole, with cast iron ring and cover, or a pre-cast concrete handhole, with cast iron ring and cover, or a fiberglass handhole. Concrete pipe (referred to as Traffic Handhole), meeting AASHTO Specification designation M86 for non-reinforced or M170 Class III for reinforced, of suitable length and diameter, and provided with cable hooks made with a minimum 1/4 inch diameter steel material. Cast iron ring and cover may be rated light-duty for non-traffic areas (155 pound minimum). Fiber optics handholes shall be as per plans.
3. Handholes on fill rural cross sections shall have a drain and drain pipe.
4. A crushed stone sump with a minimum depth of 18 inches shall be provided beneath all handholes.
5. The cover shall have the name "TRAFFIC" in 2 inch letters cast into the lid. The handhole shall be large enough to house loops in fiber optics cable as per manufacturer's recommendation for minimum diameter of the fiber optics cable loop.
6. Frames and covers for handholes shall be cast iron and conform to the dimensions shown on the plans. The top of the handhole shall be set flush with the sidewalk or driveway surface. When constructed in an earth shoulder away from the pavement edge, the top surface of the handhole shall be approximately 1 inch above the surface of the ground or as indicated on plans.
7. The ends of the conduit leading into the handhole shall extend a minimum of 1 inch and not more than 2 inches beyond the inside wall. All conduits in the handhole shall slope inward in a manner so as to provide drainage of water or condensation. Each handhole shall contain a minimum of two cable hooks. The hooks shall be permanently fastened to the inside wall near the top of the handhole.
8. When precast concrete sections are used for handholes, the conduit entrances shall be neatly grouted between the conduit and the precast concrete. The handhole ring shall fit snugly inside the precast concrete section. Grouting shall be done immediately after conduits are placed into the handhole to prevent washing in of debris.
9. After installation of handhole and before acceptance by the City, all foreign debris, including but not limited to dirt, leaves, grout, concrete, cans and glass, shall be removed.
10. All loop detector lead-in conductors shall be placed into a handhole prior to winter shut down.

**N. Conduit.**

1. All conduits, except fiber optic conduits, shall be Schedule 80 Poly Vinyl Chloride (PVC) when placed under paved surfaces and Schedule 40 elsewhere.
2. The number and size of conduit shall be as specified on the plans.

3. PVC conduits shall be rigid polyvinyl chloride meeting the requirements of NEMA TC-2, Type 2, and applicable UL standards.
4. All conduits, except fiber optic conduits, buried in open trenches shall be placed a minimum of 18 inches deep and shall extend a minimum of 3 feet 6 inches from the back of curb unless otherwise directed by the Engineer. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 24 inches below the finished pavement surface or as directed by the Engineer.
5. Fiber optic conduits shall be installed at least 42 inches below grade.
6. The backfill materials from the placement of conduit in open trenches shall be deposited in the trench in layers not to exceed 6 inches in depth and each layer shall be thoroughly compacted before the next layer is placed. All cinders, broken concrete, or other hard abrasive materials shall be moved and shall not be used in the backfill material. All surplus material shall be removed from the public right-of-way and properly disposed.
7. Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original grade and the grade involved shall be left in a neat and presentable condition.
8. Concrete sidewalks, pavements, base courses and bituminous surfaces shall be replaced with new materials.
9. Underground conduits shall be laid at a distance of at least 6 inches from any water line or other utility line.
10. When the plans require the conduit be placed without disturbing the existing pavement, 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. The size of a bored hole shall not exceed the outside diameter of the conduit, which is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than 2 feet to the back of curb unless otherwise directed by the Engineer. Conduits shall be Schedule 80 PVC unless otherwise shown on the plans.
11. When it is impractical to push the conduit under pavement due to unanticipated obstructions, the Contractor may, with the Engineer's permission, cut the existing pavement.
12. Where conduit is to be placed by trenching methods under existing asphaltic pavement, an 8 inch wide by 18 inch deep trench shall be opened along neat lines. The trench shall be backfilled with crushed stone, acceptable to the Engineer, filled with Class M high-early strength concrete to within 4 inches of the surface level. The concrete shall be allowed to set for a minimum of 48 hours without being exposed to traffic. The final 4 inches of backfill shall be a hot bituminous concrete plant mix acceptable to the Engineer.
13. A polyethylene pull rope shall be installed in all conduits, which is identified on the plans for future use. At least 2 feet of pull rope shall be doubled back into the conduit at each termination.
14. Conduit shall be laid to drain and 1 inch drains with crushed stone sumps shall be installed as shown on the plans and at all low points.
15. The backfill shall be mechanically compacted in 6 inch layers to a density equal to that of the surrounding material. Conduit shall be connected to existing and new light bases and junction boxes. All required fittings shall be furnished and installed by the Contractor to provide a

