SP- 090054
(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION and INTERCONNECT

POTTAWATTAMIE COUNTY

Project No.
STP-A-1642(661)--86-78

Effective Date
March 16, 2010

The Standard Specifications, Series 2009, Are Amended By The Following Modifications And Additions. These Are Special Provisions And They Shall Prevail Over Those Published In The Standard Specifications.

INDEX

A. TRAFFIC SIGNAL CONTROLLER UNIT

The Actuated Controller, Cabinet, and all auxiliary equipment shall be in full compliance with the NEMA Standard TS2 Type 2 requirements.

The local intersection controller shall be the most current version of the Siemens ITS M50 series controller or an equivalent approved by the City Traffic Engineer. The controller shall include the data key option or similar function. The local intersection Controller shall be capable of operating in the City of Council Bluff's existing MARC 360 Closed Loop System manufactured by Siemens ITS, and be capable of communicating with the City's current central system software. The Controller shall be capable of 10/100 BASE-T Ethernet network communication. The City Traffic Engineer may specify alternate or additional communications capabilities as needed.

All auxiliary equipment supplied in the signal cabinet not produced by the primary Controller manufacturer shall have service information and parts availability information supplied including, model number, serial number, and/or part number, and the address of the manufacturer included on the cabinet layout and master parts list. The same manufacturer as the Controller timing unit shall manufacture the cabinet terminal facilities. All other equipment may be multi-source. Refer to NEMA Standard TS2, Type 2 – 1992 for further standards and specifications for TS2 signal equipment.

B. MALFUNCTION MANAGEMENT UNIT

1.0 INTRODUCTION

This specification sets forth the minimum requirements for a shelf-mountable, sixteen channel, solid-state Malfunction Management Unit (MMU). The MMU shall meet, as a minimum, all applicable sections of the NEMA Standards Publication No. TS2-1992. An independent testing laboratory shall verify that the MMU will perform all its defined functions under the conditions set forth in Section 2 of the NEMA STANDARD (Environmental Standards and Test procedures). Where differences occur, this specification shall govern.

2.0 HARDWARE

2.1 ENCLOSURE

The MMU shall be compact so as to fit in limited cabinet space. It shall be installable on a shelf that is at least 7 inches deep. Overall dimensions, including mating connectors and harness, shall not exceed 10.5 inches H by 4.5 inches W by 11 inches D.

2.1.2 The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062 inches, and shall be finished with an attractive and durable protective coating. Model, serial number, and program information shall be permanently displayed on the rear surface.

2.2 ELECTRONICS

2.2.1 A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall force the OUTPUT RELAY to the de-energized "fault" state and indicate an error message if a pulse is not received from the microprocessor within a defined period.

2.2.2 In the interest of reliability, only the PROM memory device for the microprocessor firmware shall be socket mounted. The PROM Memory socket shall be a precision screw machine type socket with a gold contact finish providing a reliable gas tight seal. Low insertion force sockets or sockets with "wiper" type contacts shall not be acceptable.

2.2.3 A built-in, high-efficiency power supply shall generate all required internal voltages. All voltages shall be regulated and shall be monitored with control signals. Failure of the internal power supply to provide proper operating voltages shall force the OUTPUT RELAY to the de-energized "fault" state and indicate an error message. A front panel mounted fuse shall be provided for the 120 VAC input.

2.2.4 User-programmed configuration settings shall be stored in an electrically erasable programmable read-only memory (EEPROM) or via front panel DIP switches. Designs using a battery to maintain configuration data shall not be acceptable.

2.2.5 All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a resistor having a power dissipation rating of 0.5 Watts or greater. Each 120 VAC field terminal input shall be sensed by a separate precision voltage comparator device.

2.2.6 All electrical components used in the MMU shall be rated by the component manufacturer to operate over the full NEMA temperature range of -30°C to +74°C.

2.2.7 All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

a. All plated-through holes and exposed circuit traces shall be plated with solder.
b. Both sides of the printed circuit board shall be covered with a solder mask material.
c. The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.
d. All electrical mating surfaces shall be gold plated.
e. All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

2.3 FRONT PANEL & CONNECTORS

2.3.1 All displays, configuration switches, and connectors shall be mounted on the front panel of the MMU. All MMU configuration inputs beyond those required by the NEMA Standard shall be provided by front panel mounted DIP switches and shall be clearly labeled. Configuration DIP switches shall be provided for the following functions:

a. Field Check / Dual Enables l- 16
b. Green/Yellow-Dual Indication Enable
c. BND Test Disable
d. External Watchdog Enable

2.3.2 The connectors on the MMU shall have a metallic shell and be attached to the chassis internally. They shall be manufactured to meet MIL-C-26482 specifications. The connectors shall be mounted on the front of the unit in accordance with the following: Connector A shall intermate with a MS 3116 22-55 SZ, and Connector B shall intermate with a MS 3116 16-26 S.

In the interest of reliability and reparability, printed circuit board mounted MS connectors shall not be acceptable. Internal MS harness wire shall be a minimum of AWG #22, 19 strands.

2.3.3 All indicator lights shall be water clear, T-1 package, Red Super Bright type LEDs. Indicators shall be provided for the following items:

1. Channel Status 1-16
2. Conflict
3. Red Fail
4. CVM / External Watchdog
5. 24V-2
6. 24V-1
7. Clearance Fail
8. Port 1 Fail
9. Diagnostic / Program Card
10. Field Check Fail
11. Dual Indication
12. Type 12 mode
13. Power
14. Port 1 Receive
15. Port 1 Transmit

2.4 OPERATING MODES

2.4.1 The MMU shall operate in both the Type 12 mode and Type 16 mode as required by the NEMA Standard.

3.0 MONITORING FUNCTIONS

The following monitoring functions shall be provided in addition to those required by the NEMA Standard Section 4.

3.1 DUAL INDICATION MONITORING

Sixteen switches labeled FIELD CHECK/DUAL ENABLES shall be provided on the MMU front panel to enable Dual Indication Monitoring on a per channel basis. The Dual Indication Monitor function shall provide two modes of operation, Dual Indication Fault and Green/Yellow-Dual Indication Fault.

When voltages on two inputs of a channel are sensed as active for more than 1000 msec, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the DUAL INDICATION indicator. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on two inputs of a channel are sensed as active for less than 700 msec, the MMU shall not transfer the OUTPUT relay contacts to the Fault position.

When operating in the Type 16 mode with Port 1 communications enabled, Bit #68 (Spare Bit #2) of the Type #129 response frame shall be set to indicate a Dual Indication fault has been detected.

Dual Indication Monitoring shall be disabled when the RED ENABLE input is not active. When operating in the Type 16 mode with Port 1 communications enabled, Dual Indication Monitoring shall also be disabled if the LOAD SWITCH FLASH bit is set to " 1 " in the Type #0 message from the Controller Unit.

3.1.1 DUAL INDICATION MONITOR

Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel. In Type 12 mode this monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel.

3.1.2 GREEN YELLOW-DUAL INDICATION MONITOR

Green Yellow-Dual Indication monitoring shall detect simultaneous inputs of active Green and Yellow field signal inputs on the same channel. It will be used to monitor channels which have an unused Red field signal input tied to AC LINE such as a five section signal head.

Green Yellow-Dual Indication Monitoring shall be enabled by a front panel option switch. When the Green Yellow-Dual Indication Monitoring option is enabled, all channels which have the front panel FIELD CHECK/DUAL ENABLE switches OFF shall be individually monitored for simultaneous active Green and Yellow field signal inputs. All channels which have the front panel FIELD CHECK/DUAL ENABLE switches ON (i.e., enabled for Dual Indication Monitoring) shall function as described above in Dual Indication Monitoring.

3.2 FIELD CHECK MONITORING

Sixteen switches labeled FIELD CHECK/DUAL ENABLES shall be provided on the MMU front panel to enable Field Check Monitoring on a per channel basis. The Field Check Monitor function shall provide two modes of operation, Field Check Fault and Field Check Status.

Field Check Monitoring shall be disabled when the RED ENABLE input is not active. When operating in the Type 16 mode with Port 1 communications enabled, Field Check Monitoring shall also be disabled if the LOAD SWITCH FLASH bit is set to " 1" in the Type #0 message from the Controller Unit. The Field Check Monitoring function shall be disabled in the Type 12 mode.

3.2.1 FIELD CHECK MONITOR

In the Field Check Fault mode, when the field signal input states sensed as active or inactive by the MMU do not correspond with the data provided by the Controller Unit in the Type #0 message for 10 consecutive messages, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the FIELD CHECK FAIL indicator. The Channel Status Display shall indicate the channels on which the Field Check fault was detected. Bit #67 (Spare Bit #1) of the Type #129 response frame shall be set to indicate a Field Check fault has been detected. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

3.2.2 FIELD CHECK STATUS

The Field Check Status mode shall work in combination with the other fault monitoring functions of the MMU. When a Conflict, Red Fail, Clearance Fail, or Dual Indication Fail triggers the MMU, the Channel Status Display and Fault Status Display shall correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the FIELD CHECK FAIL indicator shall illuminate and double pulse once every 2 seconds. The channels on which the Field Check errors were detected shall double pulse at the same time

as the FIELD CHECK FAIL indicator. Bit #67 (Spare Bit #1) of the Type #129 response frame shall also be set to indicate Field Check errors have been detected.

3.3 BND ERROR DETECTION MONITORING

The BND Error Detection function shall be designed to detect and respond to irregular field input waveforms such as: irregularly blinking (flickering); having constant extraneous noise; being dimmed invalidly under Controller Unit software control.

Detection of a BND Error shall place the MMU into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the BND FAIL indicator. The Channel Status display shall indicate the channels on which the fault occurred. When operating in the Type 16 mode with Port 1 communications enabled, Bit #69 (Spare Bit #3) of the Type # 129 response frame shall be set to indicate a BND Error Detection fault has been detected. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the BND Fail fault state of the monitor.

3.4 EXTERNAL WATCHDOG MONITOR

The MMU shall provide the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 msec (+/-100 msec), the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and illuminate the CVM/WATCHDOG indicator. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the CVM/WATCHDOG fault state of the monitor.

When operating in the Type 16 mode with Port 1 communications enabled, Bit #70 (Spare Bit #4) of the Type # 129 response frame shall be set to indicate an External Watchdog fault has been detected.

3.5 TYPE FAULT MONITOR

The MMU shall verify at power-up that the Type 12 or Type 16 operating mode as determined by the TYPE SELECT input is consistent with the mode set by the last external reset.

Detection of a Type Fault shall place the MMU into the fault mode, transfer the OUTPUT relay contacts to the Fault position, illuminate the DIAGNOSTIC indicator, and flash the TYPE 12 indicator at a 2Hz rate. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the Type Fault state of the monitor.

4.0 DISPLAY FUNCTIONS

The following display functions shall be provided in addition to those required by the NEMA Standard Section 4.

4.1 YELLOW PLUS RED CLEARANCE INTERVAL DISPLAY

The MMU Channel Status display shall indicate with a steadily illuminated LED indicator, those channels which had the short Yellow plus Red interval (i.e., those channels which did not meet the minimum Yellow Change plus Red Clearance Interval). The conflicting

channel(s) which was sensed active Green causing the Minimum Yellow Change plus Red Clearance Fault shall also be indicated with a single pulsed LED indicator.

4.1.1 PORT 1 TRANSMIT INDICATOR

The TRANSMIT indicator shall illuminate whenever the MMU has the Port 1 transmitter enabled.

4.1.2 PROGRAM CARD INDICATOR

The DIAGNOSTIC/PGM CARD indicator shall flash at a 2Hz rate if the Programming Card is absent or not seated properly in its mating connector.

5.0 ADDITIONAL FEATURES

5.1 The MMU shall include both automatic and operator initiated diagnostics.

5.1.1 Automatic diagnostics shall verify memory and microprocessor operation each time power is reapplied to the MMU. After power has been applied, diagnostics shall continually verify the operation of essential elements of the MMU including at a minimum: PROM, EEPROM, communications, internal power supply, and the microprocessor.

5.1.2 Operator initiated diagnostics shall allow the operator to verify proper operation of all indicator lights, PROM, EEPROM, RAM and microprocessor.

