SP-232022a
(Replaces SP-232022)

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Black Hawk County
STP-A-8155(784)--86-07
STP-A-8155(785)--86-07

Effective Date
August 19, 2025

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

A. GENERAL

1. Scope

These Specifications 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 Signalization Special Provisions, all work including equipment, material, and installation, shall be in accordance with the appropriate Standard Specifications. Where reference is made to the codes, standard specifications, supplemental 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.

2. Definitions

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

- City means City of Waterloo, Iowa, or its representatives.
- WTOD 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 starts the action.
- LED means light emitting diode.
- IP means Internet Protocol.
- APS means Accessible Pedestrian Signals.

3. Related Specifications and Standards

The Contractor shall comply with all the standards listed below unless otherwise modified elsewhere by contract documents:

- ANSI Standards.
- ASTM Standards.
- EIA Standards
- IMSA Standards.
- ITE Standards.
- MUTCD.
- NEC.
- NESC.
- NEMA Standards.
- UL Specifications.
- TIA Standards.
- TIA/EIA 568
- NTCIP (The National Transportation Communications for Intelligent Transportation System Protocol).
- All pertinent local, state, and federal laws and regulations covering installation, material, design, construction, and operation.

The Contractor shall notify the Engineer in writing of any discrepancy or ambiguity as to the intent or meaning of the contract documents before starting to work on that area. The Engineer will supply the Contractor in writing with the intent. The decision of the Engineer will be final and conclusive.

B. MATERIALS AND CONSTRUCTION

The contract work shall comply with the applicable requirements of the Standard Specifications, in particular the following parts:

- Section 2525: Traffic Signalization
- Section 4189: Traffic Signal Equipment

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.

1. Actuated Traffic Signal Controller

General Requirements

The controller shall provide full reporting capabilities via open NTCIP protocols to any Advanced Traffic Management System (ATMS) that supports such protocols. All licenses, if required, for communication with a central control system shall be provided by the Contractor. The controller unit shall be compatible with NEMA TS 2 functional requirements, ensuring interoperability with NEMA TS 2 devices when required.

Standards Compliance

The traffic signal controller shall meet or exceed the applicable standards for ~~Advanced Transportation Controllers (ATC)~~ TS-2 Type 1 traffic signal controllers as mandated by ITE, AASHTO, and ~~NEMA under the ATC 5201 v06 Standard for~~ NEMA's current edition Standards Publication TS2-2003 v02.06 Traffic Controller Assemblies with NTCIP Requirements.

The controller engine board and operating system shall be fully compliant with the ITE/AASHTO/NEMA ATC 5201 v06 Standard, supporting Linux-based operating systems as specified.

The controller shall:

- Support NTCIP communications protocols
- Be fully field-programmable
- Support both actuated and coordinated operations, including time-of-day (TOD) plans and preemption

Hardware Requirements

The Controller CPU Module shall meet the following minimum specifications:

- Processor: 1 GHz minimum
- Memory: 2 GB RAM minimum
- Storage: 8 GB non-volatile storage minimum
- Networking: At least two Ethernet ports (10/100/1000 Mbps)
- Data Transfer/Updates: USB ports for data transfer and software updates
- Local Interface: Front-panel display and keypad for local programming and diagnostics

Documentation and MIB Files

The Contractor shall provide all NTCIP Management Information Base (MIB) files associated with the controller software, including both manufacturer-specific and extended objects necessary for full integration with ATMS and/or central control systems.

2. Traffic Signal Cabinet

The traffic signal controller cabinet shall be a ~~Type ATC~~ fully operational and functional NEMA TS2 Type 1 cabinet ~~designed to meet the latest ATC Standard, ITE ATC 5301 v02, and support~~ that is fiber optics ready and NTCIP ~~1202 v03 protocols for traffic signal operations and communications~~ ready and shall meet or exceed all requirements of the contract documents. ~~The cabinet shall be constructed per ATC cabinet design standards and include full provisions for modern signal operations, robust communications, and future system upgrades.~~

~~The cabinet shall provide physical and electrical isolation between high-voltage power components and low-voltage control and communication systems. All high-voltage components, including load switches, flashers, and power service equipment, shall be in a designated compartment separated from the controller and MMU/CMU logic modules by protective barriers.~~

~~The cabinet shall be constructed of aluminum, weatherproof, UL-listed, and designed for NEMA Type 3R or better environmental protection.~~

The controller cabinet shall include everything for ~~ATC~~ TS2 operations, such as bus interface units (BIU), power supplies, MMU~~/CMU~~, necessary 2-channel detector cards, and all other necessary components. Cabinet shall come with mounted 110 V power strip with at least four ~~110v~~ outlets and mounted 100/10 hardened managed Ethernet switch with at least five outlets. All external communications to the cabinet's components shall be through the Ethernet switch.

~~If an internal Fiber Optic Patch Panel is installed, it shall not block access to internal components of the control cabinet.~~

All conduit openings in the controller cabinet shall be sealed with a sealing compound. This compound shall be a readily workable soft plastic, except those provided for drains. It shall be workable at temperatures as low as 30°Fand shall not melt or run at temperatures as high as 300°F.

~~The ATC cabinet shall be dust-proof, weatherproof, and constructed from high-grade aluminum, providing secure and durable housing for the ATC equipment and terminal facilities. The cabinet shall include all necessary anchor bolts for installation.~~

~~A 15 AMP GFCI duplex receptacle and an interior LED work light with an on-off toggle switch shall be provided. The receptacle and work light shall be fused ahead of the cabinet's main circuit breaker to allow service when the cabinet breaker is off.~~

~~The cabinet shall include an Input File (detector rack) capable of supporting 8-phase operation plus a minimum of four preemption inputs.~~

~~A 12-position load bay shall be provided and populated with solid-state load switches meeting ATC cabinet requirements. Load switches shall be appropriately installed based on the signal phasing configuration.~~

~~The cabinet shall be fully compliant with the ITE/AASHTO ATC Cabinet Standard and capable of~~

~~supporting 48VDC logic-level operation while switching standard 120VAC signal indications.~~

Controller cabinets shall be dust proof, weatherproof and made from high-grade aluminum to furnish housing for the control equipment and terminal facilities. Anchor bolts shall be included. A gasket panel police door shall be provided with police lock, two keys, flash switch and signal shutdown switch. A 15 amp GFCI duplex receptacle and lamp base with on-off toggle switch shall be provided. Outlet and lamp shall be fused ahead of the cabinet circuit breaker. The detector rack(s) shall be capable of 8-phase operation plus four pre-emption channels. The 12-bay load switch shall be provided and loaded appropriately.

Maintenance Switches. Inside the cabinet shall include properly rated and of good quality stop time control, timer power, flash, and detector test switches.

The stop time control switch will be a three-position switch labeled MANUAL-OFF-NORMAL. The center off position will allow the controller to cycle normally during flash.

The flash switch shall let the controller continue to operate within the cabinet for field evaluation of the controller.

The lowest field connection shall be at least 3 inches from the bottom of the cabinet. The anchor bolts shall be secured with nuts which shall not have more than three full threads exposed or interfere with field connections. The field terminals shall attach to the controller cabinet with color coded Y, R, G and B electrical spring wire connectors. Connectors shall be designed flexible and durable with an outer insulator providing a compact, fully insulated connection without cutting or abrading wires. The four spring connectors shall have a corrosion resistant steel inner shell to strengthen them while permitting spring expansion and contraction due to temperature changes. The connector shall have a deep, flared skirt to protect against shorts and shiners. The connector shall have a flexible base to allow the connector to bend with wires.

The field terminals shall connect to the controller cabinet with standard screws. Lug terminals will not be accepted.

No hardware or terminal facilities shall be attached to the cabinet door, excluding an intersection call/display panels and test switches ~~when~~ as required.