continuous, enclosed conduit system between poles. Conduit under pavement and driveways shall be rigid steel conduit or PVC Schedule 80, Type 2, in accordance with Article 4185.10 of the Standard Specifications. All trenches shall be backfilled with material containing no broken pieces of concrete or asphalt, stone, brick, wood or other unsuitable material including nested clods.

16. All conductors and wiring shall be furnished as new material and installed by the Contractor and shall conform to Section 2525 of the Standard Specifications.
17. Conduit not under pavement or driveways shall be Schedule 40 PVC.
18. All unused conduits, whether for future use or for later use in the project, shall be capped.
19. All conduits shall be sloped to drain toward the nearest handhole, and if this should prove to be impractical, then a conduit drain shall be provided with crushed stone drainage sumps at all low points, as detailed in the plans for traffic signal bases. A permeable membrane to keep sand from washing back into the conduit shall be installed at the conduit drain.
20. Fiber optics conduit shall be high-density polyethylene (HDPE) with minimum wall thickness of 0.07 inch and shall consist of a shell or sleeve tube, over-sheathing at least 4 inner tubes. Inner tubes shall be rated for direct burial and shall have a minimum OD/ID of 16/13. Inner tubes shall be ridged longitudinally inside and shall have a smooth surface outside. The inside surface of the inner tubes shall have a low friction permanent lining to reduce friction during cable placement. The conduit shall come with preinstalled sleeved copper tracer wire of minimum size No. 20 AWG. The whole outer tube and inner tubes package shall be rated for direct bury and shall be suitable for boring under existing pavement.

**O. Fiber Optics Cable.**

1. All interconnection shall be completed using newly constructed fiber optic cable as shown in the plans. All fiber optic cable shall be placed in HDPE conduit in accordance with Article 157120.02, N. All other necessary equipment, including patch cords, termination panels and all other equipment, tools and labor necessary to complete the network connections shall be included in the Contractor's bid for Traffic Signalization. At least six strands shall be terminated inside the controller cabinet.
2. Unless otherwise mentioned on the prior in these specifications or plans, the traffic fiber optics control communications and interconnect cable shall have the following minimum properties.
3. Fiber optics cable shall be small diameter high fiber-density micro cable suitable to be deployed by blowing into small duct sizes. Micro cable fibers shall be blown through conduits and shall not be pulled to cause stresses higher than manufacturer specified tensile strength for that micro fiber.
4. A 72-Stranded Single-Mode Loose Tube Cable meeting pertinent ANSI, EIA, and TIA specifications for the usage, installation, and location type required by this Project.
5. Typical Core Diameter:  $8.3 \mu\text{m} \pm 1.0 \mu\text{m}$
6. Cladding Diameter:  $125.0 \mu\text{m} \pm 1.0 \mu\text{m}$
7. Core Concentricity:  $\pm 1\%$
8. Attenuation Uniformity: No point discontinuity greater than 0.1  $\mu\text{m}$  at either 1310 nm or 1550 nm