C. TS2 TYPE 1 CABINET ASSEMBLY

1.0 GENERAL

This specification sets forth the minimum requirements for a TS2 Type 1 traffic control cabinet assembly. The cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA Standard Publication No. TS2-1992. Where differences occur, this specification shall govern. The controller cabinet shall meet the following functional requirements:

2.0 CABINET DESIGN AND CONSTRUCTION

2.1 The cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of 0.125 inches.

2.2 The cabinet shall be designed and manufactured with materials that will allow rigid mounting, whether intended for pole, base or pedestal mounting. The cabinet must not flex on its mount.

2.2.1 A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. The cabinet door opening must be a minimum of 80 percent of the front surface of the cabinet.

2.2.2 The top of the cabinet shall incorporate a 1-inch (25mm) slope toward the rear to prevent rain accumulation.

2.3 Unless otherwise specified, the cabinet shall be supplied with a natural aluminum finish. Sufficient care shall be taken in handling to ensure that scratches are minimized. All surfaces shall be free from weld flash. Welds shall be smooth, neatly formed, free from cracks, blow holes and other irregularities. All sharp edges shall be ground smooth.

2.4 All seams shall be sealed with RTV sealant or equivalent material on the interior of the cabinet.

2.5 All cabinets shall be supplied with two removable shelves manufactured from 5052H32 aluminum. Shelf shall be a minimum of 10 inches deep.

2.6 One set of vertical "C" channels shall be mounted on each interior wall of the cabinet for the purpose of mounting the cabinet components. The channels shall accommodate spring mounted nuts or studs. All mounting rails shall extend to within 7 inches of the top and bottom of the cabinets.

2.7 The main door and police door-in-door shall close against a weatherproof and dustproof, closed-cell neoprene gasket seal. The gasket material for the main door shall be a minimum of 0.188 inches thick by 1inch wide. The gasket material for the police door shall be a minimum of 0.188 inches thick by 0.5 inches wide. The gaskets shall be permanently bonded to the cabinet.

2.8 The lower section of the cabinet shall be equipped with a louvered air entrance. The air inlet shall be large enough to allow sufficient airflow per the rated fan capacity. Louvers must satisfy the NEMA rod entry test for 3R ventilated enclosures. A noncorrosive, vermin- and insect-proof, removable air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall.

2.8.1 The roof of the cabinet shall incorporate an exhaust plenum with a vent screen. Perforations in the vent screen shall not exceed 0.125 inches in diameter.

2.9 The main door shall be equipped with a three-point latching mechanism.

2.10 The handle on the main door shall utilize a shank of stainless steel 3/4 inches minimum diameter. The handle shall include a hasp for the attachment of an optional padlock. The cabinet door handle shall rotate clockwise to open. The lock assembly shall be positioned so that the handle shall not cause any interference with the key when opening the cabinet door.

2.11 The main door hinge shall be a one-piece, continuous piano hinge with a stainless steel pin running the entire length of the door. The hinge shall be attached in such a manner that no rivets or bolts are exposed.

2.12 The main door shall include a mechanism capable of holding the door open at approximately 90, 120, and 180 degrees under windy conditions.

2.13 The main door shall be equipped with a Corbin tumbler lock number 1548-1. Two keys shall be supplied.

2.14 The police door-in-door shall be provided with a treasury type lock Corbin No. R357SGS or exact equivalent and one key.

2.15 All base mounted cabinets shall be supplied with anchor bolts to properly secure the cabinet to its base. The cabinet flange for securing the anchor bolts shall not protrude outward from the bottom of the cabinet. When a size 5 cabinet is furnished, two anchor bolts shall be provided. Size 6 and 7 cabinets shall be provided with four anchor bolts.

2.16 Each cabinet shall be of sufficient size to accommodate all equipment. At a minimum, the minimal cabinet sizes are as follows:

- Size 4 cabinets – 51 inches H by 24 inches W by 16 inches D

- Size 5 (M) cabinets – 51 inches H by 30 inches W by 16 inches D
- Size 6 (P) cabinets – 56 inches H by 44 inches W by 24 inches D
- Size 7 (R) cabinets – 77 inches H by 44 inches W by 24 inches D

The size 6 (P) cabinet is to be used unless a specific cabinet size is called out on the plans.

Note: Height measured at front of cabinet.

2.17 The cabinet shall be a base mounted unit with a concrete foundation as per the plan details. A level concrete pad with a broom finish and dimensions of 36 inches by width of cabinet x 5 inches shall be installed adjacent to the cabinet base on the front side of the cabinet door. A ½ inch expansion material shall be installed between the cabinet base and the concrete pad.

3.0 TERMINALS AND FACILITIES/MAIN PANEL DESIGN AND CONSTRUCTION

3.1 The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches minimum thickness and formed so as to eliminate any flexing when plug-in components are installed.

3.2 All 4, 8, 12 and 16 position main panels shall be hinged at the bottom to allow easy access to all wiring on the rear of the panel. It shall not be necessary to remove any shelf-mounted equipment to hinge down the main panel.

3.3 The main panel shall be fully wired in the following configurations:

a. Type 1 Configuration - Four load switch sockets, two flash transfer relay sockets, one flasher socket and two main panel Bus Interface Unit (BIU) rack positions.
b. Type 2 Configuration - Eight load switch sockets, four flash transfer relay sockets, one flasher socket and two main panel BIU rack positions.
c. Type 3 Configuration - Twelve load switch sockets, six flash transfer relay sockets, one flasher socket and two main panel BIU rack slots.
d. Type 4 Configuration - Sixteen load switch sockets, eight flash transfer relay sockets, one flasher socket and two main panel BIU rack slots.

3.4 All load switch and flash transfer relay socket reference designators shall be silkscreen labeled on the front and rear of the main panel to match drawing designations.

3.5 Up to eight-load switch sockets may be positioned horizontally or stacked in two rows on the main panel. Main panels requiring more than six load switch sockets shall be mounted in two horizontal rows.

3.6 All load switches shall be supported by a bracket extending at least three inches from the main panel.

3.7 Rack style mounting shall be provided to accommodate the required BIUs per the configuration listed in section 3.3 above. A dual-row, 64-pin female DIN 41612 Type B connector shall be provided for each BIU rack position. Card guides shall be provided for both edges of the BIU. Terminal and facilities BIU mounting shall be an integral part of the main panel. Detector rack BIU mounting shall be an integral part of the shelf-mounted detector rack.

3.7.1 All BIU rack connectors shall have prewired address pins corresponding to the requirements of the TS2 specification. The address pins shall control the BIU mode of operation. BIUs shall be capable of being interchanged with no additional programming.

3.8 All main panels shall have all field wires contained within one row of horizontally mounted terminal blocks.

3.9 All field output circuits shall be terminated on an unfused compression type terminal block with a minimum rating of 10 amps.

3.10 All field input/output (I/O) terminals shall be identified by permanent alphanumeric labels. All labels shall use standard nomenclature per the NEMA TS2 specification.

3.11 All field flash sequence programming shall be accomplished at the field terminals with the use of a screwdriver only.

3.11.1 Field terminal blocks shall be wired to use three positions per vehicle or overlap phase (green, yellow, red)

3.12 The main panel shall contain a flasher socket (silk screen labeled) capable of operating a 15-amp, 2-pole, NEMA solid-state flasher. The flasher shall be supported by a bracket that extends at least three inches from the back panel.

3.13 One RC network shall be wired in parallel with each flash transfer relay coil.

3.14 All logic-level, NEMA-controller and Malfunction Management Unit input and output terminations on the main panel shall be permanently labeled. Cabinet prints shall identify the function of each terminal position.

3.15 Terminal blocks for DC signal interfacing shall have a number 6-32 x 7/32 inch (or metric equivalent) screw as minimum. Functions to be terminated shall be as specified in the listing of Input/Output Terminals in the TS2-1992 Standard document (Section 5).

3.16 All main panel wiring shall conform to the following wire size and color:

Green/Walk load switch output	brown wire 16 gauge
Yellow load switch output	yellow wire 16 gauge
Red/Don't Walk load switch output	red wire 16 gauge
MMU (other than AC power)	blue wire 22 gauge
Controller I/O	blue wire 22 gauge
AC Line (power panel to main panel)	black wire*
AC Line (main panel)	black wire*
AC Neutral (power panel to main panel)	white wire*
AC Neutral (main panel)	white wire*
Earth ground	green wire*

**Gauge varies with power panel/main panel set*

3.17 All wiring, 14 AWG and smaller, shall conform to MIL-W-16878/1, type B/N, 600 V, 19-strand tinned copper. The wire shall have a minimum of 0.010 inches thick PVC insulation with clear nylon jacket and rated to 105°C. All 12 AWG and larger wire shall have UL listed THHN/THWN 90°C, 600V, 0.020 inches thick PVC insulation and clear nylon jacketed.

3.18 All controller and Malfunction Management Unit cables shall be of sufficient length to allow the units to be placed on either shelf or the outside top of the cabinet in the operating mode. Connecting cables shall be sleeved in a braided nylon mesh. The use of exposed tie-wraps or interwoven cables is unacceptable.

3.19 All cabinet configurations shall be provided with enough RS-485 Port 1 communication cables to allow full capabilities of that cabinet. Each communication cable connector shall be a 15-pin metal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.

3.20 All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.

3.21 All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.

3.22 The grounding system in the cabinet shall be divided into three separate circuits (AC Neutral, Earth Ground, and Logic Ground). These ground circuits shall be connected together at a single point as outlined in the NEMA TS2 Standard.

3.23 All pedestrian pushbutton inputs from the field to the controller shall be optoisolated through the BIU and operate at 12 VAC.

3.24 All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.

3.25 All main panels shall be pre-wired for a Type-16 Malfunction Management Unit.

4.0 POWER PANEL DESIGN AND CONSTRUCTION

4.1 The power panel shall consist of a separate module, securely fastened to the right side wall of the cabinet. The power panel shall be wired to provide the necessary power to the cabinet, controller, Malfunction Management Unit, cabinet power supply and auxiliary equipment. It shall be manufactured from 0.090-inch, 5052-H32 aluminum.

4.2 The power panel shall house the following components:

a. A 50-amp main breaker for 12 or 16 position cabinets or a 30-amp breaker for 4 or 8 position cabinets. This breaker shall supply power to the controller, MMU, signals, cabinet power supply and auxiliary panels. Breakers shall be thermal magnetic type, U.L. listed, with a minimum of 10,000 amp interrupting capacity.
b. A 15-amp auxiliary breaker. This breaker shall supply power to the fan, light and GFI outlet.
c. A 50 amp, 125 VAC radio interference line filter.
d. A normally open, 60 amp, mercury contactor for 12 or 16 position or a 35 amp. contactor for 4 or 8 position facilities.

e. A 13-position neutral bus bar capable of connecting three #12 wires per position

5.0 AUXILIARY CABINET EQUIPMENT

5.1 The cabinet shall be provided with a thermostatically controlled (adjustable between 27-66°C) ventilation fan in the top of the cabinet plenum. The fan shall be a ball bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute.

5.2 An LED light panel shall be mounted on the inside top of the cabinet. The LED light panel shall be 15-17W and be wired into the cabinet power circuit and not obtain power from the convenience outlet. The LED light panel shall be wired to either a ON/OFF switch mounted on the rear cover of the police plan or to a door activated switch mounted near the top of the door.

5.3 A sealable print pouch shall be mounted to the door of the cabinet. The pouch shall be of sufficient size to accommodate one complete set of cabinet prints.

5.4 Two sets of complete and accurate cabinet drawings shall be supplied with each cabinet.

5.5 One set of manuals for the controller, Malfunction Management Unit and vehicle detector amplifiers shall be supplied with each cabinet.

5.6 A permanent graphics identification template with a minimum dimension of 9 inches by 11 inches shall be inked, transferred, or silk screened using permanent ink or equal on a material comparable to the 3M product 160-130TPF Control Tac film and shall be attached to the inside of the cabinet door. The graphic will identify a general outline of the intersection, provide directional orientation, intersection phasing, signal head identification, and identify the loop numbering. The drawing shall be done neatly by hand drafting or in a computer aided drafting format. All lines, symbols, and lettering shall be highly visible using a black foreground on either a white or yellow background. The drawing need not be drawn to scale. A legend shall be provided for all symbols used within the drawing.

6.0 VEHICLE DETECTION

6.1 A vehicle detector amplifier rack shall be provided in each cabinet. Detector racks shall be available in two configurations.

a. Configuration #1 – Shall support up to eight channels of loop detection and one BIU.
b. Configuration #2 – Shall support up to 16 channels of loop detection and one BIU.