Two ~~hard copies and one electronic copy of~~ cabinet electrical prints shall be provided for each cabinet. ~~Electronic copy in PDF and DWG formats are preferred.~~

Where the cabinet seats on the concrete base, the bottom edge of the cabinet shall be waterproofed. Appropriate silicone sealing caulk shall be applied to the mating surface of concrete at a minimum bead diameter of 1/2 inch to 3/4 inch before installing the cabinet so that when the cabinet is being installed, securing anchor bolts provide for even and uniform spreading of the sealing material. The underside of the cabinet flange shall be free from any foreign objects, washers, spacers, etc., before caulking procedure.

All cabinet and police door locks shall use a standard key and standard skeleton key. The police panel flash switch shall be wired such that when it is switched to “flash” the controller will return to its initialization point and remain there until turned off flash.

All load switches shall conform to the triple-circuit solid-state type load switch as specified in the NEMA standard “TS2-6.2 Three-Circuit Solid State Load Switches”. Load switches shall have LED input and output indications. LED indications shall be provided to reflect the DC driver state for red, yellow and green. The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights or conflicting signal indications. All internal components shall be accessible without encapsulation.

~~The ATC cabinet shall be designed to accommodate standard NEMA TS 2 Section 6.2 3-circuit solid-state load switches with LED indicators. Load switches shall be easily replaceable, front-accessible, and fully compatible with the cabinet's output load bay design.~~ Power supply loads shall be metered.

Any load switch circuit supplying power to a single indication with the exception of a red light shall

have a ballast resistor attached inside the cabinet. A 10 watt or greater, 3000 ohm resistor shall be adequate.

Each circuit shall be a 10 ampere rated driver, LED lamp load at 120 VAC.

Streetlights on traffic signal poles (combination poles) shall be fed through signal cabinet and shall be on its own circuit with photocell inside traffic cabinet and vandal protection photocell cover. The power inside one pole should all come from the same source so there is no question as to where to turn it off.

Cabinet Surge Protection

Circuit Breaker: Provide an AC power surge protective device (SPD) on the load side of the cabinet circuit breaker. The SPD shall be a UL 1449 3rd (or latest revision) Edition Recognized device that is rated for a maximum operating current of 15A or greater. The SPD must be equipped with a maximum continuous operating voltage (MCOV) of 150V, L-N, L-G, and N-G modes of protection, voltage protection rating (VPR) of 700V or less, nominal discharge current rating (In) of 20kA, a short circuit current rating (SCCR) of at least 50kA, visual indication (LED) of operational status, and Form C dry contacts.

Loop Detector: Provide modular type surge protective devices comprised of a silicon breakover device for all loop detector signal inputs. The device shall be rated for a nominal voltage of 75VDC and equipped with a minimum surge current rating of 250A.

Load Relay: Provide surge protective devices comprised of metal oxide varistors (MOV) for all load relay outputs. The SPDs shall be rated for a nominal voltage of 120VAC, equipped with a surge current rating of 39kA.

Low Voltage Communication Inputs: Provide modular type surge protective devices comprised of three-stage hybrid technology protection consisting of gas discharge tubes (GDT), silicon avalanche diodes (SAD) and positive temperature coefficients (PTC) for all low voltage communication inputs. The SPDs shall be UL 497B Listed and equipped with a surge current rating of 10kA

120VAC Interconnect Signal Lines: Provide surge protective devices comprised of gas discharge tubes (GDT) for all 120VAC interconnect signal lines. The SPDs shall be equipped with a surge current rating of 10kA.

low Voltage (DC Power) Input Circuits: Provide modular type surge protective devices comprised of three-stage hybrid technology protection consisting of metal oxide varistors (MOV), silicon avalanche diodes (SAD) and series inductor for all low voltage (DC Power) input circuits. The SPDs shall be UL 497B Listed, equipped with a surge current rating of 10kA, and a continuous current rating of 5A.

Coax Video Cables: Provide surge protective devices consisting of gas discharge tubes (GDT), silicon avalanche diodes (SAD) and positive temperature coefficients (PTC) on all coax video cables. The SPD shall be equipped with s surge current rating of 20kA, and an isolated ground.

Isolation transformer ~~shall~~ to allow operation with a single point short between loop and ground. The MSD harness wiring shall all be terminated on a separate dedicated termination panel.

All incoming service voltage connections (including breakers) shall have clear plastic protective shielding covers.

Unless otherwise shown on the plans, the supplier shall install one 20 AMP breaker, 1-pole for traffic signals, one 30 AMP, 2-pole breaker for lighting, one 60 AMP, 2-pole breaker for main conductors inside each cabinet.

The controller cabinet shall have installed a disconnect panel box, which will shut power off to all circuits inside the cabinet. The disconnect panel box shall be wired as shown on the plans. The cabinet shall come with an installed disconnect breaker panel and shall be connected as per the traffic signal schematic on the project plans. ~~The cabinet disconnect breaker panel shall be rated for outdoor use (NEMA 3R minimum), sized appropriately, and from one of the following manufacturers:~~

~~GE, Square D, or Eaton/Cutler Hammer.~~ Disconnect breaker panels shall be G.E. model TL412C metal 4 circuit (9 inch by 7 1/2 inch by 3 inch), Square D model 1-Q06-12L100S metal 6 circuit (13 inch by 9 inch by 4 inch), Cutler Hammer BR48L1258P (13 inch by 11 inch by 3.5 inch) or approved equal.

Installation Inside ~~ATC~~ Traffic ~~Control~~ Signal Cabinet

The installation within the ~~ATC~~ traffic ~~control~~ signal cabinet shall meet the following requirements:

Street Lighting Equipment:
- Street lighting equipment is **not** installed inside ~~ATC~~ traffic signal ~~control~~ cabinet except for photocell street light control relays.
- Electric contactors shall be installed in an auxiliary enclosure behind a transparent protective cover to prevent accidental contact with live electrical parts.
- The contactors shall be mounted away from any cabinet door and in locations that protect them from environmental elements like rain and snow.

Fiber Termination Center:
- Fiber optic jumpers connected to the fiber termination center shall be securely mounted so that they do not interfere with the cabinet door when closed.
- Proper cable management and strain relief shall be provided to prevent damage to the fiber optic cables.

Detector Rack:
- All components installed in the detector rack shall be readily accessible for maintenance and replacement.
- No other equipment or components shall be mounted directly in front of the detector rack to ensure unobstructed access.
- Replacing or servicing components within the rack should not require the removal or relocation of other cabinet-mounted equipment.

Programming:
- All components needed for proper operation of signals shall be properly programmed to ensure the fully functional operation of the ~~ATC~~ system.
- The programming shall include, as a minimum, the following elements:
  - Basic signal controller timing and coordination
  - Vehicle detection systems (e.g., cameras, loops, radar)
  - Emergency vehicle preemption functionality
  - Fiber optic or radio network connections for remote monitoring and control

3. Traffic Signal Control System

The traffic signal control system shall be capable of adjusting traffic signal coordination within a corridor or network by sensing fluctuations in traffic flow and modifying signal timings accordingly. Timing changes may be commanded through a central application residing on a server or occur peer-to-peer between signals directly. Communications shall use NTCIP protocols.

The system shall dynamically adjust traffic signal timings based on real-time traffic conditions to optimize signal operations within a corridor or network in response to fluctuating traffic demands. The system shall include installed and integrated detection hardware, central management software, and new ~~ATC~~ NEMA TS2 signal controllers and shall comply with applicable NTCIP and MUTCD standards.

System Requirements

The system shall consist of the following major components and capabilities:

Central Management Software: A traffic management application capable of monitoring real-time traffic conditions, allowing manual override of automated functions when necessary, and storing historical performance data. The system shall provide a fail-safe mode in case of communication

loss, wherein the controllers revert to either a predetermined timing plan or a plan based on historical data.

Communications and Data Interface: All data transmissions shall be encrypted and comply with current industry cybersecurity standards. Communications between field devices and the Central Management System shall utilize NTCIP 1202 or later protocols over secure fiber optic cable or wireless systems. The system must support remote diagnostics and firmware updates.