9. Max Attenuation: 0.40 dB / Mile
10. The coating shall be a dual layer UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically strippable without damage to the fiber. The central member of the cable shall be a glass reinforced plastic rod designed to prevent the buckling of the cable. The cable core interstices shall be filled with water blocking tape to prevent water infiltration. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.
11. Buffer tubes shall be of dual layer construction with the inner layer made of polycarbonate and the outer layer made of polyester. Each buffer tube shall be water-blocked with a water-swallowable yarn or tape. Buffer tubes shall be stranded around the central member using reverse oscillation, or "SZ", stranding process.
12. The buffer tubes shall meet TIA/EIA-598A, "Color Coding of Fiber Optic Cables". The fiber cable shall include loose tubes with 12 fibers in each tube.
13. The cable tensile strength shall be provided by a high tensile strength aramid yarn and/or fiber glass.
14. All dielectric cables, without armoring, shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 0.055 inch. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The jacket or sheath shall be marked with the manufacturer's name and the words "Optical Cable," the year of manufacture, and sequential feet marks. The markings shall be repeated every 2 feet. The actual length of the cable shall be within +1% of the length marked. The marking shall be in a contrasting color to the cable jacket. Additionally, the jacket marking shall have a durable weatherproof label which shows the actual attenuation of each fiber expressed in dB/mile.
15. The cable shall be fabricated to withstand a maximized pulling tension of 600 pounds during installation (short term) and 135 pounds upon installation (long term).
16. The shipping, storing, installing and operating temperature range of the cable shall be -40°F to +158°F.
17. The manufacturer shall test at the 100% level all fiber optic cable for the following tests:
  - a. Each fiber proof tested at a minimum load of 350 Mpa.
  - b. Each fiber tested for attenuation and the reading shall be part of cable labeling.
18. The cable shall meet the appropriate standard Fiber Optic Test Procedure for the following measurements:
  - a. Fluid Penetration
  - b. Compound Drip
  - c. Compressive Loading Resistance
  - d. Cyclic Flexing
  - e. Cyclic Impact
  - f. Tensile Loading and Bending
19. The cable ends shall be available for testing. The cable ends must be sealed to prevent moisture impregnation.
20. Fiber Optic Jumpers/Patch Cords: All fibers entering the traffic signal controller cabinet shall be terminated in the fiber optic termination unit within the traffic controller cabinet. Length of patch cord will vary according to distribution unit to traffic signal controller, fiber optic modem, or video modem location within controller cabinet and shall provide for 2 feet of total slack.

21. A sufficient number of patch cords shall be installed to provide a fully-operational communications system.
22. Controller cabinet patch cords shall consist of factory-assembled patch cords, each containing two fibers. Each such fiber shall have a connector with ceramic ferrule on each end. Each patch cord shall have a dielectric strength member and a durable outer jacket designed to withstand handling.
23. Fiber Optic Termination Unit: The unit shall be a rack mount, drawer type enclosure that is dust and moisture repellent. The unit shall provide easy front access with removable rear tray for easy rear access and shall have a maximum dimension of 3.5 inches H by 18.5 inches W by 11.25 inches D. The size of the unit shall be adequate for the number of fibers, proper winding area, and splices. The unit shall provide for cable entry from the side and be capable of accommodating up to 48 connections
24. Connectors: Only connectors of ceramic ferrule and physical contact end finish shall be used to terminate fibers to equipment. ST connectors shall be used for multi-mode fiber. SC connectors shall be used for single mode fiber. Maximum attenuation per connector shall be 0.75 dB.
25. Splices: Fusion splices shall be used for all splices. The fiber cable shall be installed in continuous runs as designated on the plans. Splices shall be allowed only in the splice enclosures and controller cabinets as located on the plans. Maximum attenuation per splice shall be 0.3 dB.
26. Fan Out Kits: Fan out kits shall be provided for separation and protection of individual fibers with buffer tubing and jacketing materials suitable for termination of the fiber and fiber optic connector as specified.
27. Splice Enclosure: Continuous fiber cable runs and/or traffic signal controller branch circuit points will be spliced in an outside plant splice enclosure located in handholes as shown on plans. Green buffer tube of "trunk-line" fiber cable shall be spliced with "branch-line" fiber cable leading to traffic signal cabinet. The remaining "trunk-line" fiber cable buffer tubes shall remain in-tact and be "expressed" through the splice enclosure. Enclosure shall accept a minimum of six cables and provide enough trays to splice all fibers and provide means of "expressing" intact fiber cable buffer tubes. All fiber cables shall enter the enclosure at one end. Enclosure shall be watertight and re-enterable using gel-compressed cable connections and a re-enterable gasket.
28. Fiber splice loss shall not exceed the limits of TIA/EIA 568.
29. Tube Color: The green tube shall be extended to the traffic signal cabinet and shall be used exclusively for traffic communications and video monitoring purposes. Orange color tube shall be set aside for other City Entities.
30. Interconnection: All controllers shall be interconnected and connected to Waterloo Traffic Control Center by fiber optic cable.