6.2 Each cabinet shall contain detector interface panels for the purpose of connecting field loops and vehicle detector amplifiers. The panels shall be manufactured from .090 inches minimum thickness 5052-H32 aluminum.

6.3 One 8-position interface panel shall be provided for an 8-channel rack cabinet and one 16-position interface panel shall be provided for a 16-channel rack cabinet. The interface panel shall be secured to the left sidewall of the cabinet.

6.4 Each interface panel shall allow for the connection of eight or sixteen independent field loops. A ground bus terminal shall be provided between each loop pair terminals to provide a termination for the loop lead-in cable ground wire.

6.5 Lightning protection device mounting holes shall be provided to accommodate an Edco SRA-16C, or Edco SRA-6, or Edco LCA-6, or a varistor lightning protection device. Lightning

protection devices shall not be provided unless specifically called for in the special provisions of this specification.

6.6 A cable consisting of 22 AWG twisted pair wires (red and orange) shall be provided to enable connection to and from the panel to a detector rack.

6.7 All termination points shall be identified by a unique number and silk screened on the panel.

6.8 Detectors shall utilize extension and delay timings and be similar to the Eberle Design model LM622 2-channel loop detectors. All card slots shall be filled with detectors. A dual output detector card, Eberle Design model LM632t, shall be used when dual detector outputs are required on the plans.

6.9 Each detector rack shall be powered by the cabinet power supply (refer to section 9.6 of this specification).

6.10 When alternative vehicle detection methods are specified and approved by the City Traffic Engineer, this section (C.6) may not apply.

7.0 CABINET TEST SWITCHES AND POLICE PANEL

7.1 A test switch panel shall be mounted on the inside of the main door. The test switch panel shall provide as a minimum the following:

- **a.** AUTO/FLASH SWITCH. When in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall not be stop timed when in flash. If required by the plans and specifications, an optional RC network shall be provided to give the controller an external start pulse when switch is returned to the auto position. This will force the controller to initiate the start up sequence when exiting flash.
- **b.** STOP TIME SWITCH. When applied, the controller shall be stop timed in the current interval.
- **c.** CONTROL EQUIPMENT POWER ON/OFF. This switch shall control the controller, MMU, and cabinet power supply AC power.

Momentary test pushbuttons for all vehicle and pedestrian inputs to the controller are not required. The TS2 controller to be provided with the cabinet assembly shall provide vehicular and pedestrian call inputs from its keyboard while in the standard status display.

7.2 The police door switch panel shall contain the following:

- **a.** SIGNALS ON/OFF SWITCH. In the OFF position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the OFF position, the MMU shall not conflict or require reset.
- **b.** AUTO/FLASH SWITCH. In the flash position, power shall not be removed from the controller and stop time shall be applied. If required by the plans and specifications, an optional RC network shall be provided to give the controller an external start pulse when switch is returned to the auto position. This will force the controller to initiate the start up sequence when exiting flash.
- **c.** AUTO/MANUAL SWITCH. Cabinet wiring shall include provisions for an AUTO/MANUAL switch and a momentary pushbutton or hand cord. The AUTO/MANUAL switch and pushbutton or hand cord shall not be provided unless it is called for in the special provisions of this specification.

7.3 All toggle type switches shall be heavy duty and rated 15 amps minimum. Single- or double-pole switches may be provided, as required.

7.4 Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.

7.5 All switch functions must be permanently and clearly labeled.

7.6 All wire routed to the police door-in-door and test switch pushbutton panel shall be adequately protected against damage from repetitive opening and closing of the main door.

8.0 CONTROLLER TELEMETRY INTERFACE PANEL

8.1 A telemetry interface harness and interface panel shall be supplied with each cabinet assembly.

8.2 The harness shall be a minimum of 6 feet long and shall consist of two twisted pairs, 22 AWG wire, terminated to a 9-pin "D" type connector at one end. The pin out of the 9-pin connector shall be in exact accordance with the NEMA TS2 Standard. The opposite end of the harness shall be terminated on a 10-position EDCO PCB- 1 B or exact equal lightning protection socket base.

8.3 All terminal block designations and peripheral board-mounted components shall be labeled as to their number and function and shall correspond to the cabinet wiring diagrams.

8.4 The following signals shall be accessible from the telemetry interface panel:

- Local controller command lines 1 & 2.
- Local controller readback lines 1 & 2.
- Master controller command lines 1 & 2.
- Master controller readback lines 1 & 2.
- Earth grounds.

8.5 A socket mounted communication line transient protection device shall be supplied with the telemetry interface panel. The device shall be an EDCO model PC642C008D or exact approved equivalent. The transient protection device shall be wired in series with the telemetry communication circuit.

9.0 AUXILIARY DEVICES

9.1 LOAD SWITCHES

9.1.1 Load switches shall be solid state and shall conform to the requirements of Section 6.2 of the NEMA TS2 Standard.

9.1.2 Signal load switches shall have a minimum rating of 10 amperes at 120 VAC for an incandescent lamp load.

9.1.3 The front of the load switch shall be provided with three indicators to show the input signal from the controller to the load switch.

9.1.4 Load switches shall be dedicated per phase. The use of load switches for other partial phases is not acceptable.

9.1.5 The full complement of load switches shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed.

9.2 FLASHERS

9.2.1 The flasher shall be solid state and shall conform to the requirements of section 6.3 of the NEMA TS2 Standard. Flashing of field circuits for the purpose of intersection flash shall be accomplished by a separate flasher.

9.2.3 The flasher shall be rated at 15 amperes, double pole with a nominal flash rate of 60 FPM.

9.3 FLASH TRANSFER RELAYS

9.3.1 All flash transfer relays shall meet the requirements of Section 6.4 of the NEMA TS2 Standard.

9.3.2 The coil of the flash transfer relay must be de-energized for flash operation.

9.3.3 The full complement of relays shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed.

9.4 MALFUNCTION MANAGEMENT UNITS

9.4.1 Each cabinet assembly shall be supplied with one Malfunction Management Unit (MMU) as defined by the requirements of Section 4 of the NEMA TS2 Standard.

9.4.2 Malfunction Management Units shall be a Type 16. The MMU shall be an EDI Model MMU-16.

9.5 BUS INTERFACE UNITS

9.5.1 All Bus Interface Units (BIUs) shall meet the requirements of Section 8 of the NEMA TS2 Standard.

9.5.2 The full complement of BIUs shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.

9.5.3 Each Bus Interface Unit shall include power on and transmit indicators. All indicators shall be LEDs.

9.6 CABINET POWER SUPPLY

9.6.1 The cabinet power supply shall meet the requirements of Section 5.3.5 of the NEMA TS2 Standard.

9.6.2 The cabinet power supply shall provide LED indicators for the 12 VDC, 12 VAC, and 24 VDC outputs.

9.6.3 The cabinet power supply shall provide (on the front panel) jack plugs for access to the +24 VDC for test purposes.

9.6.4 One cabinet power supply shall be supplied with each cabinet assembly.

10.0 ETHERNET SWITCH

10.1 Each cabinet shall be equipped with an 8 port managed Ethernet switch. The Ethernet switch shall be NEMA TS-2 rated. The switch will have six 10/100 Ethernet ports and two Single Mode Fiber ports. The switch shall be powered by AC line voltage. The Ethernet switch shall be a GarrettCom model 6KQE, or equivalent approved by the City Traffic Engineer.

10.2 The Ethernet switch shall be attached to a side panel of the cabinet.

10.3 Patch cables to provide functional connection of the Ethernet switch to the Fiber Optic distribution panel and to the signal controller shall be provided.

11.0 TESTING AND WARRANTY

11.1 TESTING

11.1.1 Each controller and cabinet assembly shall be tested as a complete entity under signal load for a minimum of 24 hours.

10.1.2 The cabinet shall be assembled and tested by the controller manufacturer or authorized local distributor to ensure proper component integration and operation.

11.2 WARRANTY

11.2.1 The controller and Malfunction Management Unit shall be warranted by the manufacturer against mechanical and electrical defects for a period of 1 year. The manufacturer's warranty shall be supplied in writing with each cabinet and controller. Second party extended warranties are not acceptable.

11.2.2 The cabinet assembly and all other components shall be warranted for a period of one year.

11.2.3 Any defects shall be corrected by the manufacturer or supplier at no cost to the owner.

D. ELECTRICAL DESIGN

1.0 The distribution of the 117 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices. The cabinet shall be provided with power protection devices, which include the main AC+ power circuit breakers, radio interference suppressers, and lightning and surge protectors. The cabinet shall be provided with surge protection and radio interference (RFI) filters and lightning protection. These functions may be combined into one or more devices. Combining of devices shall be supported by manufacturer's printed literature stating specific compliance to standard industry levels, such as EDCO Model ACP 340 surge protectors, as a minimum. Surge protectors shall provide a general cabinet protection as a parallel device. Additional protection shall be provided to all electronic devices such as the traffic Controller and conflict monitor via a series surge protector working in conjunction with the general cabinet protection. Surge protection, RFI's, etc shall be rated at the ampacity of the breaker protection. Main cabinet circuit breakers for shall be a minimum of 50 amps. A minimum of three circuit breakers shall be provided. The main cabinet breaker shall service all Controller and terminal facilities. The auxiliary breaker shall provide service to the cabinet detectors, masters, and other electronic equipment. The service breaker shall provide service to the fan, thermostat, , etc. Duplex outlets, which are provided for equipment such as modems and other low current auxiliary equipment, shall be provided with series-parallel lightning protection. Such outlets will be clearly identified to denote that they are specifically to be used for low current auxiliary electronic equipment only. The surge protector shall be capable of a peak current of 20,000 amps in an eight by twenty microsecond wave shape; have a life test with a maximum of a five percent change; have a clamp voltage not to exceed 280 volts @ 20 KA; have a response time to insure that the maximum voltage never exceeds 280 volts; is rated

for 10 amps continuous service; and can operate from -40°C to +85°C degrees. Load switches and other high current devices shall require only parallel lightning protection devices. An MOV shall be installed on the radio interference suppressor between both the AC+ line to ground and the AC+ load to ground. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

2.0 Each signalized location shall utilize a standard 2 pole, weather tight circuit breaker type disconnect. The unit shall be rated a minimum of 60 amps and grounded as per NEC standards.

3.0 The controller shall contain a connector enabling outgoing and incoming electrical circuits to be connected or disconnected easily without the necessity of installing or removing individual wires. The connector may be a multiple pin jack; a spring connected mounting, or approved equivalent mounting.

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

4.0 Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple plug; a spring connected mounting or approved equivalent arrangement.

5.0 All cabinet wiring shall be neatly trained throughout the cabinet and attached to the interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced or tied or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors.

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

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

6.0 An AC+ convenience outlet with a 3-wire grounding type receptacle shall be provided and be easily accessible. This receptacle and the incandescent lamp shall be separately fused from the main AC+ circuit breaker. The outlet shall be provided with ground fault protection.

7.0 The cabinet duct fan shall be fused separately and wired after the main AC+ circuit breaker.

8.0 The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod system located outside the controller cabinet. (See grounding sections for details.) No ground rods shall be installed inside the controller cabinet.

E. TRAFFIC SIGNAL BATTERY BACKUP SYSTEM (BBS)

1.0 Description. This specification is for a system to provide back-up power to fully operate a traffic signal when normal line voltage is interrupted and to maintain a useable output voltage when line voltage is outside normal levels.

2.0 Materials. Furnish, assemble, fabricate, or install new corrosion resistant materials in accordance with specifications. Supply a “rack mounted” UPS unit, including a front panel with indicators and control switches.

3.0 Functional Requirements. This specification is for establishing the minimum requirements for a complete emergency battery backup system for use with Light Emitting Diode Traffic Signal Modules at traffic signals with NEMA, 170 or 2070 cabinets. The Battery Backup System (BBS) shall include, but not be limited to the following: Inverter/Charger, Batteries, a separate automatic and manually operated Bypass Switch, and all necessary hardware and interconnect wiring. The BBS shall be capable of providing power for both the full normal operation of a traffic signal with all LED displays (all colors: red, yellow, green and pedestrian heads), and flashing mode operation with all LED displays. The BBS shall be designed for outdoor applications.