Detection: The detection system shall be of the type recommended by the Traffic Signal Control System manufacturer to ensure compatibility and robust performance under various traffic conditions. If no recommendation is provided, radar detection is preferred. Detector placement shall be designed by the Contractor as required by the system to accurately capture traffic volumes, speeds, and other parameters. Sensors shall have an accuracy of ±5% or better for volume and speed measurement and must operate continuously in harsh environmental conditions.

~~ATC~~ NEMA TS2 Traffic Signal Controllers: As specified in the contract documents.

Signal Controller Interface: The Traffic Signal Control System shall send and receive commands to and from ~~ATC~~ NEMA TS2 traffic signal controllers and adjust timing plans dynamically. It shall interface with ~~ATC~~ NEMA TS2 controllers supporting NTCIP-compliant communications protocols for remote programming and data reporting.

Functionality: The software shall monitor real-time traffic conditions, display performance metrics such as queue lengths and delay times and allow operators to adjust system parameters.

User Interface: The user interface shall be intuitive, provide English-language menus and/or graphical user interface, include graphical displays of intersection performance, historical trends, and system alerts.

Data Logging: The system shall count volumes, speeds, and other parameters required by the Traffic Signal Control System to automatically implement timing plans suitable for traffic conditions. All events and data shall be logged for at least 90 days, and the system shall be capable of producing reports.

Integration: Installation and integration of all components such as detection hardware, communications modules, and interface units on the signal controller cabinet shall be completed in accordance with manufacturer recommendations. The system shall be fully functional with communications established between the central control and the signal system.

Functional Testing and Validation: The Contractor shall conduct a complete system test, verifying detector accuracy, communication integrity, and proper execution of adaptive timing plans. System performance shall be validated by comparing actual traffic conditions with system calculations during a peak hour and an off-peak hour of operation. Programming parameters shall be adjusted, as necessary. A report and certification shall be prepared confirming the system is fully functional and that collected data closely matches actual street conditions (e.g., volumes collected by the system compared to actual volume collected independently).

Documentation: Provide comprehensive documentation of installation, calibration, configuration, and commissioning procedures, including baseline data and performance reports. All necessary software and training shall be provided to enable the City of Waterloo to define a group of signals as a system, configure it, and make it operational.

Training: The Contractor shall provide training sessions for Waterloo traffic engineers and maintenance personnel covering system configuration, operation, troubleshooting, and software updates.

System Configuration: The Contractor shall provide all tools needed to configure the system, including software, training materials, reference manuals, and documentation. The Contractor is responsible for the initial configuration but must provide sufficient training and tools so local staff can configure or reconfigure the system as needed for acceptance.

Technical Support: A dedicated technical support line shall be available during the warranty period

to address any system issues.

System Capabilities: The system shall allow the operator to define a corridor, segments of a corridor, or a network of two or more arterials to be grouped, controlled, and timed together as one system. The system shall allow the operator to set and adjust conditions for fine-tuning and optimizing operations.

Licenses: All licenses to install, use, and operate the system for at least 5 years shall be included.

Warranty

The hardware, software, and all components shall be warranted for a minimum of two years from the date of installation. The warranty shall cover defects in materials and quality under normal use and service conditions.

Maintenance

The vendor shall provide a detailed maintenance plan, including recommended inspection intervals, calibration procedures, and software update protocols. Preventive maintenance visits shall be scheduled at least semi-annually.

Submittals

- Product data sheets, including performance specifications and wiring diagrams.
- Software interface descriptions, including algorithm logic for signal timing adjustments.
- Functional Testing and Verification Report.
- Field Demonstration Plan and Commissioning Procedures.
- Training guides, system settings, and operator manuals.

4. Ethernet Switch

The Ethernet switch shall be NEMA TS2 compliant and support the open standard protocol Terminal Access Controller Access-Control System Plus (TACACS+). It shall provide 16 10/100Base-TX Ethernet ports and four Gigabit RJ45/SFP Combo Ports, designed for reliable operation in harsh traffic cabinet environments.

The switch shall meet the following requirements:

Port Configuration and Network Performance

- At least eight IEEE 802.3at (PoE+) ports with a minimum 120W PoE power budget to support IP cameras, wireless devices, and sensors.
- Minimum of two SFP ports supporting optical fiber connectivity.
- Non-blocking switching fabric of at least 11.2Gbps to ensure high-speed data transmission.
- 1.5 Mbytes shared memory for packet buffering and 9 Kbytes jumbo frames for efficient large data packet transfers.

Industrial-Grade Reliability and Environmental Protection

- Wide operating temperature range: -40°C to 75°C.
- High electromagnetic compatibility (EMC), compliant with IEC 61850-3 / IEEE 1613 / EN 61000-6-2/4 standards.
- Real hardware watchdog for automatic system recovery in case of software failure.
- Multiple event dry relay output alarms and digital inputs for remote monitoring and fault detection.

Network Redundancy and Layer 2+ Features

- Redundant ring, RSTP (IEEE 802.1w), MSTP (IEEE 802.1s), and Super Chain for enhanced network redundancy and failover protection.
- IEEE 802.1Q VLAN, Private VLAN, trunking, DHCP server/client, traffic prioritization, and forwarding rate control for optimized Layer 2 network performance.
- Layer 2+ packet filtering with MAC-based filtering and TCP/UDP/ICMP filtering for enhanced

security.

Security and Management Features

- Advanced network security including MAC security, IEEE 802.1X port-based access control, and RADIUS authentication.
- Full device management capabilities:
  - SNMP v1/v2c/v3
  - RMON (Remote Monitoring)
  - Web-based UI
  - Telnet and local console access
  - Support for industry-standard OpenFlow, NetFlow, or SDN compatibility for vendor-neutral network management.
- Management platform shall allow network operators to easily pinpoint and troubleshoot issues remotely.

5. Loop Detector Amplifiers

Acceptable amplifiers can be any of IDC, Sarasota, EDI, or Reno brands. The detector card rack shall also accommodate video detection cards when necessary.

Detectors shall have the capability of operating in “pulse” or “presence” mode, “delay” timing on each channel, adjustable in 1 second increments or less, and “extension” timing on each channel, adjustable in 0.5 second increments or less.

6. Traffic Signal Uninterrupted Power Supply

SERVICE ENCLOSURE:

- Service enclosure shall meet Electric Utility Service Equipment Requirements Committee
- (EUSERC) requirements.
- Service enclosure shall be fabricated from minimum 1/8 inch aluminum.
- Interior of service enclosure shall be fabricated from minimum 14 gauge cold rolled steel and painted white.
- Service enclosure shall be anodized aluminum.
- Service enclosure shall have continuous welded seams.
- Service enclosure shall have full length deadfront with stainless steel hinge.
- Service enclosure shall be in accordance with UL 508A standards for industrial control panels and labeled for service entrance equipment.
- Service enclosure shall have pull section with removable step.
- Service enclosure shall have fully framed side hinged outer door with swaged close tolerance sides for flush fit with top drip lip and closed cell neoprene flange compressed gaskets.
- Service enclosure shall have hinged deadfront with 1/4 turn latch and knurled knobs.
- Deadfront door shall be hinged on the same side as exterior door and open a minimum of 100 degrees.
- Removable backpan shall be mounted on four welded 1/4 inch studs.
- All circuit breakers shall be mounted in a vertical position, handle up for “On” handle down for “Off.”
- Circuit breakers shall be of cable-in cable-out type.
- Service enclosure shall consist of absolutely no “Bolt-On” or “Plug-In” circuit breakers.
- Service enclosure shall be completely prewired in the factory.
- Wiring should be to NEMA IIB standards showing external connections and external equipment.
- All bussing shall be UL approved copper THHN cable bussing, fully rated.
- The function of all circuit breakers, switches and other components as required shall be identified by laminated engraved plastic nameplates with minimum 1/4 inch letters fastened with minimum of two #4-40 stainless steel machine screws.
- Wiring schematics shall be Computer Aided Drafting and include all external equipment and

connections per NEMA IIB.
- As Built factory drawings shall be laminated and affixed to the inside of the outer door.
- Manufacturers shall be required to furnish independent laboratory certification of metal preparation and finish and to confirm that the overall product meets these specifications. If this agency wishes to witness this testing, all costs to be paid by Contractor.