**P. Mounting Hardware.**

1. Mounting heights for pedestrian heads should meet the minimum mounting height requirements. Pedestrian heads of the same type and size mounted on the same pole should be approximately the same height measured from the bottom of the pedestrian signal head housing to the closest sidewalk elevation. Different size pedestrian signal heads on the same pole should be mounted with their middle point having approximately the same height.



2. All pedestrian and vehicular signals heads shall be provided with adjustable cable brackets for mounting, as well as all other hardware necessary to completely mount the signals. All signal heads shall connect to poles and mast arms using adjustable cable tie supported brackets. Brackets shall not be painted unless otherwise shown on the plans. Plumbizers are not acceptable. All openings not used shall be plugged with a metal octagonal signal closure cap. No plastic devices of any type will be allowed. Top and bottom brackets will be required for all pole-mounted signal heads unless otherwise shown in the plans. All mounting brackets shall be stainless steel, not painted.
3. Control cabinet mounting will be on its own concrete base unless otherwise noted on plans.

**Q. Accessible Pedestrian Signals.**

1. Push Buttons: Pedestrian pushbutton detectors shall be ADA-compliant and shall have a pressure or piezo-electric activated solid-state contact without levers, handles, or toggle switches. The contacts shall be entirely insulated from the case and operating button with terminals for making connections. Push button shall have a visible and audible indicator that the button press has occurred.
2. Pedestrian detection shall have locator tone audio capability with differing frequencies corresponding to each pedestrian signal indication and audio tactile push buttons. The push button should activate the audible signal only for the crosswalk where the push button is activated. The locator tone shall self adjust against the ambient noise and be at the lowest setting when the ambient noise level is lowest.
3. The entire assembly shall be weatherproof, watertight, and freeze-proof and shall be secure against electrical shock and be of such construction as to withstand continuous hard usage. The contact shall be normally open and no current flowing except at the moment of actuation.
4. The push button shall have an LED light and shall flash each time the button is pushed. The push button shall emit an audible sound when the button is pushed and emit an audible sound of different frequency when the button is released.
5. Accessible Pedestrian Signals and Detectors shall be provided at all pedestrian crosswalk locations and shall meet the requirements of the latest version of the Manual on Uniform Traffic Control Devices.
6. Each pedestrian pushbutton shall be provided with the following features:
  - A Pushbutton locator tone
  - A Tactile arrow
  - A Speech walk message for the WALKING PERSON indication indicating the direction and/or name of the street to be crossed
  - A Speech pushbutton information message
7. APS shall be provided with the following features:
  - Both audible and vibro-tactile walk indications
  - Vibro-tactile walk indications shall be provided by a tactile arrow on the pushbutton that vibrates during the walk interval
  - An audible walk indication during the walk interval only. The audible walk indication shall be audible from the beginning of the associated crosswalk. The audio volume and direction shall be programmed to be heard as close to the crosswalk it is controlling as possible to avoid confusion with the other nearby crossing. It shall be placed as close to the curb of the corresponding crosswalk as possible.
  - Automatic volume adjustment in response to ambient traffic sound level shall be provided.

8. All audible walk indications for this project shall be a speech walk message
9. Speech walk messages shall be patterned after the following model: "Franklin. Walk sign is on to cross Franklin Street."
10. Audible detection beacon audio intensity shall be auto adjusted based on ambient noise. Extended pushbutton features are not required for this project.
11. Contractor shall submit shop drawings for all accessible pedestrian signals and detector equipment for approval.
12. Additional wiring and equipment required for a complete accessible pedestrian signal and detector installation is not indicated in the plan drawings, but shall be included in the Traffic Signalization bid item.

**R. Power Disconnect.**

The cabinet shall come with a properly rated power disconnect. It shall disconnect the power from the utility source to the cabinet so that there are no "hot" circuits or terminals inside the cabinet when servicing it.