4.0 Enclosure Construction:

4.1 Enclosure: The BBS Enclosure shall be capable of being either a Side Mount or Ground Mount installation. The enclosure will house the batteries, UPS and bypass switches. The cabinet must meet the requirements for NEMA 3R enclosures. The housing must have the dimensions so that it may easily be attached to the side of an M, P, or 332 Type traffic signal cabinet. Dimensions of the enclosure shall not exceed 50 inches H by 20 inches W by 17 inches D. The UPS enclosure must not interfere with the opening of the traffic cabinet door. The complete enclosure and door must be made from .125 inch thick aluminum. All external seams must be continuously welded. The door opening must have a double flange for weather sealing purposes.

4.2 Door: The cabinet must have a door to provide access to the complete cabinet interior. The door must be mounted on a continuous piano hinge. The key lock must be a Corbin cylinder lock with a #2 key. A continuous neoprene gasket must be used to weatherproof the enclosure when the door is closed.

4.3 Finish: The entire enclosure must be natural aluminum.

4.4 Ventilation: Vents and a thermostatically controlled exhaust fan shall be installed in the cabinet.

5.0 Battery System:

5.1 Individual batteries shall be easily replaced and commercially available off the shelf.

5.2 Batteries shall be maintenance free, type AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid). The batteries must be designed for stand-by applications.

5.3 Batteries shall be certified by the manufacturer to operate over a temperature range of – 25°C to +74°C.

5.4 Batteries shall have a minimum Manufacturer's Warranty of 2 Years Full Replacement from date of delivery. The warranty shall cover any battery that does not meet 80% of its original reserve capability during the warranty period.

6.0 BBS Unit:

6.1 The BBS shall provide a minimum two hours of full run-time operation with an additional four hours minimum of Red Flash operation at an LED only traffic signal with a maximum 800 W active output load. The inverter, when on batteries, shall operate with a minimum efficiency of 84% with a load ranging from 25% to 90% of the BBS total output rating. The BBS shall operate at 97% or higher when operating under normal condition (utility power is available).

6.2 The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 5 milliseconds. 5 milliseconds maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

6.3 The BBS shall include a rack mounted Fail Safe Automatic/Manual Bypass Switch for bypassing the UPS for maintenance. The FS-ATS bypass switch will be a 3-stage configuration, UPS Normal mode, bypass UPS on and bypass UPS off. The FS-ATS Bypass Switch shall mount in a rack inside of the BBS side mount enclosure.

6.4 The BBS shall provide 6 sets of programmable output contacts. These shall include:

6.4.1 One output to indicate the system is "on battery".

6.4.2 One output to indicate a programmable low battery condition.

6.4.3 One output that energizes after a programmable period after the unit switches to battery operation.

6.4.4 An indication of a fault or alarm condition.

6.4.5 The BBS will provide a visual indication for each output when activated.

6.5 The BBS shall provide inputs to turn the BBS off and to start the self-test.

6.6 Operating temperature for both the inverter/charger, and manual bypass switch shall be –37°C to +74°C.

6.7 The Fail Safe ATS Bypass Switch shall be rated at 240VAC/30 amps, minimum.

6.8 The BBS shall use a temperature compensated charging system. The BBS shall employ a charging system that balances the charge across all the batteries.

6.9 BBS shall bypass the utility line power whenever the utility line voltage is outside of the following voltage range: 85VAC to 175VAC (± 2VAC). During a utility input from 85 VAC to 175 VAC the UPS shall maintain a full load output of 108 VAC to 131 VAC at 60Hz.

6.10 When utilizing battery power, the BBS output voltage shall be between 110 VAC and 128 VAC, pure sine wave output, ≤ 3% THD, 60Hz ± 3Hz.

6.11 BBS shall be compatible with NEMA, 170 or 2170 Controllers, and cabinet components for full time operation. All loads to the maximum rating of the BBS shall be powered through the BBS system to utilize the UPS internal over/under voltage regulation.

6.12 BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service. The UPS module must be UL approved and labeled.

6.13 In the event of inverter/charger failure, battery failure or complete battery discharge, the Fail Safe Transfer Switch shall revert to the NC (and de-energized) state, where utility line power or generator power, if available, is connected to the cabinet.

6.14 Recharge time for the battery, from “protective low-cutoff” to 90% or more of full battery charge capacity, shall not exceed eight hours, unless limited by the Temperature Regulated charger due to excessive battery heat.

6.15 The battery charger will be compatible with the specified batteries.

6.16 The BBS shall have lightning and surge protection compliant with IEEE/ANSI C.62.41.

6.17 The BBS shall be equipped with an integral system to prevent battery from destructive discharge and overcharge.

7.0 Maintenance, Displays, Controls and Diagnostics:

7.1 The BBS shall include a display and /or meter to indicate current battery charge status and conditions.

7.2 The BBS and batteries shall be easily replaced with all needed hardware and shall not require any special tools for installation.

7.3 The BBS shall display via a front panel indicator the number of times the BBS was activated and the total number of hours the unit has operated on battery power. The status display shall show the UPS mode, Alarm status, Input and output voltages, Output current, Battery voltage, battery charger current and last event.

7.4 The BBS shall include two separate communication ports, an RJ-45, 10/100 Ethernet port and a DB-9, RS 232 serial port. All programming and monitoring functions shall be available through either port.

7.5 The BBS shall include software for programming and monitoring the BBS. The software shall be capable of being used on a PC with all current Microsoft operating systems.

7.6 Manufacturer shall include a set of operation manuals and wiring diagrams of the BBS with each BBS.

8.0 Materials Warranty

8.1 The manufacturer shall provide a two (2) year factory-repair warranty for parts and labor on the BBS. Batteries shall be warranted by the manufacturer for full replacement for a minimum two (2) years from date of delivery. A battery shall be considered bad when it cannot deliver 80% of its original capability within the stated warranty period.

8.2 Warranty shall be included in the total price of the BBS.

F. ELECTRICAL SERVICE PEDESTAL

1.0 When a ground mounted service enclosure are specified in the plans, these specification shall apply.

2.0 SERVICE ENCLOSURE

The service enclosure shall be TESCO class 26-100-M-A2 or equal and shall meet the requirements of UL 508, Industrial Control Equipment. Fabricate the exterior of the service enclosure using 1/8 inch aluminum. Fabricate the interior of the service enclosure using 14 gauge, cold-rolled steel. Paint the interior of the service enclosure white. The interior dimensions of the service enclosure shall be 12 inches wide, 43 inches high and 7-1/2 inches deep. The service enclosure shall have continuously welded seams, a full-length deadfront with stainless steel hinge and a pull section with a removable step.

The service enclosure shall have a fully framed, side-hinged, swaged outer door, flush fitted with top drip lip and closed cell neoprene flange-compressed gaskets. The service enclosure shall have a hinged deadfront with a 1/4 turn latch and knurled knobs. Hinge the deadfront door on the same side as the exterior door. The deadfront door shall open a minimum of 100 degrees. Mount a removable backpan on four (4) welded 1/4 inch studs. The service enclosure shall be completely pre-wired in the factory. Bolt-on or plug-in circuit breakers are not acceptable.

3.0 WIRING SCHEMATICS

3.1 Produce wiring schematics using drafting software. Include all external equipment and connections in accordance with NEMA IIB. Enclose as-built factory drawings in clear plastic. Store drawings inside the outer door using welded hooks.

3.2 Service conductors shall meet the requirements of Section 230 of the National Electric Code (NEC).

G. VIDEO VEHICLE DETECTION SYSTEM

1.0 VIDEO DETECTION – GENERAL

1.1 This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using only video images of vehicle traffic.

1.2 The video detection system shall consist of one, two or four video cameras, a video detection processor (VDP) which mounts in a standard detector rack; a detector rack mounted extension module (EM), surge suppressor for each video input, and a pointing device.

1.3 The system shall include software that detects vehicles in multiple lanes using only the video image. Detection zones shall be defined using only an on board video menu and a pointing device to place the zones on a video image. Up to 24 detection zones per camera shall be available. A separate computer shall not be required to program the detection zones.

2.0 FUNCTIONAL CAPABILITIES

2.1 The VDP shall process video from one, two or four sources depending upon the VDP module used. The source can be a video camera, DVD or video tape player. The video shall be input to the VDP in NTSC or PAL composite video format and shall be digitized and analyzed in real time. Dual and quad video VDP's shall process images from all video inputs simultaneously.

2.2 The VDP shall detect the presence of vehicles in up to 24 detection zones per camera. A detection zone shall be approximately the width and length of one car.

2.3 Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the VDP. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. A separate computer shall not be required for programming detection zones or to view system operation.

2.4 The VDP shall store up to three different detection zone patterns. The VDP can switch to any one of the three different detection patterns within 1 second of user request via menu selection with the pointing device. Each configuration shall be uniquely labeled for identification and the currently active configuration indicator shall be displayed on the monitor.

2.5 The VDP shall detect vehicles in real time as they travel across each detector zone.

2.6 The VDP shall have an EIA232 port for communications with an external computer. The VDP EIA232 port shall be multi-drop compatible.

2.7 The VDP shall accept new detector patterns from an external computer through the EIA232 port when the external computer uses the correct communications protocol for downloading detector patterns. A Windows™-based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability shall be provided with the system.

2.8 The VDP shall send its detection patterns to an external computer through the EIA232 port when requested when the external computer uses the appropriate communications protocol for uploading detector patterns.

2.9 The extension module (EM) shall be available to avoid the need of rewiring the detector rack, by enabling the user to plug an extension module into the appropriate slot in the detector rack. The extension module shall be connected to the VDP by an 8-wire cable with modular connectors. VDP and EM communications shall be accommodated by methods using differential signals to reject electrically coupled noise. The extension module shall be available in both 2 and 4 channel configurations. EM configurations shall be programmable from the VDP. A separate I/O module with 24 outputs – 8 inputs using external wire harness for expanded flexibility shall also be available.

2.10 The camera system shall be able to transmit the composite video signal, with minimal signal degradation, up to 1000 feet under ideal conditions.

2.11 The associated VDP shall default to a safe condition, such as a constant call on each active detection channel, in the event of loss of video signal.

2.12 The system shall be capable of automatically detecting low-visibility conditions such as fog and respond by placing all defined detection zones in a constant call mode. A user-selected output shall be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.

3.0 VEHICLE DETECTION

3.1 A minimum of 24 detection zones shall be supported and each detection zone shall be user definable in size and shape to suit the site and the desired vehicle detection region.

3.2 The VDP shall provide up to 24 output channels of vehicle presence detection per camera through a standard detector rack edge connector and one or more extension modules.

3.3 A single detection zone shall be able to replace multiple inductive loops and the detection zones shall be OR'ed as the default or may be AND'ed together to indicate vehicle presence on a single phase of traffic movement.

3.4 Placement of detection zones shall be done by using only a pointing device and a graphical interface built into the VDP and displayed on a video monitor. No separate computer shall be required to program the detection zones.

3.5 Detection zone outputs shall be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse, extend, and delay outputs shall be user definable between 0.1 to 25.0 seconds.

3.6 Up to six detection zones shall be capable to count the number of vehicles detected. The count value shall be internally stored for later retrieval through the EIA232 port. The zone shall also have the capability to calculate and store average speed and lane occupancy at bin intervals of 10 seconds, 20 seconds, 1 minute, 5 minutes, 15 minutes, 30 minutes and 60 minutes.

3.7 When a vehicle is detected within a detection zone, the corners of the detection zone shall activate on the video overlay display screen to confirm the detection of the vehicle.

3.8 Detection zone setup shall not require site specific information such as latitude and longitude to be entered into the system.

3.9 A minimum of 3 detection zone patterns shall be saved within the VDP memory. The VDP's memory shall be non-volatile to prevent data loss during power outages. The VDP shall continue to operate (e.g. detect vehicles) using the existing zone configurations even when the operator is defining/modifying a zone pattern. The new zone configuration shall not go into effect until the configuration is saved by the operator.

3.10 The selection of the detection zone pattern for current use shall be done through a local menu selection or remote computer via EIA232 port. It shall be possible to activate a detection zone pattern from VDP memory and have that detection zone pattern displayed within 1 second of activation.

3.11 The VDP system shall have the capability to automatically switch to any one of the stored configurations based on the time of day which shall be programmable by the user.

3.12 The VDP shall provide dynamic zone reconfiguration (DZR) to enable normal detector operation of existing channels except the one where a zone is being added or modified during the setup process. The VDP shall output a constant call on any detection channel corresponding to a zone being modified.