ENCLOSURE SPECIFICATIONS:

Aluminum weatherproof enclosure shall house BBS and batteries. Enclosure shall be TIG welded construction with welding materials specifically designed for the material to be welded. Enclosure shall have fully framed side hinged outer doors with swaged close tolerance sides for flush fit with drip lip and closed cell neoprene flange compressed gaskets. Front door shall incorporate a full-length piano hinge, Type II keyed lock, pad-lockable draw latch (center area on door-latch side), and a pad lockable welded-in place vandal-proof tab, rated at 2000 lbs. There shall be no exposed nut, bolts, screws, rivets, or other fasteners on the exterior of the enclosure. ~~Maximum cabinet dimensions 46 inches H by 20 inches W by 10.25 inches D.~~ Weight 300 pounds with batteries. BBS shall be mounted in an interior tilt out housing with 800 pound rated stops. Battery connectors shall be Anderson Connectors with silver plated contacts. Batteries shall be installed in fixed position framed shelves for seismic safety and be readily accessible for maintenance. Batteries shall be mounted allowing airflow front and back. Enclosure can include two transfer bypass switches, one for BBS bypass the second for auxiliary generator (optional). All switches must be panel mounted on interior dead front panel board. UV resistant plastic laminated nameplates shall identify all controls and major components. A plastic covered wiring diagram shall be attached to the inside of the front door. All components shall be factory wired and conform to required NEMA, NEC, and UL standards. A chassis ground point shall be provided. Panel shall be UL 508 Industrial Control Panel rated and must meet the following specifications.

BBS PANEL MINIMUM FEATURES:
- Typical run time is six to twelve hours full operation, based on the actual load.
- BBS bypass and BBS isolation switch.
- Deadfront safety panel board with all switches and plugs pre-wired with phenolic nameplates.
- All nameplates shall be phenolic engraved type.
- All wire terminating lugs shall be full wrap around type.
- All batteries shall be captive spaced from external captive sides in earthquake proof shelving.
- Cabinet ventilation shall be by two 4 inch by 1/4 inch louvers top and bottom with encapsulated bug screens, cleanable filters and a 100 cubic feet per minute fan to completely exchange air 25 times minimum per minute.
- All DC terminals and connections shall incorporate safety covers such that the safety covers are in place for every normal maintenance mode.
- Event Counters and Total Run Time Counter.

BBS UNIT MINIMUM SPECIFICATIONS:

BBS unit shall provide a true sine-wave output with minimum 2000 Volt-Amp continuous capacity. BBS must provide for utility service isolation when in operation. The minimum rating for wattage output shall be 1200 watts. The BBS shall be capable of running an intersection with LED lights (for Run Time consult manufacturer). The unit shall operate off-line, with transfer time of 2 to 4 ms or less, with battery condition indicator, with automatic test provisions, and with hot-swappable batteries (all batteries in system). BBS shall automatically recharge batteries from full discharge to 90% capacity within 8 hours. BBS shall provide on-line operation for a minimum input of 90 to 150 VAC, provide full load output of 120VAC – 10% / +4% at 60 Hz +/- 0.05% over a temperature range of -34.6°F(optional adder) to 165.2°F and conform to and be based on a UL Approved Design.

For safety and maintenance, the inverter shall not exceed 40 pounds. The BBS unit shall be delivered with maintenance manuals.

BBS UNIT MINIMUM FEATURES:

- 2KVA 1200 Watts, with quick make/break connectors and plugs. (Systems requiring hard wiring termination to/from the inverter are unacceptable).
- Surge energy - Per IEEE 62.41 (formerly IEEE 587)
- Common mode clamping 0 ns < 5ns typical UL 1449
- Conditioned power – Computer quality
- Transient lighting protection – Per IEEE 62.41 (formerly IEEE 587)
- Transfer to battery time – 2 to 4 ms
- Retransfer to utility – 2 to 4 ms
- Each battery shall be 24 volts at 18 AH with heavy duty Anderson plugs connections to the BBS for greater system reliability and ease of maintenance. Series wiring is unacceptable.
- Fan cooling shall be fused for locked rotor current.
- Cooling air shall be ducted to cool the front and back of each battery with air space on all four sides and top of battery.
- Inverter covers shall be 60% open on both sides to diminish the environmental effects of extreme temperatures.
- Includes USB and RS232, DB9 Computer Interface Ports.
- Low voltage safety design at 24V DC. (Higher voltage DC systems are unacceptable).

BBS COMMUNICATIONS MODULE:

All inverter connections shall be made without the use of tools. This includes:

- A/C-Input, A/C-Output, Normally-Open, and Normally-Closed programmable contacts.
- Smart Slot Relay I/O Module.
- Input #1 Turn the BBS on.
- Input #2 Turn the BBS off.
- Input #3 Start the BBS self-test.
- Input #4 Shut down the BBS (when on battery).
- Output #1 The BBS is on-battery (during a power failure, self-test or run time calibration).
- Output #2 BBS has a low battery – Programmable.
- Output #3 The protected load is not receiving power from the BBS.
- Output #4 Replace the BBS batteries.
- Output #5 The BBS is overloaded.
- Output #6 Any BBS fault or self-test failure.

BATTERIES:

Batteries shall be maintenance-free, type AGM/VRLA (Absorbed Glass Mat / Valve Regulated Lead Acid) or Gel Cell. Batteries shall be independently pre-wired and individually fused. Batteries shall be furnished with heavy-duty 50 amp rated silver-plated Anderson Connectors. 100 Amp internal fuse by Battery supplier. Batteries shall be lightweight for personnel safety and protection plus ease of installation and maintenance. Batteries shall not exceed a weight of over 27.64 pounds.

ENCLOSURE TEMPERATURE COMPENSATION:

Operating temperature shall be a minimum -34.6°F to 165.2°F.

POWER SYSTEM ANALYZER AND CONFLICT RESOLUTION MODULE:

The inverter should incorporate an integrated power system analyzer and conflict resolution system. The analyzer should evaluate and make limited adjustments to the incoming utility power and automatically transfer load to the battery back-up power if utility power is lost. When utility power becomes available, the BBS should analyze the power to verify stability and return to normal operation. The system should provide automatic BBS failure detection and automatically isolate the failed BBS and lock the unit on to utility power. Once the failure has been corrected, the system should return to normal operation.

TRIPLE BYPASS SYSTEM FOR OFFLINE BBS:

1. Power Analyzer with Conflict Monitor Isolation and Transfer Module.
2. PCM – Power Conflict Monitor. The PCM is a totally redundant failsafe system. It monitors load bus power available continuously. If load bus power fails for 5 ms, the PCM shall transfer and isolate the BBS and guarantee that commercial power shall be locked on.
3. Timer – Redundant 5 ms delay and hard transfer to utility power.
4. The outboard Transfer Switch shall not interrupt the normal controller function. Transfer time shall be 2ms.
5. Onboard I/O module shall execute lockout of battery backup system upon detection of any inverter BBS fault. If BBS resets itself, it shall automatically be available for backup.
6. ON Inverter to timed relay for Full Time control of Output, 0 to 10 hours.

BATTERY CHARGER:

Shall charge from shut off discharge to 90% fully charged in less than 8 hours. The battery charger shall utilize Advanced Battery Management to extend battery life.

HOT-SWAPPABLE BATTERY REPLACEMENT:

The unit shall be capable of user-friendly battery replacement without interrupting signal operation.

WARRANTY

Manufacturers shall provide a 2 year factory-replacement parts warranty on the BBS. Batteries shall be warranted for full replacement for 2 years. The warranty shall be included in the total bid price of the BBS.

7. Vehicular Signal Heads

Signal head doors should open so the light assembly can be changed without removing the door or loosening the head.

Signal indications shall be 12 inches in diameter and sectional in construction requiring one section for each light indication.