**S. Emergency Vehicle Pre-Emption (EVP) System.**

1. EVP system shall be fully compatible with City's existing OPTICOM system and shall conform to the plans using Model 764 detectors.
2. EVP Detector and Light Installation: The detectors, indicator lights, wiring and connections shall be installed in accordance with the manufacturer's instructions.
3. In the event at installation a noticeable obstruction is present in line with the detector, the Contractor shall advise the Engineer before installation.
4. The detector and indicator light shall be attached to the traffic signal mast arm to the satisfaction of the Engineer.
5. All hardware shall be tightened securely.
6. The detector and indicator light shall be installed and mounted in such a way so as to insure the watertight integrity of the complete assembly. The detector shall be installed with the drain hole at the bottom.
7. There shall be no detector cable splices from the EVP detector on the traffic signal mast arm to the traffic signal cabinet. The detector cable shall be marked in the traffic signal cabinet as to which street and direction it is associated.
8. All EVP detectors and EVP indicator lights shall be operational when each traffic control signal system is initially turned on.
9. The Contractor shall furnish and install 3/c No. 20 AWG EVP detector cables and 3/c No. 14 cables for the confirmation lights where indicated in the plans. Emergency vehicle pre-emption cables (3/c No. 20) shall be installed continuous without splices or terminals from the EVP detector to the traffic signal cabinet.

**T. Traffic Detection Camera.**

1. Unless stated otherwise on the plans, detection system at each intersection shall consist of four cameras aimed towards each side street approach and major street approach. The cameras

shall meet the following requirements:

2. The Video Detection System and its components, referred to as the VDS, shall be a complete and working system.
3. Shall be IP compatible (IP addressable and network compatible).
4. Camera shall be mounted according to the manufacturer's recommendations.
5. NEMA compatible output to NEMA TS2 Type 1 controller with signal output for detection as NEMA loop detectors.
6. Settable and definable loop zone detection area up to at least 300 feet measured from the camera mounting location.
7. Minimum roadway surface coverage within 15 degree cone of camera vision from camera lens axis measured from the camera mounting.
8. Software and hardware to provide for defining detection area (loops) zones as small as 6 feet by 6 feet or smaller, and defining large detection zones/areas, minimum of five zones/loops per lane, and minimum of four lanes per camera.
9. Detector features shall include count detection, presence and passage detection, speed detection, label displays, data gathering stations, and contrast loss detection.
10. Image shall be able to be calibrated for accurate distances.
11. Fail-safe feature with fixed time, max time, or min time selection.
12. User friendly and easy programming with Windows XP and Windows 7 interface. The camera assembly, including mountings, shall withstand 90 mph winds.
13. Performing during night hours with no ambient lighting.
14. Shall have heating or features to ascertain full operability in presence of snow and ice.
15. Shall not fog.
16. Shall provide all the software and hardware needed to program and run the video detection system from both the cabinet, and remotely from Waterloo Traffic Operations Center. Communication link will be provided as a different part of the project. VDS system will be connected to an inside cabinet Ethernet switch to establish the VDS link to the Traffic Operations Center.
17. The system shall have a 2 year warranty. Housing shall be maintenance free.
18. Shall not cause adverse electronic effect on the controller's operations.
19. Shall operate at a mounting height of 20 feet or less and up to 35 feet or more.
20. Self-diagnostics of power-up and reporting failures.
21. The system shall be capable of recognizing vehicular travel/movement directions. Desirable feature is communications over power line between cabinet and camera. Remote zooming capability.

22. Operating temperatures –30°F to 140°F
23. Camera and camera assembly shall have features or shall be designed to reduce the need for manual cleaning of the camera or enclosure lens.