3.13 Detection shall be at least 98% accurate in good weather conditions and at least 96% accurate under adverse weather conditions (rain, snow, or fog). Detection accuracy is dependent upon site geometry; camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.

3.14 The VDP shall output a constant call for each enabled detector output channel if a loss of video signal occurs. The VDP shall also output a constant call during the background learning period.

4.0 VDP AND EM HARDWARE

4.1 The VDP and EM shall be specifically designed to mount in a standard NEMA TS-1, TS-2, 2070 ATC, 170 type detector rack, using the edge connector to obtain power and provide contact closure outputs. No adapters shall be required to mount the VDP or EM in a standard detector rack. Detector rack rewiring shall not be required.

4.2 The VDP and EM shall operate in a temperature range from -34°C to +74°C and a humidity range from 0%RH to 95%RH, non-condensing.

4.3 The VDP and EM shall be powered by 12 or 24 volts DC. These modules shall automatically compensate for the different input voltages.

4.4 VDP power consumption shall not exceed 300 milliamps at 24 VDC. The EM power consumption shall not exceed 120 milliamps at 24 VDC.

4.5 The VDP shall include an EIA232 port for serial communications with a remote computer. The VDP EIA232 port shall be multi-drop compatible. This port shall be a 9-pin "D" subminiature connector on the front of the VDP.

4.6 The VDP shall utilize flash memory technology to enable the loading of modified or enhanced software through the EIA232 port without modifying the VDP hardware.

4.7 The VDP and EM shall include detector output pin-out compatibility with industry standard detector racks.

4.8 The front of the VDP shall include detection indications, such as LED's, for each channel of detection that display detector outputs in real time when the system is operational.

4.9 The front of the single and dual VDPs shall include one or two BNC video input connectors suitable for RS170 video inputs as required. For four channel VDPs, an adapter cable that converts a DB15 interface to 4 individual BNC connectors shall be used. The video input shall include a switch selectable 75-ohm or high impedance termination to allow camera video to be routed to other devices, as well as input to the VDP for vehicle detection. RCA type connectors/jacks for video input are not allowed. Video shall not be routed via the edge connectors of the processor.

4.10 The front of the VDP shall include one BNC video output providing real time video output that can be routed to other devices. A RCA type connector/jack for video output is not allowed.

4.11 The front panel of the VDP and EM shall have a detector test switch to allow the user to place calls on each channel. The test switch shall be able to place either a constant call or a momentary call depending on the position of the switch.

5.0 VIDEO DETECTION CAMERA

5.1 Video detection cameras used for traffic detection shall be furnished by the video detection processor (VDP) supplier and shall be qualified by the supplier to ensure proper system operation.

5.2 The camera shall produce a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 1.0 lux to 10,000 lux.

5.3 The imager luminance signal to noise ratio (S/N) shall be more than 50 dB.

5.4 The camera shall be digital signal processor (DSP) based and shall use a CCD sensing element and shall output color video with resolution of not less than 470 TV lines. The CCD imager shall have a minimum effective area of 768(h) x 494(v) pixels.

5.5 The camera shall include an electronic shutter control based upon average scene luminance and shall be equipped with an auto-iris lens that operates in tandem with the electronic shutter.

5.6 The camera shall utilize automatic white balance.

5.7 The camera shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier.

5.8 The horizontal field of view shall be adjustable from 5.4 to 50.7 degrees. This camera configuration may be used for the majority of detection approaches in order to minimize the setup time and spares required by the user. The lens shall be a 10x zoom lens with a focal length of 3.8mm to 38.0mm.

5.9 The lens shall also have an auto-focus feature with a manual override to facilitate ease of setup.

5.10 The camera shall incorporate the use of preset positioning that store zoom and focus positioning information. The camera shall have the capability to recall the previously stored preset upon application of power.

5.11 The camera electronics shall include automatic gain control (AGC) to produce a satisfactory image at night.

5.12 The camera shall be housed in a weather-tight sealed enclosure. The enclosure shall be made of 6061 anodized aluminum. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface.

5.13 The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view. The camera enclosure with sunshield shall be less than 6 inches diameter, less than 18 inches long, and shall weigh less than 6 pounds when the camera and lens are mounted inside the enclosure.

5.14 The enclosure shall be design so that the pan, tilt and rotation of the camera assembly can be accomplished independently without affecting the other settings.

5.15 The camera enclosure shall include a proportionally controlled Indium Tin Oxide heater design that maximizes heat transfer to the lens. The output power of the heater shall vary with temperature, to assure proper operation of the lens functions at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure.

5.16 The glass face on the front of the enclosure shall have an anti-reflective coating to minimize light and image reflections.

5.17 The glass face shall also employ a special coating to minimize the buildup of environmental debris such as dirt and water.

5.18 When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperature range from -34°C to +60°C and a humidity range from 0% RH to 100% RH. Measurement of satisfactory video shall be based upon VDP system operation.

5.19 The camera shall be powered by 120-240 VAC 50/60 Hz. Power consumption shall be 30 watts or less under all conditions.

5.20 Recommended camera placement height shall be 33 feet above the roadway, and over the traveled way on which vehicles are to be detected. For optimum detection the camera should be centered above the traveled roadway. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier.

5.21 The camera shall provide 2 options for set up, diagnostic testing, and viewing of video. A lens adjustment module (LAM) supplied by the VDP supplier, when connected directly to the camera shall allow set up, diagnostic testing, and viewing of video while the camera is installed on a mast arm or pole. The (LAM) shall also allow set up, diagnostic testing, and viewing of the video from the cabinet when connected to the coaxial cable.

5.22 The video signal shall be fully isolated from the camera enclosure and power cabling

5.23 Cable terminations at the camera for video and power shall not require crimping tools.

5.24 No BNC or other connector shall be used for the coaxial video cable termination at the camera.

5.25 The power connection at the camera shall use connector terminations that only require the use of wire strippers and a standard screwdriver. No special crimping tools or other types of terminations shall be used.

5.26 A weather-proof protective cover shall be provided shall be provided to protect all terminations at the camera. No special tooling shall be required to remove or install the protective cap.

6.0 INSTALLATION

6.1 The coaxial cable to be used between the camera and the VDP in the traffic cabinet shall be Belden 8281. The coax cable shall be a continuous unbroken run from the camera to the VDP. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. BNC plug connectors shall be used at both the camera and cabinet ends. The coaxial cable, BNC connector, and crimping tool shall be approved by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection.

6.2 The power cabling shall be 16 AWG three conductor cable with a minimum outside diameter of 0.325 inch and a maximum diameter of 0.490 inch. The cabling shall comply with the National Electric Code, as well as local electrical codes. Cameras may acquire power from the luminaire if necessary.

6.3 The video detection camera shall be installed by factory-certified installers as recommended by the supplier and documented in installation materials provided by the supplier. Proof of factory certification shall be provided.

6.4 The camera enclosure shall be equipped with separate, weather-tight connections for power and setup video cables at the rear of the enclosure. These connections may also allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module (LAM) supplied by the VDP supplier. Video and power shall not be connected within the same connector.

6.5 Recommended camera placement height shall be 33 feet above the roadway, and over the traveled way on which vehicles are to be detected. For optimum detection the camera should be centered above the traveled roadway. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier.

7.0 TS2 INTERFACE MODULE

7.1 This specification sets forth the minimum requirements for a full-function BIU and

7.2 The module shall provide outputs to the controller of vehicle calls from video processors and other modules (e.g. loop amplifiers) that reside within the detector rack.

7.3 FUNCTIONAL CAPABILITIES

7.3.1 The module shall have the capability of monitoring phase information and passing that information and other system data such as “time” from the controller to video detection processor modules. The module shall also accept data from video processor modules and relay the information to the controller. The unit shall provide a maximum of 64 detector outputs to the controller via the SDLC interface.

7.3.2 The module shall reside in a NEMA TS-2 BIU slot of a detector rack to maximize the use of detector slots for video detection processor modules. The module shall interface with up to 4 video processor modules.

7.4 REQUIREMENT

7.4.1 The module shall be in compliance with the following industry specifications:

Transportation Electrical Equipment Specifications (TEES), August 16, 2002 (or latest edition), California Department of Transportation

NEMA Standard Publication TS 1-1989 (or latest edition), Traffic Control Systems, National Electrical Manufacturers Association

NEMA Standard Publication TS 2-2003, Traffic Controller Assemblies With NTCIP Requirements, Version 02.06 (or latest edition), National Electrical Manufacturers Association

7.5 DATA INTERFACES

The module shall have three data interfaces:

- The interface to the controller shall be accomplished by the use of the TS-2 SDLC port and protocol in accordance with the TS-2 specifications. The module shall be able to be configured to respond to BIU addresses 8, 9, 10 and 11 or a combination thereof.
- The interface with the detector rack shall use discrete logic inputs and outputs as defined in the TS-2 specifications for BIU's.
- The interface to communicate with card rack video detection processors shall be manufacturer specific.

8.0 USER INTERFACE

8.1 GENERAL

The module shall be self-initiating upon application of power or upon power-on reset via the reset button. The operational user interface shall be limited to those items on the front panel and shall not require a video monitor, mouse (pointing device) or computer attached directly to the module.

8.2 RESET BUTTON

A manual single pole single throw (SPST) reset push button shall be provided to the user to conduct a power-on reset of the module. The depression of the reset button shall not cause the MMU to go into "intersection flash" mode. The reset button shall be accessible from the front panel.

8.3 SYSTEM INDICATORS

High intensity LED indicators shall be used. The LED devices shall be clear when not lit and high intensity when lit. The indicators shall be "ON" for the active state and "OFF" for the inactive state.

8.4 SDLC COMMUNICATION INDICATORS

One LED indicator shall be provided for the TS-2 SDLC interface. The indicator shall be used to inform the user of any communication activity on the TS-2 port.

8.5 DETECTOR OUTPUT INDICATORS

LED indicators on the module representing the current status of the 64 output channels shall be provided. An illuminated LED indicator shall represent a “call” status; and a non-illuminated LED indicator shall represent a “no-call” status.

8.6 PRIMARY POWER INTERFACE

Power requirements of the module shall meet the requirements defined in the TS-2 specifications for BIU modules. The module shall require a normal supply voltage of 24 VDC $\pm$ 2 VDC. A voltage of 16 VDC or less shall be considered loss of power and a voltage of 18 VDC or more shall be considered adequate for operation.

The plug-in card shall be design for “hot swapping”; in other words designed so that the unit is not damaged by insertion to or removal from a powered rack.

8.7 ENVIRONMENTAL REQUIREMENTS

The unit shall operate within the environmental limits identified in the NEMA TS-2 specifications. The module shall be designed and tested to meet the environmental requirements specified in the TS-2 specifications.

9.0 MECHANICAL

9.1 SYSTEM FORM FACTOR

The physical form factor of the module shall be in accordance with NEMA TS-2 BIU form factor requirements as specified in the TS-2 specifications.

9.2 ACCESSIBILITY

All interface cables and display indicators shall be on the front of the unit for easy access.

9.3 MATERIAL AND CONSTRUCTION

The module front panel shall be aluminum and shall be designed for ease of manufacturability. All ferrous metal parts shall be protected against corrosion. All materials shall be moisture and fungus resistant.

9.4 PRINTED CIRCUIT BOARDS

Printed circuit boards shall meet the requirements of the TS-2 specifications.

9.5 CONNECTORS

Input and output connectors shall be provided with locking mechanisms that eliminate accidental extraction of interface cables.

10.0 SINGLE POINT INTERFACE ETHERNET DEVICE

10.1 This specification sets forth the minimum requirements for a module that provides a single point interface to multiple rack-mounted video detection units. This module shall also have the capability to stream up to 4 simultaneous video streams over an Ethernet interface.

11.0 FUNCTIONAL CAPABILITIES

11.1 The interface device shall provide capabilities to enable multiple rack-mounted video detection processors to be locally and remotely accessed from a single point via one set of user interface devices. User interface devices are defined as a pointing device (mouse or track-ball) and video monitor.

11.2 Up to four video detection processor chains (video detection processor and extension modules) shall be accommodated.

11.3 The device shall allow the operator to switch video output display for any of the attached rack-mounted video detection processors by pressing a momentary switch or by using the remote access software.

11.4 Local user access to video detection programming shall be limited to the detection processor unit that is currently being displayed on the monitor.