All traffic signal light sources shall be LED. LED and LED assemblies shall meet all pertinent NEMA, IEEE, and ITE standards.

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.

The housing for the individual sections shall be black in color and 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.

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.

One section of a three or more-section assembly shall be equipped with terminal block for termination of field wiring.

The lamp socket shall be equipped with color-coded wire, red, yellow, or green, depending upon the lens color of the section.

The socket wires shall be a minimum of 26 inches long, composed of wire with insulation 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.

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.

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 Specifications. If there are any items which do not comply with the contract documents, a list of those exceptions must be detailed on the certification.

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.

All surfaces of metal signal housing doors and visor shall be oven baked, black, enamel, except the doors and visors shall be flat black.

During 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

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.

One solid ball red signal head (only one red, not yellow and not green) facing each approach should have a thermostat control heater and covered-up detector to melt ice and snow covering the lens.

8. Pedestrian Signal Heads

Signal head doors should open so the light assembly can be changed without removing the door or loosening the head.

All pedestrian signal heads shall include all the necessary fittings and adjustable cable tie type brackets and shall use LED.

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.

Other properties shall be the same as vehicular traffic signal heads defined earlier.

9. Backplates

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 inches 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.

The size of each backplate shall be suitable for mounting on three-section and five-section, 12 inch signal heads. All mounting hardware shall be rustproof and corrosion resistant.

10. Foundations

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.

The concrete bases shall conform to the dimensions shown in 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.

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.

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.

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.

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.

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, notify the Engineer in writing of the portions that are in conflict. Immediate response will be given by the Engineer to avoid delays.

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.

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.

The foundation must be given seven days to cure before the structures are erected.

New bases shall be constructed and finished to the dimensions shown on the plans. Concrete shall be as specified in Article 2403.02 of the Standard Specifications for Class C, Mix No. C-4, air-entrained P.C. concrete, and shall be placed in accordance with Article 2403.03 of the Standard Specifications.

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.

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.

Concrete sidewalks, pavements, base courses, and bituminous surfaces shall be replaced with new materials.

The backfill shall be mechanically compacted in 6-inch layers to a density equal to that of the surrounding material.

11. Signal Pedestal Poles

All traffic signal pedestals shall be Sch 80 galvanized steel or Sch 80 spun aluminum (push-button poles may be Sch 40) and shall be in conformance with Section 2525 of the Standard Specifications. 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.

All hardware shall be of hot dipped galvanized steel in accordance with the latest revision of ASTM A123.

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.

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.

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.

12. Galvanized Steel Traffic Signal Supports

Configuration:
The signal mast arms, support poles, and light poles shall be continuous steel members of the anchor-base type, as shown on the plans. Poles shall be fabricated from low-carbon steel (maximum 0.30% carbon) of U.S. Standard Gauge and constructed from steel sheet having one continuous welded vertical seam.

Mechanical Properties:

- After fabrication, poles shall exhibit a minimum yield strength of 48,000 psi.
- The base shall consist of heavy cast or rolled steel, securely attached to the lower end of the shaft by a continuous weld on both the inside and outside surfaces.
- The bolt circle diameter shall conform to the pole manufacturer's specifications.

Fabrication:

- Poles and mast arms may be fabricated by welding two sections together; however, such fabrication shall be performed solely by the vendor and in strict accordance with the Structural Welding Code AWS.
- Welding and fabrication shall conform to the AASHTO Standard Specifications for Welding of Structural Steel for Highway Bridges and the Standard Specifications.

Design Loads and Applications:

- Poles shall be designed to support the designated traffic signals, lights, signs, and cameras, and other devices with clearances as indicated on the plans.
- Where specified, poles shall incorporate high-rise design luminaire arms for streetlights. The luminaire riser may be fabricated as a separate, add-on component.
- Luminaire extensions shall be provided to achieve a 40 foot mounting height with a 12 foot overhang, unless otherwise indicated on the plans.

Transformer Base:

- Each pole shall be equipped with an integral transformer base of a minimum size of approximately 2 feet by 1 foot 10 inches, or as otherwise specified.

Hardware and Assembly:

- All necessary hardware, shims, and anchor bolts required for a complete installation shall be supplied with the mast arms and support poles.

Surface Treatment and Material Requirements

Galvanizing:

- All hardware and exposed steel surfaces shall be hot-dipped galvanized in accordance with the latest revision of ASTM A123.
- All mast arms and support poles shall be fabricated from galvanized steel and shall conform to Section 2525 of the Standard Specifications.

Anchor Bolts

Material and Strength:

- Anchor bolts shall be constructed from A36 steel with a minimum yield strength of 50,000 psi.
- To minimize corrosion, anchor bolts shall be hot-dipped galvanized on at least 12 inches of the threaded portion.
- It is recommended that if dissimilar metals are used (for example, stainless steel poles with carbon steel bolts), proper corrosion mitigation measures (such as insulation or protective coatings) be applied.

Configuration:

- Each pole shall be secured by four anchor bolts.
- Anchor bolts shall be provided with a minimum threaded length of 6 inches at one end and a 4 inch long, 90 degree bent leg at the other end for proper embedment and to resist pullout.

Installation and Erection

Foundation:

- Poles shall be erected on a cast-in-place reinforced concrete foundation with a minimum compressive strength of 4000 psi. Foundation dimensions shall be as specified on the plans.

Pole Erection:

- All poles shall be erected vertically with mast arms oriented at a right angle to the centerline of the street, unless otherwise specified.
- The pole shall be securely bolted to the concrete foundation at the locations shown on the plans.
- Leveling shall be accomplished by adjusting nuts on each anchor bolt. One nut shall be placed on each bolt prior to positioning the pole. The upper nuts shall then be loosely applied to allow for vertical adjustment, and final tightening shall expose a maximum of three full threads.

Anti-Turning Provision:

- All threaded pedestal poles shall be drilled and tapped to accept a 1/4 inch diameter by 3/4 inch long galvanized or stainless-steel bolt through the base and pole to prevent rotation.

Utility Coordination:

- The locations of all signal standards shown on the plans are subject to adjustment based on the actual positions of existing underground and overhead utilities. Final locations will be determined at the time of construction.

Certification and Inspection

Fabricator Certification:

- The fabricator shall certify that the mast arms and support poles are capable of withstanding winds of at least 100 mph without failure.
- Certification shall also state that only certified welding operators, in accordance with AWS D1.1 (or the latest revision), were employed, and that welding electrodes comply with the current AASHTO Standard Specifications for Welding of Structural Steel for Highway Bridges.

Final Inspection:

- Upon completion of installation, a thorough inspection shall be performed to ensure compliance with the above specifications, including proper anchorage, alignment, and adherence to design loads.

Galvanized Finish

Both liquid finish and powder topcoat 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 five-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:

Materials:

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.

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 contaminates 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.

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 standard black elected from the manufacturer's standard color table and shall the be readily matched for future repair.

Construction:

Packaging. Prior to shipment, all items shall be protected to prevent damage during shipment and handling at project site.

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.

13. <u>Stainless Steel Light Poles</u>

Material:

- The poles shall be made of Grade 316 stainless steel with a smooth, brushed finish. The material shall be resistant to corrosion and weathering, with an appropriate alloy selection based on local environmental conditions (e.g., coastal or highly humid areas may require Grade 316).

Height:

- The poles shall be 33 feet tall, as measured from the ground level to the luminaire.

Design:

- The poles shall be of conical or tapered design, with a smooth transition from the base to the top, ensuring a clean, modern aesthetic.
- The pole shall be designed to accommodate single-arm or double-arm streetlights at the top, with provisions for electrical wiring and any additional mounting hardware.
- The top of the pole shall be fitted with a standard mounting bracket for street light fixtures (e.g., 2 3/8 inch tenon or appropriate size per fixture requirements).
- The pole shall have a flat base plate to secure to the foundation via anchor bolts.

Finish:

- The pole shall have a polished or brushed stainless steel finish with a minimum 2B or #4 finish to prevent corrosion and provide durability against external elements.