**U. Inductive Detector Loops.**

1. Loops in existing pavements shall be saw-cut. Loops in new pavement shall be prefabricated and buried/embedded. All loops shall be individually placed in pavement and terminated in handholes.
2. Loop Wire. The loop wire shall be 600 volt stranded copper, No. 14 AWG, Type THWN, with UL approval. The loop wire shall be protected by a flexible vinyl plastic tubing of 3/16 inch inner diameter, a minimum of 1/32 inch wall thickness, 1/4 inch outer diameter. The tubing shall also be highly abrasion resistant and have a smooth bore.
3. New Pavement Loop Cable: Shall be prefabricated and designed to be overlaid with hot asphalt or embedded in Portland cement concrete. The loop cable and assembly shall be capable of direct placement under asphalt overlays or concrete pavement without need for additional tubing. Each component of the prefabricated loop assembly, including the loop, the lead-in cable and the splice enclosure, shall be designed to resist moisture penetration and to continue functioning under minor pavement cracking. The cable may be around 0.36 inch O.D. and shall be made with such material as to ensure long, trouble free life. Splices are allowed only inside the handhole. All other connections shall be factory connected and sealed.
4. The Contractor shall obtain Engineer's field verification of all loop locations prior to beginning of construction.
5. If the prefabricated loop detector is destroyed before, during or after the paving operation, it will be replaced with another prefabricated loop detector even if this entails the removing of several panels of concrete. Cost of replacement shall be the responsibility of the faulty party and no cost will be borne by the City.
6. Existing Pavement: Inductive loops consisting of three turns (four turns for back loops) of wire shall be saw-cut in the pavement, with the width of cut being 3/8 inch and with a depth of 2 1/2 inches to 2 3/4 inches deep. Sharp (120 degree or less) corners shall be provided with an additional diagonal saw cut as shown in the plans. All saw cuts shall be overlapped sufficiently so that a full 2 1/2 inch to 2 3/4 inch depth of cut results around the entire perimeter of the loop. For each additional turn of wire, 1/4 inch of depth shall be added to the saw cut. Generally, all front loops have three turns and all back loops have four turns of No. 14 AWG wire unless otherwise shown on plans or determined by Engineer during construction of the loop.
7. For curbed streets, the saw cut shall be extended to the gutter line and a hole shall be drilled through the gutter line toward the handhole. No saw cut will be allowed into the curb face. For non-curbed streets, the saw cut shall extend to a hole drilled near the edge of the pavement as shown on the plans. A length of 3/4 inch diameter PVC conduit shall be inserted and sealed into the drilled hole from the outside edge of the pavement.
8. Prior to placement of wire, the saw cut shall be clean and free of water and all foreign materials that may cause premature failure. Loop wire, encased in plastic vinyl tubing, shall be placed in the finished cut.
9. Short pieces of backer rope of 3 to 4 inches shall be used, where necessary, to assure that the loop wire will remain at the bottom of the saw cut and not float up into the sealant. Lead-in wires outside of the loop shall be twisted approximately one turn per foot. All wire installation must be made without damage to the wire or its insulation. All damaged wire shall be replaced.