11.5 All local programming and setup parameters for the video detection processor shall be user accessible through the interface unit without requiring the user to swap user interface cables between video detection processors.

11.6 Remote access to the device shall be through the built-in Ethernet port or EIA-232 port via access software running on a Microsoft Windows based personal computer.

11.7 An internet browser-based remote access firmware shall also be available for remote setup and diagnostics of the interface unit.

11.8 The interface unit shall support streaming video technology using MPEG4 and H.264 standards to allow the user to monitor video detection imagery over the Ethernet interface. Motion JPEG streaming video shall not be allowed.

11.9 The user shall be able to select which video input to be displayed on the output video monitor by repeatedly depressing the menu button.

11.10 The user shall be able to select a quad view of all of the four cameras simultaneously on the output video monitor by depressing the menu button.

11.11 The interface unit shall allow four independent streams, one from each video detection processor, to be transported via Ethernet to four independent streaming video players simultaneously in CIF resolution.

11.12 The interface unit shall also have a browser interface that allows the user to configure the module.

11.13 The browser interface shall also allow the user to view the streaming video on the browser interface.

11.14 The browser interface shall allow the user to select the resolution of the displayed streamed video.

11.15 The interface unit shall support the streaming and display of D1, CIF, QCIF, VGA and QVGA video resolutions in a single stream or four concurrent streams in CIF resolution.

11.16 The interface unit shall allow the user to select a quad-view of all four input video signals to be shown on the browser interface.

11.17 The interface unit shall allow the user to manage the unit's Ethernet bandwidth usage by allowing the user to select the maximum bandwidth limit between 256 kbps and 7.0 Mbps.

11.18 The browser interface shall allow the user to change the unit's Ethernet network settings of IP address, subnet mask and default gateway.

11.19 The interface unit shall allow the user to upload new application firmware through the use of the browser interface.

11.20 Access to the interface unit shall be under password control and the browser interface shall allow the user to change the password.

11.21 The interface unit shall have the capability to perform IP port redirecting between the remote management software and each attached video detection processor. A unique IP port number shall be assigned for each video detection interface. The port number shall not be identical to the web browser interface of 80.

12.0 INTERFACE DEVICE HARDWARE

12.1 The interface device shall be specifically designed to mount in a standard TS-1, TS-2, and 170 type detector rack, using the edge connector to obtain power. No adapters shall be required to mount the interface device in a standard detector rack.

12.2 The interface device shall occupy no more than two slots in the detector rack and shall provide a loop-type handle for easy installation and removal.

12.3 The interface device shall be powered by 12 or 24 volts DC and shall not consume more than 6.25 watts. The unit shall automatically compensate for the different input voltages and shall be hot-swappable.

12.4 The interface device shall operate in a temperature range from -35°C to +74°C and a humidity range from 0% RH to 95% RH, non-condensing.

12.5 Video Ports - The interface unit shall accommodate a maximum of four composite video inputs and one video output.

12.6 Video inputs and video output shall be made via BNC connectors to ensure secure connections. RCA or other straight friction plug-in type connections shall not be allowed. Video inputs shall use a vendor supplied "octopus" cable to accommodate the four video inputs. Provisions shall be made to accommodate the mating cable to utilize jack screws for securing the octopus cable.

12.7 The interface unit shall accommodate either monochrome or color video signals conforming to NTSC or PAL video standards.

12.8 The interface unit shall automatically sense the video input signal and configure the video output port to either NTSC or PAL standards. Each video input signal shall be separately sensed to allow mixed video signals.

12.9 The interface unit shall interface with up to four video detection processors using RJ-45 interface connectors.

12.10 The interface unit shall support the use of USB pointing devices. The unit shall support either a USB mouse or trackball. Pointing devices shall not require vendor specific pointing device software drivers.

12.11 An EIA-232 communications port shall be provided for local and remote access. The connector for this port shall be a 9-pin “D” subminiature connector on the front of the interface unit. Provisions shall be made to accommodate mating cables to utilize jack screws for securing cables.

12.12 Hi-intensity LED status lights shall be provided to facilitate system monitoring. Indicators shall be provided to show the status of the internal processor, video lock and indication of which video input is being monitored.

12.13 An Ethernet port shall be integrated within the interface unit. The Ethernet port shall conform to 802.3 Ethernet specifications and shall auto-sense between 10 and 100 Mbps data rates. Industry standard TCP/IP (UDP and TCP packets) protocol shall be supported. The Ethernet connection shall be made through a RJ-45 connector.

13.0 MAINTENANCE AND SUPPORT

13.1 The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the video detection system. These parts shall be available for delivery within 30 days of placement of an acceptable order at the supplier's then current pricing and terms of sale for said parts.

13.2 The supplier shall maintain an ongoing program of technical support for the video detection system. This technical support shall be available via telephone, or via personnel sent to the installation site upon placement of an acceptable order at the supplier's then current pricing and terms of sale for on site technical support services.

13.3 Installation or training support shall be provided by a factory-authorized representative and shall be a minimum IMSA-Level II Traffic Signal Technician certified.

13.4 All product documentation shall be written in the English language.

14.0 SYSTEM INSTALLATION & TRAINING

14.1 The supplier of the video detection system may supervise the installation and testing of the video detection system and computer equipment as required by the contracting agency.

14.2 Training shall be made available to personnel of the contracting agency in the operation, set up, and maintenance of the video detection system.

15.0 WARRANTY, SERVICE, & SUPPORT

15.1 For a minimum of two (2) years, the supplier shall warrant the video detection system. Ongoing software support by the supplier shall include all software updates. These updates shall be provided free of charge during the warranty period. The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be available to the contracting agency in the form of a separate agreement for continuing support.

H. EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM

1.0 The 3M Corporation Opticom brand of radio activated, GPS based emergency vehicle traffic signal priority control system (Preempt System) shall be installed in all traffic signal systems.

1.1 All equipment and cabling necessary for the operation of the Preempt System shall be supplied and installed by the contractor to 3M specifications.

1.2 Software configuration and system testing of the Preempt System shall be completed by the City Traffic Division personnel.

I. FIBER OPTIC INTERCONNECT

1.0 All designed interconnect systems shall use single-mode fiber optic, interconnect cable.

1.1 This work shall consist of furnishing and installing a fiber optic network for a traffic signal Controller in accordance with Traffic Signal System, Scope of Work as herein before specified and the following. All fiber optic components, except the interconnect cable specified separately, required to provide proper communication between local Controllers and/or the Master shall be furnished and installed as a part of this item. These items shall include but not be limited to the following items:

2.0 **DISTRIBUTION ENCLOSURE.** Field cable shall terminate in the Controller cabinet within a wall mount distribution enclosure. The distribution enclosure shall be dust and moisture repellent. The size of the enclosure shall be adequate for the number of fibers, proper winding area, and splices. The enclosure shall be mounted on the inside cabinet wall or other approved location, which does not interfere with the normal maintenance of the cabinet electronics. The field cable shall be secured to the enclosure in a manner that does not degrade the fiber optic cable but insures a firm and secure mount. The field cable jacket shall be removed and all protective gel shall be removed and the cables and tube areas shall be prepared in accordance with the manufacture's recommendation. Sufficient lengths of every loose tube shall be coiled within the enclosure to provide spare distance and reach the fiber interface panel. Enclosures shall be 3M brand 8173/W4 <4 coupler> or 8173/W8 <8 coupler> or approved equal. Only fibers needed to operate equipment plus two spares shall be terminated. All other fibers shall be capped and sealed in accordance with manufacturer's recommendation.

3.0 **CONNECTORS.** SC or ST type connectors of ceramic ferrule and Physical Contact <PC> end finish shall be used to terminate fibers to equipment. The signal design shall specify the type of connector used. Mechanical connectors shall not be used to splice cables.

4.0 **SPLICES.** The fiber cable shall be installed in continuous runs between Controller cabinets unless otherwise specified on the Plans. No splices shall be allowed outside the Controller cabinets. Only mechanical or fusion splices will be allowed when splices are authorized.

5.0 **FIBER OPTIC CABLE.** This work shall consist of furnishing and installing the fiber optic cable of the type, size, and number of fibers specified and all associated accessories. Materials and accessories shall be the standard products of a manufacturer regularly engaged in the manufacture of fiber optic products. All materials and equipment furnished shall be completely free from defects and poor workmanship. All fibers in the cable must be usable and meet specifications. The product provided shall meet the latest applicable standard specifications by American National Standards Institute <ANSI>, Electronics Industries Association <EIA>, and Telecommunications Industries Association <TIA> for the type mode cable of the size specified and the specifications herein. The specified cable used shall be specified in the project plans.

5.1 Cable terminations shall be made by a trained and qualified technician with a minimum of two years experience in installing and terminating fiber optic cable. This function may be provided by a person other than the installing Contractor. Upon Request by the Engineer, the Contractor shall provide documentation on qualifications and experience for fiber optic

equipment installations. The Engineer shall be the sole judge of the acceptability of the experience level of the proposed individual selected for this function.

5.2 After the complete System is installed and terminated, but excluding the capping of unused fibers, an OTDR reading shall be preformed on all cables to insure that each section is in compliance with the issued specification. A hard copy of OTDR signature traces for all fibers for all sections shall be provided to the Engineer. Fibers that have been terminated shall be indicated in the report. In addition to the OTDR test report, the Contractor shall provide the test results of an Attenuation Test for the installed fibers using the insertion loss test procedure and the Transmitter/Receiver Power Level Test and the Continuity Test. The results of all testing shall be recorded along with the date of the test, the name of the person performing the test, brand name, model number and serial number of all equipment used during the test, and any other pertinent information and data. The complete documentation file of all tests conducted and factory tests shall be submitted to the Engineer.

6.0 **FIBER OPTIC SLACK, BENDING, AND PULLING**. The cable end shall be secured inside the Controller cabinet so that no load is applied to the exposed fiber strands. The minimum bend radius for static storage shall not be less than ten times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.

6.1 The minimum bend radius during installation shall not be less fifteen times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer. Note: The Contractor should not use tie wrap devices on fiber optic cable due to the force exerted on the fiber and the ease of which this force can permanently damage the fiber.

6.2 Slack cable shall be left in each handhole or double handhole, at the top of any conduit riser, junction box, and Controller. This slack cable requirement may be deleted where existing hand holes or through points lack sufficient area to maintain the minimum bend requirements. Where slack has been deleted, extra slack equal to the amount that would have been distributed in the through points shall be equally divided between the two Controller cabinets and shall be in addition to the slack mandated at the cabinets. Each handhold or through point shall be provided with a minimum of 6.5 feet of slack. Controller cabinets shall be provided with a minimum of 19.5 feet. Slack cable shall be coiled and the coils bound at three points around the coil perimeter and supported in their static storage position.

7.0 **CABLE INSTALLATION IN CONDUITS**. A suitable cable feeder guide shall be used between the cable reel and the face of the conduit. The cable feeder shall be designed to protect the cable and guide the cable directly into the conduit off the reel. During the installation, the cable jacket shall be carefully inspected for jacket defects. If defects are found the Engineer shall be notified prior to any additional cable being installed. The Contractor shall take unusual care in the pulling of the cable to insure that the cable does not become kinked, crushed, twisted, snapped, etc. A pulling eye shall be attached to the cable and be used to pull the cable through the conduit. A pulling swivel shall be used to preclude twisting of the cable. The cable shall be lubricated prior to entering the conduit with a lubricant recommended by the manufacturer. The lubricant shall be water base type. Dynamometers or break away pulling swing shall be used to insure that the pulling tension does not exceed the specified force of 600 lbs. or the cable manufacture's recommendations, which ever is less. The mechanical stress on the cable shall not allow the cable to twist, stretch, become crushed, or forced around sharp turns, which exceed the bend radius or scar or damage the jacket. The pulling of the cable shall be hand assisted at each pull point.

7.1 At each hand hole or through point and at the cabinet, the cable shall be visibly marked or tagged as "CAUTION-FIBER OPTIC CABLE."

7.2 An insulated copper wire, AWG No. 12 shall be pulled in the same conduit as the fiber optic cable in order to trace the installation. The ends of the trace wire shall be insulated and terminated in the last hand hole prior to the Controller cabinet. Due to the electrical conducting characteristics of the wire, especially during electrical storms, the wire shall not enter any Controller cabinet.