Load Rating:

- The pole shall be designed to withstand wind speeds of up to 130 mph (or local design wind speed requirements), with a safety factor of 1.5.
- The pole shall be capable of supporting a maximum light fixture weight of 100 pounds, or as required by the project specifications.

Compliance:

- The poles shall meet or exceed the AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, and the ANSI standards for lighting poles.

Anchor Bolts, Washers, and Base Plates for Stainless Steel Street Light Poles Material:

- All material shall be compatible with stainless steel pole to eliminate galvanic corrosion.
- The anchor bolts shall be made of Grade 316 stainless steel to match the material of the poles.
- The anchor bolts must be corrosion-resistant and compatible with the stainless-steel pole material to prevent galvanic corrosion.

1. **Number and Size:**
    - The anchor bolt assembly, number and size shall be determined by the pole manufacturer.

2. **Bolt Configuration:**
    - The bolts shape shall be as shown on the plans
    - The unthreaded portion of the bolt (embedded in the foundation) should be such that to prevent pullout and ensure firm anchorage.

3. **Threaded End:**
    - The threaded portion of the anchor bolts shall be of sufficient length as determined by the manufacturer or shown on the plans and securely attach the pole's base plate with nuts and washers.
    - Nut and washer assemblies shall be used to securely fasten the pole to the anchor bolts made of material that is inert or does not cause galvanic corrosion.
4. **Anchor Bolt Installation**
    - Concrete Foundation: The pole foundation shall be a cast-in-place reinforced concrete base with a minimum strength of 4000 psi and a minimum dimension of 3 feet by 3 feet by 4 feet or as specified in the plans.
    - Foundation Form: A steel template shall be used to hold the anchor bolts in place while the concrete foundation is poured. The template shall maintain the correct spacing and orientation for the anchor bolts and ensure that the pole base plate fits properly.
    - Anchor Bolt Placement: The anchor bolts shall be placed such that the distance between centerlines of adjacent bolts is a minimum of 10 inches and shall match the bolt pattern of the pole base flange.
    - The anchor bolts shall be installed vertically and aligned so that the threaded portion is positioned above the foundation, ensuring proper connection to the pole.
    - Bolt Tightening: After the concrete has cured (minimum of 7 days), the nuts and washers shall be tightened on the anchor bolts to securely affix the stainless-steel pole to the foundation.
    - Proper torque specifications for the anchor bolt nuts shall be followed, typically 150 to 200 foot-pounds, depending on the bolt size and material.
    - Leveling: The pole base flange shall be checked for level and vertical alignment before tightening the anchor bolt nuts to ensure the pole stands plumb and true.
    - Inspection: The installed pole, anchor bolts, and foundation shall be inspected for compliance with the manufacturer's specifications and local safety standards prior to final use.

14. **Electrical**

Weatherproof connectors shall be used.

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.

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.

Service Installation. (Traffic Signal and Lighting): The Contractor shall supply and install a 2 inch No. 11 high-density polyethylene (HDPE) 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 shall be provided at the time of construction. Any above ground conduit shall be rigid steel.

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.

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.

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.

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.

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.

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.

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.

A uniform systematic color code shall be used.

All wiring shall comply with the NEC and City Ordinance and shall be subject to the inspection of the Engineer.

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.

Bonding and Grounding

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.

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.

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.

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.

Existing ungrounded metal poles shall be grounded by means of a driven ground rod.

Cables and Wires

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.

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.

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 be No. 16 AWG cable (the number of conductors shall be specified on plans) and composed of stranded wire.

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 4185.11 of the Standards Specifications and shall be of the size and number shown on the plans.

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.

Tracer Wire: Tracer wire is only required in fiber optic conduits where the conduit does not have built-in 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 only contain fiber optic cable. 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.

15. Handholes

Unless otherwise indicated on the plans, handholes shall be constructed as per these Specifications.

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.

Handholes on fill rural cross sections shall have a drain and drainpipe.

A crushed stone sump with a minimum depth of 18 inches shall be provided beneath all handholes.

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.

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.

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.

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.

After installation of handhole, all foreign debris including, but not limited to, dirt, leaves, grout, concrete, cans, and glass, shall be removed before acceptance by the City.

All loop detector lead-in conductors shall be placed into a handhole prior to winter shut down.

16. Conduits

All conduits, except fiber optic conduits, shall be HDPE conduit the number and size of conduit shall be as specified on the plans.

HDPE conduits shall meet the requirements of NEMA TC-7 and applicable UL standards (such as UL 651A for continuous conduit or UL 1990 for power and fiber-optic applications).

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.

Fiber optic conduits shall be installed at least 42 inches below grade.

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.

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.

Concrete sidewalks, pavements, base courses, and bituminous surfaces shall be replaced with new materials.

Underground conduits shall be laid at a distance of at least six inches from any water line or other utility line.

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 No. 11 HDPE unless otherwise shown on the plans.

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.

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 four inches of backfill shall be a hot bituminous concrete plant mix acceptable to the Engineer.

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.

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.

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 No. 11 HDPE. 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.

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.

All unused conduits, whether for future use or for later use in the project, shall be capped.

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.

Fiber optics conduit shall be 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.

17. <u>Fiber Optic Cable</u>

All interconnection and monitoring 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 Section 16. 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. All 12 strands shall be terminated inside the controller cabinet.

Unless otherwise mentioned in these specifications or plans, the traffic fiber optic control communications and interconnect cable shall have the following minimum properties.

Fiber optics cable shall be small diameter high fiber-density micro cable suitable to be deployed by blowing into small duct sizes, except where length and location might require use of reinforced fiber optic cable. Micro cable fibers shall be blown through conduits and shall not be pulled to cause stresses higher than manufacturer specified tensile strength for that microfiber.

A 72 Stranded Single Mode Loose Tube Cable Meet Pertinent ANSI, EIA, and TIA Specifications for the Usage, Installation, and Location Type Required by This Project

Typical Core Diameter 8.3 um ± 1.0 um Cladding Diameter 125.0 um ± 1.0 um Core Concentricity ± 1 Percent

Attenuation Uniformity No Point Discontinuity Greater Than 0.1 um at either 1310 nm or 1550 nm Max Attenuation 0.40 dB/Mile

The coating shall be a dual layer UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically strippable without damage to the fiber. The central member of the cable shall be a glass reinforced plastic rod designed to prevent the buckling of the cable. The cable core interstices shall be filled with water blocking tape to prevent water infiltration. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.

Buffer tubes shall be of dual layer construction with the inner layer made of polycarbonate and the outer layer made of polyester. Each buffer tube shall be water-blocked with a water-swelling yarn or tape. Buffer tubes shall be stranded around the central member using reverse oscillation, or "SZ", stranding process.

The buffer tubes shall meet TIA/EIA-598A, "Color Coding of Fiber Optic Cables". The fiber cable shall include loose tubes with 12 fibers in each tube.

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

All dielectric cables, without armoring, shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 0.055 inch. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The jacket or sheath shall be marked with the manufacturer's name and the words "Optical Cable," the year of manufacture, and sequential feet marks. The markings shall be repeated every 2 feet. The actual length of the cable shall be within the range plus 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.

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).

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

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

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

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

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

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

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 shall 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.

A sufficient number of patch cords shall be installed to provide a fully operational communications system.

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.

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.

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.

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.

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.

Splice Enclosure: Continuous fiber cable runs and/or traffic signal controller branch circuit points shall be spliced in an outside plant splice enclosure located in handholes as shown on plans. Green buffer tube of “trunkline” fiber cable shall be spliced with “branch-line” fiber cable leading to traffic signal cabinet. The remaining “trunkline” 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” in-tact 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.

Fiber splice loss shall not exceed the limits of TIA/EIA 568.

Tube Color: The green tube shall be extended to the traffic signal cabinet and shall be used for traffic communications and video monitoring purposes.

Interconnection: All controllers and traffic monitoring cameras shall be interconnected and connected to Waterloo Traffic Operations Center by fiber optic cable and/or radio.