10. Loop testing completed in accordance with Article 2505.03, F, 6 of the Standard Specifications. During saw cut and prefabrication loop testing, the City of Waterloo, the Contractor, and/or Engineer shall be present during all testing procedures. Any loop that tests below the 100 mega ohms value shall be considered to be a faulty loop and shall be replaced.
11. After obtaining satisfactory test results, the loop shall be sealed with Pro-Seal 6006 EX, Ruscoe Q Seal 290S, 3M Detector Loop Sealant 5000 or approved equivalent. If an approved equivalent is used, it must be approved by the City of Waterloo's Traffic Operations Department. The sealer shall be used strictly in accordance with the manufacturer's instructions. If sealant is placed below recommended manufacturer's temperature requirements, i.e., placement during late fall and winter, the loop shall not be accepted until the outside air temperature is at or above the manufacturer's temperature. The sealer shall be poured into the slot to half depth. When both the loop and lead-in slots are half-filled, check for air bubbles or material pileup and then proceed to fill the slots to roadway level. Excess sealant shall be removed by means of a "Squeegee."
12. In all cases, there shall be neither a trough nor a mound formed. The sealer, when poured into a saw cut, should completely surround the wire, displace all air therein and completely fill the area of the slot, except for that portion filled with the wire hold down material. Allow sufficient time for the sealer to harden in accordance with manufacturer's instructions before allowing traffic to move over the area.
13. The saw slot filler shall be a two-component system, high viscosity liquid or approved equal formulated for use in sealing inductive wire loops and leads embedded in asphalt concrete and Portland cement concrete. The saw slot filler shall be useable on grades of 15% or less without excessive flow of material, unless otherwise approved by the Engineer.
14. The Engineer will approve the sealer. Approval of other sealants shall be based on Specifications and/or test data about their physical properties, performance properties and chemical resistance. The cured sealer shall be unaffected by oils, gasoline, grease, acids and most alkalis. The mixing of components and the filling of the cut shall be in accordance with the directions of the manufacturer.
15. After completion of the sealing, the loop shall be final tested, as described in paragraph above. Completed sealed loop must pass continuity and resistance test prior to being accepted.
16. Loop Splicing: The electrical splice between the loop lead-in cable to the controller and the loop wire shall be soldered using dipped or resin core solder and provided with a watertight protective covering for the spliced wire, the shielding on the loop lead-ins and the end of the tubing containing the loop wires. No torch soldering will be allowed. Remove the insulation from each conductor of a pair of lead-in cable conductors for 1 inch and scrape both copper conductors with knife until bright. Remove the plastic tubing from the loop wires for 1 1/2 inches. Remove the insulation from the loop wires for 1 inch and scrape both copper conductors with knife until bright. Solder the loop wires together where needed for series connection and to the lead-in wires and cover with a wire nut twisted on tightly. Cover the exposed shielding, drain wire and wire nut splices with a fast-drying brush-up type sealant and bonding compound manufactured for this purpose to protect surfaces against moisture, corrosion and other contaminants. The compound shall withstand Iowa's extreme weather conditions. Any unused loop lead-in wire shall have the end of it also covered with the appropriate product designed and manufactured for this purpose.

## V. Luminaires.

1. Unless otherwise shown or modified on the plans, the luminaires shall meet the requirements listed under this section.
2. Luminaires shall be Philips Lumec RFM-108W32LED4K-T R3M DMG RCD PH9 BK, Acuity

- Brands ATB2-40BLEDE70-MVOLT-R3-BK or Engineer-approved equivalent meeting the following requirements:
- LED 120-277 Multi-Tap
  - Type III Light Distribution
  - Photocell Receptacle (Empty)
  - 100-130 Lumens Per Watt
  - 3700-4000K Light Temperature
  - Lights Shall Not Require Separate Power Supply or Driver
  - Shall be Finished to Meet Pole Color
  - Minimum 50,000 Hours at 70% Lumen
3. Maintenance Luminaire shall be finished to match color and style of pole.
  4. Supplier shall provide a catalog cut sheet of luminaire for review by WTOD prior to acceptance.
  5. Luminaires shall be installed for operation on 240 volt AC, single-phase, 60 Hz.
  6. Each luminaire shall be complete with EEI-NEMA Standard through terminal polarized, twist-lock type photoelectric control receptacle with shorting caps on all luminaires. Photoelectric control for the intersection shall be installed in the controller cabinet.
  7. Where a photocell is to be installed, the Contractor shall verify that the luminaire photocell is operational prior to installation.
  8. Individual luminaires shall be provided with molded in-line fuse connector within the mast arm pole base and be sized to fit the conductors. Fuses shall be 10 ampere cartridge type. The neutral conductor shall not be fused.
  9. Street light connectors shall be used for all luminaire cable connections. Split bolts shall not be used.
  10. The photoelectric control turning "ON" and "OFF" roadway luminaires shall be in accordance with the following:
    - The photoelectric controls shall be of a solid-state crystal sensing type with an inverted turn-on and turn-off design and shall meet the design and quality requirements specified in the current acceptable standards to ANSI C136.10. The device shall have surge protection conforming to the requirements in the current acceptable surge protection ANSI standards.
    - The voltage rating of the control device shall be multi-voltage operating properly over the input voltage range of 105 to 285 volts, 50-60 Hz, alternating current with no change in the turn-on and turn-off foot-candle values, and a maximum total drift of not more than 1 percent over 10 years.
    - The control device shall have a minimum 30 second time delay to eliminate false operation due to lightning or stray passing lights, shall provide fail-safe operation (the light supply shall remain "ON" if the control circuit fails), and shall be equipped with an arrester for built-in transient surge protection.
    - The "TURN ON" level of the control device shall be 3.0 foot-candles at the appropriate voltage; the "TURN OFF" level of the control device 60% of the turn-on value.
    - An "ON-OFF" switch shall be provided inside each controller cabinet that controls power to all lighting circuits at that intersection.