J. GROUNDING SYSTEM. (See plan details for further information.)

1.0 An equipment grounding conductor (EGC) shall be installed to electrically bond together all non-current carrying conductive materials, including cabinets, poles, pull boxes and raceways, to form an effective ground-fault current path to the overcurrent protective device (breaker) at the service location, as per NEC section 250.4(A)(5). The earth shall not be used as the sole equipment grounding conductor or effective ground-fault path. The EGC shall be electrically isolated from A.C. Neutral in the controller cabinet.

1.1 The EGC shall be copper XHHW insulated wire sized per NEC section 250.122. Stainless steel fasteners and copper compression lugs shall be used. Use a specification grade bonding bushings, with stainless steel and hot dip galvanized construction. Use a listed copper conductive compound on all threads and conductors.

1.2 The grounding system to the service disconnect shall consist of four 5/8 inch X 10 foot copper clad ground rods placed fifteen feet in opposite directions away from the utility pole. The ground rods shall be connected using Cadweld connectors to #2/0 copper cable. Bolt type clamps shall not be used. A common #2/0 copper cable may be connected into the disconnect equipment with the four cables being spliced at the base of the pole.

1.3 The Controller cabinet shall be grounded via a #6 copper wire to a 5/8 inch X 10 foot copper clad ground rod located in a handhole a minimum distance of fifteen feet away from the Controller cabinet. No ground rods may be installed within the cabinet.

1.4 A 5/8 inch X 10 foot copper clad ground rod shall be installed at each lighting standard and traffic signal pole. These rods shall be interconnected to each other and the service panel. Interconnection conductors shall be a minimum of #6 copper wire and have an insulation type of TW or approved equal. The rod shall be offset below grade to extend into earth and be centered in base in top end of concrete and extend approximately 6 inches above concrete.

1.5 All loop detector lead-in cables shall have the drain shield wire grounded at the point where the loop wires are connected to the lead-in cables. The drain shield wire shall be removed and covered at the cabinet. The loop lead-in grounding system shall not be connected to or come in contact with any portion of the remainder of the AC grounding system.

K. CONTRACTOR COORDINATION

1.0 The Contractor shall coordinate with the City of Council Bluffs Permits & Inspections Department and the local power company for the electrical connection for the 120 VAC power source to the Traffic Signal. Conduit and wire as specified in the plans shall be furnished and installed from the point of the power source to the cabinet. The cost of furnishing and installing this conduit and wire and the termination shall be considered incidental to the project and no additional bid item is provided other than the installation of the Traffic Signal. All conduit, wiring, and power service installations shall meet or exceed current National Electrical Codes and any other applicable local codes and ordinances.

1.1 The Contractor is required to coordinate with the various utilities in order to obtain clearances required for the installation of conduit and other accessories required to install the complete

signal system. All costs incurred in the obtaining of space, marking, defining and coordination are considered incidental to the installation of the Traffic Signal.

L. GUARANTEE

1.0 The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class workmanship manner from good quality material.

1.1 The entire Controller unit shall be warranted to be free from defects in workmanship and materials for a minimum of one year from date of acceptance. Any part(s) found to be defective, upon concurrence of the defect by the manufacturer, shall be replaced or repaired free of charge.

1.2 The owner shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items, which do not comply with this specification, then a list of those exceptions must be detailed on the certification and on the equipment submittals for the project. Failure to submit a list of exceptions on either the equipment submittals of the certification shall be deemed to be compliance with all used specifications. Should deviations from the specifications be determined from either the review of the equipment submittals or the installation of the hardware into the complete system, the Contractor shall be provided 30 days to correct the deviations(s) before rejection of the project and removal of the equipment.

M. VEHICULAR SIGNAL HEADS

1.0 All vehicular signal heads shall be constructed with 12 inch diameter lens openings. All components of the vehicular signal heads furnished under this specification shall comply with the latest version of the Institute of Transportation Engineers Standard(s) for Adjustable Face Vehicle Traffic Control Signal Heads.

1.1 Lenses shall be 12 inches in diameter and shall be polycarbonate. Glass lenses are not acceptable. The lenses shall have an optimal curvature to allow maximization of heat dissipation within the signal (reflector to lens) and reduce the possibility of lens burning.

1.2. Visors shall be tunnel type and at least 9-1/2 inches long. Reflectors shall be Alzak treated aluminum or glass. All external signal hardware and fasteners of the signal shall be stainless steel, including hinge pins and latching mechanisms.

1.3 The optical unit of the signal shall be of a design to permit the opening of the signal face for relamping of the signal without the removal of the lamp socket from the reflector assembly.

1.4 The color of all polycarbonate signal heads, except door fronts and inside and outside of visors, shall be federal yellow. Door fronts and inside and outside of visors shall be black in their entirety. The color of the material shall be an integral part of the materials composition.

1.5 All signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both the horizontal and vertical planes. Bracket assemblies shall be of a design similar to that shown on the plans. Bracket assemblies shall be aluminum.

1.6 All signal heads placed on mast arms shall be provided with backplates. Backplates shall be of 5 inch borders and be attached to the signal heads in accordance to city standards. Backplates shall be constructed of one-piece vacuum formed durable black plastic capable of withstanding a 100 MPH wind, excluding five section signal displays. The outer edge of the backplate shall utilize a stabilizer formed from the same material as the backplate. The backplates shall be

attached to the signal heads utilizing appropriate machine screws, fender washers and locking nuts as per details.

1.7 All vehicle signal indications (red, yellow and green) shall be the Dialight LED 12 inch display or an approved equal. The unit shall be mounted and appear as a normal indication within the signal head. All standard arrows shall utilize LED technology signal displays. All LED signals shall meet ITE specifications for signal color and intensity.

1.8 All LED Ball Signal Modules (8 inch and 12 inch) shall be fully compliant to the ITE VTCSH LED Circular Supplement specifications dated and adopted June 27, 2005.

1.9 All LED 12 inch Arrow Signal Modules shall be fully compliant to the "Omni-directional" specifications of the ITE VTCSH -LED Vehicle Arrow Traffic Signal Supplement adopted July 1, 2007.

1.10 The on-board circuitry of all LED traffic signal modules shall include voltage surge protection, to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.8, NEMA Standard TS 2-2003. In addition, the module shall comply with the following standards: IEC 1000-4-5 at 3kV with a 2 ohm source impedance, ANSI/IEEE C62, 41-2002; IEC 61000-4-12 (6kV, 200A, 100kHz ring wave).

N. PEDESTRIAN SIGNAL HEADS & PUSH BUTTONS

1.0 The pedestrian signal head shall comply with the latest version of the Institute of Transportation Engineers Standards on Pedestrian Traffic Control Signal Indications and the Manual on Uniform Traffic Control Devices. The pedestrian signal head shall be a stacked two-section head with 12 inch lenses or one 18 inch section with side-by-side indications as shown on the plans. Combination hand/person pedestrian signal modules shall incorporate separate power supplies for the hand and the person icons. The pedestrian signal head shall be the Dialight Countdown Pedestrian Signal or an equivalent signal approved by the City Traffic Engineer.

2.0 SIGNAL HEAD ASSEMBLY

- **a.** The signal heads shall use the international symbols (walking person and raised hand).
- **b.** Lenses shall be polycarbonate; glass lenses are not acceptable.
- **c.** All pedestrian signal indications shall be LED. The "walking person" symbol and "raised hand" symbol shall be Dialight LED display or approved equal. All LED signal indications shall meet ITE specifications for signal color and intensity.
- **d.** The "walking person" symbol shall be Portland orange and the "walking person" symbol shall be lunar white.
- **e.** The color of all polycarbonate signal heads, except door fronts and inside and outside of visors, shall be federal yellow. Door fronts and inside and outside of visors shall be black in their entirety. The color shall be an integral part of the materials composition.
- **f.** Pedestrian signal mounting hardware shall consist of 1-1/2 inch diameter polycarbonate with appropriate fittings and shall be federal yellow. Pedestrian signals shall be secured to pole by using a minimum 5/8 inch wide stainless steel band.
- **g.** The pedestrian signal head shall include polycarbonate visors for each section. Visors shall be a minimum of 9 inches long.
- **h.** The one-section pedestrian head shall include a 1-1/2 inch deep egg crate or Z-crate screen of polycarbonate.

3.0 PEDESTRIAN PUSH BUTTONS

3.1 The pedestrian push button shall be pressure activated, with no moving parts. The pedestrian push button shall provide audible and visual feedback of actuation. The feedback indications shall be powered by the existing switch wires.

3.2 **Construction**. The push button body shall be constructed of aluminum with a yellow powder coated finish. The button material shall be stainless steel.

3.3 **Solid State Switch.** The push button shall be equipped with a solid state switch with these characteristics:

- Operating force no greater than 3 pounds
- Operating temperature shall be -30°F to 165°F
- Operating voltage shall be 15-36V DC or 12-28V AC
- On resistance shall be 10Ω typical
- Operating life shall be greater than 100 million operations
- Switch hold time shall be 6 seconds minimum
- Operating Standby Current shall be 10μA typical (equivalent to 2MΩ at 20V)

3.4 **LED.** The LED indicator shall display an approx. 0.025 second red flash each time the button is pressed, with a luminous intensity of greater than 1200 mcd, and a viewing angle of 160 degrees or greater.

3.5 **Beeper.** The beeper shall sound simultaneously with the LED flash. The beeper shall emit separate tones for press and release.

3.6 **Sign**. An MUTCD R10-4B sign shall be provided and installed by the contractor.

O. MAST ARMS AND POLES

1.0 All steel traffic signal mast arm pole assemblies shall be designed and detailed by the manufacturer supplying the poles. In the event special sized poles and mast arms are required for a signalization project, the Contractor shall submit from the pole manufacturer calculations of all loads transmitted to the bases prior to fabrication. Calculations shall be stamped by a registered professional engineer in the State of Iowa. All calculations shall be submitted with shop drawings and shall be reviewed by the Engineer prior to fabrication.

P. POLE BASES

1.0 All concrete pole bases shall be designed as per the standard plans. When special bases are required, all calculations of all loads transmitted to the bases shall be submitted prior to fabrication. A registered professional engineer in the State of Iowa shall stamp calculations. All calculations shall be submitted with drawings and shall be reviewed by the Engineer prior to fabrication.

Q. CONDUIT AND CONDUIT FITTINGS

1.0 Conduit and conduit fittings for direct bury applications shall be galvanized rigid steel conforming to UL-6, UL Standard for Safety for Electrical Rigid Metal Conduit – Steel; high-density polyethylene conforming to ASTM F2160, Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD); or rigid polyvinyl chloride conforming to UL-651, UL Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit.

1.1 Conduit and conduit fittings for boring applications shall be high density polyethylene conforming to ASTM D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter. Furnish in standard lengths with UL label.

1.2 Rigid steel conduit fittings shall be galvanized steel or galvanized malleable iron. Galvanizing shall comply with ASTM C123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. PVC conduit fittings and cement shall be compatible with the PVC conduit. Transitions between HDPE and PVC conduits shall conform to the manufacturer's recommendations. Conduit size shall be the minimum trade size permitted for the application and shall have a constant circular cross sectional area. Conduit installed for above ground risers shall be galvanized rigid steel conduit.

R. ELECTRICAL CABLE

1.0 GENERAL

a. Electrical cable for intersection signalization shall be rated 600 volts minimum and be IMSA specification cable where applicable.

b. The number of conductors and size of all electrical cable shall be as shown on the plans.

c. 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.

d. All conductors used in the Controller cabinet shall be a minimum of No. 22 AWG (or larger, if required by the amperage requirements of the particular circuit), tinned copper conductors with a minimum of 19 strands, and shall conform to Federal Specifications IL-W-16878D, Type B or D, Vinyl-Nylon Jacket, 600 volts, 105°C, equal or better. Conductors used in the Controller cabinet shall conform to the NEC color codes:

A. C. Neutral	White
A. C. Line	Black
Chassis, Safety Ground	Green
Control	Any color not listed above

2.0 POWER LEAD-IN CABLE

a. Power lead-in cable shall be of the sizes as shown on the plans.

b. Power lead-in cable shall be 600 volt, single conductor, stranded copper, Type USE, and UL approved.

3.0 SIGNAL CABLE

a. Signal cable shall be 600 volt, multi-conductor, with copper conductor of the number and size as shown on the plans.

b. Signal cable shall meet the requirements of the International Municipal Signal Association (IMSA) specification 19-1, latest revision thereof for polyethylene insulated, polyvinyl chloride jacketed signal cable. All conductors shall be #14 AWG unless otherwise specified on the plans.