Fiber optic cable installed on span wire shall be rated for outdoor and UV exposure and protected by flexible polyethylene jacket. Lash aerial fiber to galvanized steel messenger wire. Contractor shall provide engineer calculations for messenger wire size based on cable loads and span lengths for approval. Calculations shall include sag distance, and attachment method to poles, and include measurements for snow, wind, and ice loads. Messenger wire shall be connected to ground rod in the handhole at the base of the pole. Install strain relief on wood pole and ensure that fiber bend radius does is not less than manufacturer requirements. Initial stringing tension, maximum permissible span length, and sagging shall be in accordance with the cable manufacturer's recommendations.

18. <u>Mounting Hardware</u>

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.

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 an octagonal metal signal closure cap. No plastic devices of any type will be allowed. Top and bottom brackets shall be required for all pole-mounted signal heads unless otherwise shown in the plans. All mounting brackets shall be stainless steel, not painted.

Control cabinet mounting shall be on its own concrete base unless otherwise noted on plans.

19. <u>Accessible Pedestrian Signals</u>

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.

Pedestrian detection shall have 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 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.

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.

Accessible Pedestrian Signals and Detectors shall be provided at all pedestrian crosswalk locations and shall meet the requirements of the latest version of the MUTCD.

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 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.

All audible walk indications for this project shall be a speech walk message

Speech walk messages shall be patterned after the following model: “Franklin. Walk sign is on to cross Franklin Street.”

Audible detection beacon audio intensity shall be auto adjusted based on ambient noise. Extended pushbutton features are not required for this project

Contractor shall submit shop drawings for all accessible pedestrian signals and detector equipment for approval.

Additional wiring and equipment required for a complete accessible pedestrian signal and detector installation is not indicated in the plans but shall be included in the Traffic Signalization bid item.

20. Signal Service Meter Bypass Socket

Service panel cabinets shall be furnished when indicated on the project plans and be installed onto the traffic signal controller cabinet by the Contractor. Meter socket shall be UL and ANSI approved and a stamp showing approvals must be visible on inside of the socket. Meter sockets shall be constructed of steel and finished with light gray coating. The coating shall be electrostatically applied.

The meter socket shall be rated for two 100 amp or 200 amp terminals and have a fifth terminal as a neutral. The meter socket shall also operate with a bypass device so that the traffic signal shall not power down during installation or removal of the utility meter. The utility company will supply and install the meter once the Contractor notifies them of the traffic signal startup.

All units shall be any one of the following brands Anchor Electric U42552-HO, Landis and GYR, HQ-5U-40405-015, Millbank NU9318-XL, or Durham T-H5213-U (HCP).

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.

21. Emergency Vehicle Pre-Emption (EVP) System

Where an existing traffic signal system is replaced, Contractor to remove existing EVP system and reinstall on new signal system. Contractor shall supply new wire and mounting brackets for EVP

equipment.

EVP system shall be fully compatible with City's existing OPTICOM system and shall conform to the plans using Model 764 detectors.

EVP Detector and Light Installation: The detectors, indicator lights, wiring and connections shall be installed in accordance with the manufacturer's instructions.

In the event at installation a noticeable obstruction is present in line with the detector, the Contractor shall advise the Engineer before installation.

The detector and indicator light shall be attached to the traffic signal mast arm to the satisfaction of the Engineer.

All hardware shall be tightened securely.

The detector and indicator light shall be installed and mounted in such a way so as to ensure the watertight integrity of the complete assembly. The detector shall be installed with the drain hole at the bottom.

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.

All EVP detectors and EVP indicator lights shall be operational when each traffic control signal system is initially turned on.

The Contractor shall furnish and install 3/c No. 20 AWG EVP detector cables and 3/c No. 14 AWG cables for the confirmation lights, where indicated in the plans. Emergency vehicle pre-emption cables (3/c No. 20 AWG) shall be installed continuous without splices or terminals from the EVP detector to the traffic signal cabinet.

22. Traffic Monitoring System

Outdoor monitoring cameras shall be installed with remote control and monitoring capability activated from Waterloo Traffic Operations Center at 625 Glenwood Street Waterloo, Iowa. Unless stated otherwise in the plans, monitoring system at each intersection shall consist of network cameras directed aimed towards approaches, and a "look-down" network camera directed down towards the intersection.

23. Traffic Video Detection System (VDS)

The VDS, shall be a complete and working system. The system shall have the capability to be remotely monitored and programmed through fiber optic network and shall come with all the software and hardware necessary to do so and be readily monitored and programmed remotely once installed. The VDS shall be complete with all the required components such as cables, in-cabinet devices, cameras, mounting hardware, etc. VDS shall be capable of detecting vehicles on all approaches. The VDS shall meet the following minimum requirements:

The VDS shall be capable of stop bar detection and at the same time detection at min of 500 feet upstream of the stop bar. Each detection area in each lane must be programmed as an independent detection area with an independent output.

Camera assembly shall be mounted according to the manufacturer's recommendations and shall include mounting hardware to directly install on the arm of mast-arm pole, on a riser, or on luminaire extension, or on its own cantilever arm as needed. While the plans may show a typical camera position and mounting height, it shall be the Contractor's responsibility to supply and install the required hardware matching the supplied VDS to fulfil the Specifications detection requirements.

Shall be IP compatible (IP addressable and network compatible).

NEMA compatible output to NEMA TS2 Type 1 controller with signal output for detection as NEMA loop detectors.

Minimum roadway surface coverage within 15 degree cone of camera vision from camera lens axis measured from the camera mounting.

Software and hardware to provide for defining stop bar detection area zones as small as 6 feet by 6 feet or smaller, and defining large detection zones, minimum of five zones per lane, and minimum of four lanes per camera. The system shall be capable of at least 64 independent detection zones with discrete channel assignments.

Detector features shall include count detection, presence and passage detection, label displays, data gathering stations, and contrast loss detection.

Image shall be able to be calibrated for accurate distances.

Fail-safe feature with fixed time, max time, or min time selection.

User friendly and easy programming with Windows® 10 interface.

The camera assembly, including mountings, shall withstand 90 mph winds.

Performing during night hours with no ambient lighting.

Shall have heating or features to ascertain full operability in presence of snow and ice.

Shall not fog.

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 shall be through a combination fiber optic and/or radio interconnection.

The system shall have a minimum 2 year warranty. Housing shall be maintenance free.

Shall not cause adverse electronic effect on the controller operations.

Shall operate at a mounting height of 20 feet or less, and up to 35 feet or more. Self-diagnostics of power-up and reporting failures.

The system shall be capable of recognizing vehicular travel/movement directions. Desirable feature is power over Ethernet (PoE) between cabinet and camera.

Operating temperatures –30°F to 140°F

Camera and camera assembly shall have features or shall be designed to reduce the need for manual cleaning of the camera or enclosure lens.

24. <u>Radar Detection System</u>

Shall be Signal Control System's recommended type when used for adaptive control.

25. <u>Wireless Communications</u>

Wireless technology shall be compatible with Waterloo's existing system. Signal controller and monitoring cameras shall be connected to WTOD Traffic Operations Center (TOC) by any combination of fiber optic and wireless communications. Controllers shall be connected to City's ATMS located at Public Works Building, 625 Glenwood Street Waterloo, Iowa 50703. Traffic monitoring cameras should be connected to City's Video Management System (Salient) located at TOC. For more information on locations and type of existing devices contact Tina Schellhorn, Associate Traffic Engineer, at (319) 291-4440.

Warranty: One year on parts and labor from date of installation and operation, or manufacturer's warranty if manufacturer's warranty provides for a longer coverage.

The Contractor shall be responsible for providing a fully functional wireless communication system connected to TOC. It shall be the Contractor's responsibility to assure the delivery of a working system, including the use of proper equipment, appropriate installation, to achieve acceptable communication.

System shall include antennas, cables, jumpers, pole mounts, protectors, and all items necessary to

make a complete working system, which shall be in accordance with the wireless and camera manufacturer's recommendations to provide a complete working system suitable for traffic monitoring.