**W. Reflectorized Street Name Signs.**

1. Length and Width: Sign length and width are determined based on the street name, letter size

- and type. Street name signs mounted overhead shall use 12 inch Upper Case and 9 inch Lower Case lettering. The substrate shall be aluminum, 6061-T6, 0.10 inch minimum thickness or of material specified on the plans. The nameplate shall have a minimum length of 48 inches. The sign length shall be in 6 inch increments.
2. Un-mounted faces shall be shipped 1/4 inch wider and with 1/4 inch longer than the required width and length. The face shall be registered in the lower right corner with right and bottom border correct (3/4 inch) and the extra 1/4 inch at the top and left edge. Corners of the mounted nameplate shall be rounded (radius of corner must correspond to border radius) or as specified on the plans.
  3. Reflective Sheeting: The sign face shall be made from Type III or Type IV prismatic type retro-reflective sheeting.
  4. Processing: When screen processing, transparent screen process color shall be coated with a clear finish. Screen processed opaque black color need not be clear coated. All screen processing and clear coating shall be in accordance with the recommendations of the sheeting manufacturer. Sign faces may be produced by direct application of cutout copy onto mechanically applied background in accordance with sheeting manufacturers' recommendations.
  5. Application: For mounted signs, reflective sheeting shall be applied to sign blades that have been properly prepared. The sign faces shall be applied using the heat-vacuum process or squeeze roller application in accordance with the recommendations of the sheeting manufacturer.
  6. Letter Design: Standard abbreviations for street, avenue, boulevard, etc., shall be used following the street name or number. Legend shall optically be spaced and centered, both horizontally and vertically. The charts for standard alphabets (capital or upper case) for highway signs for letter design and spacing shall be used.
  7. Border: The border shall be 3/4 inch wide with 2 1/4 inch radius corners set on a square corner. The dimension between the inside edges of the border vertically and horizontally shall be 16 1/2 inches wide by 1 1/2 inches shorter than the chosen length of the sign blade.
  8. Shop Drawings: Submit a sign layout shop drawing for each different mast arm-mounted street name sign for review and acceptance prior to sign fabrication.

### **157120.03 SALVAGED MATERIALS.**

- A. All existing signal materials and equipment not listed in the Special Provisions and which are not being incorporated into the final project shall be salvaged by the Contractor and stockpiled on the project site for pick up by WTOD personnel. Such items will remain the property of the City. Existing traffic signal equipment and materials to be salvaged include:
  - Galvanized poles and mast arms
  - Signal heads and signs mounted on signal poles or mast arms
  - Signal controller(s)
  - Pedestrian push buttons
  - Conduit
  - Handholes
- B. Among items to be properly disposed of by Contractor shall include:
  - Traffic signal pole footings – whole or partial – to be removed.
  - Old street name signs to be removed.
  - Painted poles and mastarms to be removed.

**157120.04 TRAFFIC CONTROL.**

It shall be the Contractor's full responsibility to set up and maintain traffic control that is in compliance with the MUTCD and Iowa DOT Standard Road Plans.

**157120.05 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.**

- A.** The Traffic Signalization work includes all traffic signal system components, interconnection system, luminaire pole extensions and luminaires which are mounted on the traffic signal poles, as detailed on the plans and described in these Special Provisions, to provide a fully operational system. Unless listed as a separate bid item, no other payment will be made for work covered by the Special Provisions, but all work will be considered to be included in the lump sum price for Traffic Signalization. Contractor shall provide a breakdown list price for all items on Lump Sum traffic Signalization bid items immediately after a contract is signed or within a period specified on the plans.
- B.** Compensation to the Contractor for all work covered by these Special Provisions shall be made at the Contract Lump Sum price for the signal system installation, complete, in place, and operating. No measurement or payment of individual traffic signal items will be made except for purposes of progress payments. The Contract Lump Sum payment shall be full compensation for all items of work and no separate payment for any individual items will be made.