4.0 LOOP DETECTOR WIRE (WITH PLASTIC TUBING)

The loop wire shall meet the requirements of the International Municipal Signal Association (IMSA) specification 51-5, latest revision thereof for a nylon or cross-linked polyethylene jacketed

conductor, loosely encased in a polyethylene tube loop detector wire. The conductor shall be #16 A.W.G. unless otherwise specified on the plans.

5.0 DETECTOR LEAD-IN CABLE

Detector lead-in cable shall meet the requirements of the international Municipal Signal Association (IMSA) specification 50-2, latest revision thereof for polyethylene insulated, polyethylene jacketed loop detector lead-in cable. All conductors shall be # 14 A.W.G. unless otherwise specified on the plans.

6.0 COMMUNICATIONS CABLE (TELEPHONE) (WHEN APPLICABLE)

a. Traffic control communications cable for signal interconnection circuits shall be #19 AWG, solid copper conductor, twisted pairs. The cable shall meet the requirements of the International Municipal Signal Association (IMSA) specification 39-2, latest revision thereof for paired polyethylene insulated, polyvinyl chloride jacketed cable with electrical shielding.

b. The number of twisted pairs required shall be as shown on the plans (minimum of two pairs).

7.0 TRACER CABLE

a. A tracer cable shall be installed in all conduits with signal cables, detector lead-in cables, or fiber optic communication cables.

b. The tracer cable shall be a single conductor, stranded copper, AWG #12, Type THHN, with UL approval and an orange colored jacket.

c. The tracer cable shall be identified in the Controller cabinet, handholes, and poles by means of identification tags.

8.0 GROUNDING CABLES

a. The EGC shall be copper XHHW insulated wire sized per NEC section 250.122. Stainless steel fasteners and copper compression lugs shall be used. Use a specification grade bonding bushings, with stainless steel and hot dip galvanized construction. Use a listed copper conductive compound on all treads and connectors.

b. Grounding conductors within lighting standards and traffic signal poles shall be a #6 copper cable.

c. All grounding conductors which tie grounding systems together with conduits shall be a #6 copper cable with a TW insulating jacket.

d. All grounding conductors that connect bonding bushings to grounding systems shall be a #6 copper cable.

e. All grounding conductors between terminal strip support plates and the cabinet grounding bus shall be a minimum of a #10 copper cable or a braided copper cable with equal cross sectional area.

S. LOOP DETECTORS

1.0 PREFORMED LOOPS

1.1 In all projects where new pavement is to be placed in the loop areas and wherever possible and practical, preformed loops shall be installed within or under the pavement in lieu of pavement sawn loops. The Engineer shall be notified when the Contractor requests to substitute pavement sawn loops for preformed loops and the Engineer shall determine if the request should be approved. Preformed loops may either be manufactured by an approved supplier, or built by the contractor.

1.2 Currently approved manufactured preformed loops are 1) Patriot Detection Systems model CG16MMC, and 2) Reno A&E model PLH. Equivalent products may be approved by the City Traffic Engineer.

1.3 Preformed loops built by the contractor shall consist of 1/2 inch rigid polyvinyl chloride conduit with approved IMSA loop wire conductors placed within the conduit. The conductors within the conduit shall be held firmly in place by a filler material such as backer rod, expanding foam, or silicone based sealants, which will remain flexible and provide rigidity to the conductors throughout the life of the preformed loop. The conduit shall be thoroughly solvent welded to prevent moisture infiltration and provide mechanical strength to the loop. A PVC pulling elbow shall be placed at the point where the lead-in point meets the edge of the loop.

1.4 When installed, no part of the loop shall be within 2 feet of reinforcement rods in the surrounding pavement.

1.5 The loop should not be situated directly over any large metal object in the ground within 5 feet of the surface.

2.0 SAWCUT LOOPS

2.1 **Loop Wire.** The detector loop wire shall be inserted into a flexible plastic tubing (IMSA Specification 50-2-1984) of the full length from the point of the splice and placed into the slot with the number of turns specified. The tubing shall be of a continuous length from the point of splicing of the loop wire to the lead-in cable. The field loop conductors installed in the pavement shall run continuously from the terminating service box or base with no splices permitted. The field loop conductors shall be spliced to the lead-in cable and the lead-in cable shall run continuously from the terminating service box or base to the detector-sensing unit. However, on multiple loop installations additional loop conductors may be spliced to the lead-in cable as directed by the Engineer. At the time of placing the loop wire in the sawed slots, the ends of the tubing shall be sealed to prevent any entrance of moisture into the tubing.

2.2 **Wire Twisting.** Wherever possible in order to reduce line noise, all lengths of loop wires and tubing that are not embedded in the pavement shall be twisted with at least five turns per foot, including lengths in conduits and service boxes.

2.3 **Loop Wire Splices.** The wires shall be spliced by soldering iron using 40/60 rosin core solder only. The solder joint shall be smooth and provide proper physical bonding of the conductors. A flame shall not be used for soldering.

2.3.1 The wire portion of the splice shall be covered with a layer of heat shrink tubing. The heat shrink shall be secured by an electrical heat gun with heat reflector to insure uniform heat distribution on the tube. No flame may be used on the heat shrink tubing.

2.3.2 The final layer of heat shrink tube shall be an outdoor rated heat shrink tube equal to the Thomas & Betts HS12-6L cross-linked polyolefin heat shrink tubing. The tubing shall be centered with a minimum of 1 inch of the outer jacket being encapsulated by the heat shrink tubing.

2.3.3 Lead-In cable to loop wire splices shall be soldered together leaving only enough exposed insulation and conductor to make the splice.

2.3.4 Loop wire to lead-in cable splices shall be environmentally sealed against weather, moisture and abrasion using a commercially available encapsulating enclosure kit.

2.4 **Location of Loops.** The location of each loop shall be marked on the pavement with crayon or spray paint. The Contractor shall obtain the approval of the Engineer prior to cutting the saw slots.

2.5 **Concrete Sawing.** The saw shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. The blade used for the saw cut shall provide a clean, straight, well-defined 3/8 inch wide saw cut without damage to adjacent areas. The depth of the saw cut shall be 2 inches. Where the loop changes direction, the saw cuts shall be overlapped to provide full depth at all corners. All adjacent cuts must be at angles greater than or equal to 90 degrees. The saw cut depth shall not vary by more than 1/4 inch within each loop. A diamond blade with water shall be used in the saw cut operation. Carbide blades are not acceptable.

2.6 **Loop Slots.** Before installing loop wire, the saw slots shall be checked for the presence of jagged edges or protrusions. Should they exist, they must be removed. The slots shall be cleaned and dried to remove cutting dust, grit, oil, moisture or other contaminants. Cleaning shall be achieved by flushing with a stream of water under a minimum of 1000 PSI pressure and following, the slots shall be cleared of water and dried using oil-free air.

2.7 **Loop Conductor Installation.** Loop detector conductor shall be installed using a 3/16 inch to 1/4 inch thick wood paddle or rotary wire insertion tool. If the wire does not lie close to the bottom of the saw cut, it shall be held down by means of a material such as duct sealant or backer rod.

2.8 **Loop Wire Placement.** Each loop shall be coiled clockwise unless specified within the plans. The beginning conductor shall be marked with a single color-coded piece of permanent tape and the associated end marked with two pieces of permanent tape of the same color. The markings shall be recorded for future information.

2.9 **Loop Detector Saw Slot Filler**

2.9.1 The saw slot filler shall be a rapid cure, high viscosity, liquid epoxy, or approved equal, formulated for use in sealing inductive wire loops and leads embedded in asphaltic concrete and portland cement concrete. The saw slot filler shall be usable on grades of 15 percent or less without excessive flow of material, unless otherwise approved by the Engineer.

2.9.2 The loop sealer or sealant shall be a two-component system, which consists of, a resin constituent identified as pourable and a hardener identified as quick setting. The sealer shall be Bondo P-606 for concrete and seasoned asphalt, E709 for new asphalt; WR Meadows Sealex; 3M Detector Loop Sealant Series 5000; or equal, as approved by the Engineer. Both the resin and the hardener shall be in liquid form before mixture of the two components. Approval of other sealants shall be based on specification and/or test data about their physical properties and chemical resistance. Loop sealant shall not be installed during rain or other forms of precipitation or below temperatures specified by the manufacturer of the product.
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.

2.9.3 No measurable amount of sealant shall be left on the surface of the pavement and the sealant within the saw cut shall be level with the pavement surface.

3.0 **LOOP TESTING**

3.1 After installation of the loops, the Contractor shall test the continuity, inductance, and resistance of the loop and lead-in wire. Tests should be conducted with one or more loop

tester devices capable of measuring the induced ac voltage, inductance in microhenrys (μH), integrity of the wire insulation, and loop wire resistance in ohms.

3.2 The wiring diagram of the plan set or the inspection report should include a table of calculated values of the inductance in microhenrys and resistance in ohms for each loop. Two values should be shown: one at the pull box without the lead-in cable, and the second at the controller cabinet with the lead-in cable connected. The loop installation is acceptable under the following conditions:

- Induced voltage: There is no deflection of the pointer on a voltmeter.
- Inductance: The inductance reading on the loop tester is within 10 percent of calculated value.
- Leakage to ground: The resistance to ground of a newly installed loop exceeds 100 megohms as measured with a 500 volt (V) megger.
- Loop resistance: The reading on an ohmmeter is within 10 percent of the calculated value.
- The total loop system (loop plus lead-in) inductance is within the acceptable range of the vehicle detector specified in the plan.
- The detector system (loops + lead-in + electronic detector) shall be capable of reliably detecting all licensed vehicles.

3.3 The Contractor shall provide the Engineer with a report on company letterhead indicating the inductance, leakage to ground, and loop resistance test values for each loop. The test shall be conducted from the curbside handhole. An inductance, leakage to ground, and loop resistance test shall also be conducted and reported for the total detector lead-in and loop system with the test being conducted at the Controller cabinet. The City Traffic Engineer may independently test any or all loops at any time. Any Loop not meeting the requirements for an acceptable loop installation shall be repaired or replaced as directed by the Engineer. The Contractor shall bear all costs of replacing loop installations deemed unsatisfactory by the Engineer.

T. WIRE SPLICING

1.0 No below grade splicing of any traffic signal wiring, except loop to loop lead-in cable, shall be allowed. All splices shall be made in signal pole bases or approved above grade enclosures.

1.1 Wires being spliced shall be twisted in a clockwise direction in order that solderless connectors can be forced onto the splice.

1.2 Solderless connectors and splice cap covers shall be secured and made water tight with either vinyl electrical tape or a liquid insulating sealant equivalent to Scotchkote electrical coating.

1.3 All exposed single layer insulation, splice cap covers, and solderless connectors shall be encapsulated in rubber electrical tape. This is to provide a cushion to the single layer of insulation.

1.4 The rubber tape shall be encapsulated in a layer of vinyl electrical tape. All portions of the tape are to be smooth and well secured.

1.5 All splices shall be oriented with the splice above the spliced wire to avoid water collecting in the splice.

1.6 Two nylon tie straps shall then be secured approximately 2 inches beyond the wire splice at 1 inch increments to act as a strain relief to the splice.

U. STREET NAME AND REGULATORY SIGNS MOUNTED ON SIGNALS

1.0 The Contractor shall furnish and install all regulatory and information signs as per project plans. The signs shall meet current MUTCD specifications in relation to size and message standards. The signs shall use urban rated prismatic reflective sheeting. The City of Council Bluffs Traffic Maintenance Division shall supply the mast arm street name signs, which shall be installed by the Contractor. Any required brackets and/or supports for the mast arm signs shall be furnished by the Contractor.

V. SIGNAL HEAD COVERS

1.0 During construction all signal heads shall be covered with black vinyl covers specifically designed for this purpose. The covers shall be fastened to the heads with nylon straps utilizing a cam lock mechanism to secure the straps. Plastic bags, cardboard, burlap and other similar materials are not acceptable covers.

W. SCHEDULE OF UNIT PRICES

1.0 Prior to the preconstruction meeting the traffic signal contractor shall forward to the engineer a list of unit costs for the individual traffic signal items. The sum of costs for each item shall equal the total Contract Lump Sum price for the traffic signal installation. The total cost shall not be unreasonably distributed among the individual unit items.