26. Inductive Detector Loops

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. Refer to the plans for loop connectivity. Each loop must be on its own independent detection channel regardless of what is stated in the plans.

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.

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 (HMA) or concrete (PCC) 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.

The Contractor shall obtain Engineer's field verification of all loop locations prior to beginning of construction.

If the prefabricated loop detector is destroyed before, during or after the paving operation, it shall 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.

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.

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.

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.

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.

Loop testing completed in accordance with Article 2525.03, B, 1, k of the Standard Specifications. During saw cut and prefabrication loop testing, the Contractor, and the 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.

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 Engineer. 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.

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.

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.

The Engineer shall 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.

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.

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.

27. <u>Luminaires</u>

Unless otherwise shown or modified on the plans, the luminaires shall meet the requirements listed under this section.

Luminaires shall meet the following requirements:

- LED 120-277 Multi-Tap
- Type III Light Distribution
- Photocell Receptacle (Empty)
- 100 to 130 Lumens Per Watt
- 3000K to 3700K Light Temperature
- Lights Shall Not Require Separate Power Supply or Driver
- Minimum 50,000 Hours at 70% Lumen Maintenance.
- Luminaire shall be finished to match color and style of pole.

Supplier shall provide a catalog cut sheet of luminaire for review by the Engineer.

Luminaires shall be installed for operation on 240-volt AC, single phase, 60 Hz.

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 with vandal protection provisions.

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.

Street light connectors shall be used for all luminaire cable connections. Split bolts shall not be used.

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 ten 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.

28. <u>Reflectorized Street Name Signs</u>

Length and Width: Sign length and width are determined based on the street name, letter size and type. Unless otherwise stated in the plans 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 sign length shall be in 6 inch increments.

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 in the plans.

Reflective Sheeting: The sign face shall be made from Type III or Type IV prismatic type retro-reflective sheeting.

Processing: If 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. Printed signs shall follow manufacturer’s recommendations.

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.

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.

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.

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.

29. Salvaged Materials

All existing signal materials and equipment not listed in the Standard Specifications, 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. Contractor may be allowed to deliver the salvaged equipment and materials to the City, but prior authorization and coordination is required. Existing traffic signal equipment and materials to be salvaged, as specified on plans.

Items to be properly disposed of by Contractor are as specified on the plans.

C. TRAFFIC CONTROL

It shall be the Contractor's full responsibility to set up and maintain traffic control in compliance with the contract documents.

D. METHOD OF MEASUREMENT AND BASIS OF PAYMENT

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 in the plans and described in this Specifications, to provide a fully operational system. Unless listed as a separate bid item, no other payment will be made for work covered by the Specifications, 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 in the plans.

Compensation to the Contractor for all work covered by this Specifications 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.

E. ESTIMATED QUANTITIES FOR LUMP SUM TRAFFIC SIGNALIZATION BID ITEM – Project No. STP-A-8155(784)--86-07

The successful bidder shall complete and submit this form as specified in the contract documents.

Item No.	Item Description	Units	Estimated Quantity	Unit Price	Total
1	TRAFFIC SIGNAL CONTROLLER CABINET, REMOVE AND SALVAGE	EA	5		
2	TRAFFIC SIGNAL CONTROLLER CABINET, COMPLETE, FURNISH AND INSTALL	EA	5		
3	TRAFFIC SIGNAL CONTROLLER, REMOVE AND SALVAGE	EA	10		
4	TRAFFIC SIGNAL CONTROLLER, FURNISH AND INSTALL	EA	10		
5	EXTERIOR CABINET ENCLOSURE, FURNISH AND INSTALL	EA	2		
6	FIBER TERMINATION PANEL, 12-POSITION, FURNISH AND INSTALL, COMPLETE WITH TERMINATIONS	EA	7		
7	ETHERNET SWITCH, HARSH ENVIRONMENT, LAYER 2, MANAGED, FURNISH AND INSTALL	EA	10		
8	MODIFY EXISTING DETECTION SYSTEM	EA	3		
9	TRAFFIC SIGNAL DETECTION SYSTEM, 4-CAMERA, REMOVE AND SALVAGE	EA	7		
10	TRAFFIC SIGNAL DETECTION SYSTEM, 4-RADAR, COMPLETE, FURNISH AND INSTALL	EA	7		
11	ADAPTIVE TRAFFIC CONTROL SYSTEM LICENSING	EA	10		
12	ADAPTIVE TRAFFIC CONTROL SYSTEM INSTALLATION AND CONFIGURATION	EA	10		
13	FIBER OPTIC CABLE, 12-CT, SINGLE-MODE, FURNISH AND INSTALL	LF	225		
14	FIBER OPTIC CABLE, 72-CT, SINGLE-MODE, REMOVE AND SALVAGE	LF	725		
15	FIBER OPTIC CABLE, 144-CT, SINGLE-MODE, FURNISH AND INSTALL	LF	1870		
16	WIRELESS INTERCONNECT SYSTEM, TWO INTERSECTIONS, FURNISH AND INSTALL	LS	1		

F. ESTIMATED QUANTITIES FOR LUMP SUM TRAFFIC SIGNALIZATION BID ITEM – Project No. STP-A-8155(785)--86-07

The successful bidder shall complete and submit this form as specified in the contract documents.

Item No.	Item Description	Units	Estimated Quantity	Unit Price	Total
1	TRAFFIC SIGNAL CONTROLLER, FURNISH AND INSTALL	EA	~~8~~ 9		
2	TRAFFIC SIGNAL CONTROLLER, REMOVE AND SALVAGE	EA	~~8~~ 9		
3	TRAFFIC SIGNAL CONTROLLER CABINET, COMPLETE, FURNISH AND INSTALL (NOT INCLUDING NEW, IN-CABINET FIBER OPTIC NETWORK EQUIPMENT: 12-POSITION TERMINATION PANEL, LAYER 2 SWITCH, ETC.)	EA	~~2~~ 1		
4	TRAFFIC SIGNAL CONTROLLER CABINET, REMOVE AND SALVAGE	EA	~~2~~ 1		
5	EXTERIOR FIBER OPTIC CABINET ENCLOSURE, COMPLETE WITH PATCH PANEL FURNISH AND INSTALL	EA	3		
6	FIBER TERMINATION PANEL, 12-POSITION, FURNISH AND INSTALL, COMPLETE WITH TERMINATIONS	EA	5		
7	ETHERNET SWITCH, HARSH ENVIRONMENT, LAYER 2, MANAGED, FURNISH AND INSTALL	EA	10		
8	FIBER OPTIC CABLE PATCH PANEL	EA	8		
9	MODIFY EXISTING VEHICLE DETECTION SYSTEM	EA	4		
10	STOP BAR DETECTION, RADAR	EA	6		
11	TRAFFIC SIGNAL MONITORING SYSTEM, 4-CAMERA, COMPLETE, FURNISH AND INSTALL	EA	3		
12	ADAPTIVE SYSTEM LICENSING	EA	10		
13	ADAPTIVE SYSTEM INSTALLATION AND CONFIGURATION	EA	10		
14	REWIRE EXISTING TRAFFIC SIGNAL AND INSTALL NEW POWER SERVICE	EA	1		

Item No.	Item Description	Units	Estimated Quantity	Unit Price	Total
15	HANDHOLE, TYPE III, FURNISH AND INSTALL	EA	19		
16	WIRELESS COMMUNICATION SYSTEM, THREE INTERSECTIONS	EA	1		
17	CONDUIT, 2-INCH DIA., HDPE, FURNISH AND INSTALL	LF	14,340		
18	FIBER OPTIC CABLE, 72-CT, SINGLE-MODE, FURNISH AND INSTALL	LF	18,200		
19	CONDUIT, 2-INCH DIA. RIGID STEEL, FURNISH AND INSTALL	LF	60		
20	STEEL MESSENGER WIRE, FURNISH AND INSTALL	LF	130		
21	REMOVALS, MISCELLANEOUS	LS	1		
22	SURFACE RESTORATION	LS	1		

Project No. STP-A-8155(785)--86-07