

CITY OF COUNCIL BLUFFS

SPECIAL PROVISIONS

FOR

TRAFFIC SIGNALS

AND

INTERCONNECT

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TRAFFIC SIGNAL SUPPLEMENTAL SPECIFICATIONS

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A. TRAFFIC SIGNAL CONTROLLER UNIT

1. GENERAL

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 fully compatible with the City of Council Bluff's existing TACTICS Advanced Traffic Management System manufactured by Siemens ITS. 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 – 2003 for further standards and specifications for TS2 signal equipment.

B. MALFUNCTION MANAGEMENT UNIT

1.0 Functions

1.1 GENERAL

This specification sets forth the minimum requirements for a shelf-mountable, sixteen channel, solid-state Malfunction Management Unit (MMU) with Ethernet capability. The MMU shall meet as a minimum, all applicable sections of the ***NEMA Standards Publication No. TS2-2003 (R2008)*** including ***NEMA TS-2 Amendment #4-2012***. Where differences occur, this specification shall govern.

1.1.1 NEMA TS-2 AMENDMENT #4-2012 FOR FLASHING YELLOW ARROW

The MMU shall be fully compliant with the requirements of the ***NEMA TS-2 Amendment #4-2012*** for Flashing Yellow Arrow. This standard defines the operation of a Type **MMU** device. The MMU itself shall be labeled as an **MMU**.

1.2 MONITORING FUNCTIONS

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

1.2.1 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.

When voltages on two inputs of a vehicle channel are sensed as active for more than 450 msec, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the DUAL INDICATION fault. 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 vehicle channel are sensed as active for less than 200 msec, the MMU shall not transfer the OUTPUT relay contacts to the Fault position.

When operating 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.

1.2.1.1 DUAL INDICATION PROGRAMMING

Programming shall be provided to enable the Dual Indication monitoring function for the Green and Red, Green and Yellow, and Yellow and Red combinations for each individual channel. In the Type 12 mode, the Walk inputs shall be logically OR'ed with the Green inputs for purposes of Dual Indication programming.

1.2.2 FIELD CHECK MONITORING

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.

1.2.2.1 FIELD CHECK MONITOR

In the Field Check Fault mode, when the field signal input states sensed 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 indicate the FIELD CHECK FAIL fault. 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.

1.2.2.2 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 inputs on which the Field Check errors were detected shall be reported on the Channel Status display. Bit #67 (Spare Bit #1) of the Type #129 response frame shall also be set to indicate Field Check errors have been detected.

1.2.2.3 FIELD CHECK PROGRAMMING

Programming shall be provided to enable the Field Check monitoring function for each Green, Yellow, and Red input individually. Programming shall be provided to enable the Field Check monitoring function for channel 2, 4, 6, and 8 Walk input individually when operating in the Type 12 with SDLC mode.

1.2.3 RECURRENT PULSE MONITORING

The Signal Monitor shall detect Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs. These recurring pulses shall result in a latching fault with the RECURRENT PULSE STATUS indicated along with the resulting Conflict, Red Fail, or Dual Indication status. An option shall be provided to disable the RP detect function for testing purposes.

When operating with Port 1 communications enabled, Bit #69 (Spare Bit #3) of the Type #129 response frame shall be set to indicate a Recurrent Pulse status has been detected.

1.2.4 EXTERNAL WATCHDOG MONITORING

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 indicate the WATCHDOG fault. 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 WATCHDOG fault state of the monitor. The EXTERNAL WATCHDOG input shall be wired to connector MSB-S.

When operating 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.

1.2.5 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, and indicate the TYPE 12/16 fault. 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.

1.2.6 FLASHING YELLOW ARROW PPLT SUPPORT

The MMU shall be designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement as specified by NEMA TS-2 Amendment #4-2012. Twelve cabinet configurations shall be supported for the MMU Type 16 mode and four modes for the Type 12 mode, in order to support cabinet configurations limited by the number of load switches provided and the capabilities of the Controller Unit. The MMU shall be designed to provide the same fault coverage for the FYA approaches as it does for conventional protected left turn phases, including Conflict, Red Fail, Dual Indication, and both Minimum Yellow and Minimum Yellow Plus Red Clearance monitoring.

1.3 CONFIGURATION OPTIONS

1.3.1 WALK DISABLE OPTION

This option will modify the operation of Red Fail and Dual Indication Monitoring in the TS-1 Type 12 mode only. When enabled, the Red Fail and Dual Indication Monitoring function will not monitor the Walk field outputs. Absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU into the Red Fail fault mode causing the Output relay contacts to transfer. Presence of active signals on the Walk output will not cause a Dual Indication when concurrent with active Red or Yellow signals.

1.3.2 LED SIGNAL THRESHOLD ADJUST

The MMU shall provide the capability to sense field inputs signals with the following thresholds:

Conflict, Dual Indication Low Threshold Signal Inputs (Green, Yellow, and Red)

No Detect less than 15 Vrms

Detect.....greater than 25 Vrms

Red Fail High Threshold Signal Inputs (Green, Yellow, and Red)

No Detect less than 50 Vrms

Detect.....greater than 70 Vrms

1.3.3 CVM LOG DISABLE OPTION

The MMU shall provide a means to disable the logging of CVM fault events.

1.3.4 CVM 3X/DAY LATCH OPTION

The MMU shall provide a mode for allowing up to two CVM events in a 24 hour period to be non-latching. The third CVM event in a 24 hour period shall be latching. Following the third event a power cycle shall reset the count from 3 to 2. A manual reset shall reset the count to 0

1.4 DISPLAY FUNCTIONS

The following display functions shall be provided in addition to those required by the NEMA TS-2 Standard Section 4. A PC shall not be required to display the following parameters.

1.4.1 FIELD SIGNAL VOLTAGES DISPLAY

A mode shall be provided to display the RMS voltage of each field signal input. If the MMU is not in the fault mode, the displayed voltage will be the currently applied RMS voltage. If the MMU is in the fault mode, the displayed voltage will be the applied RMS voltage at the time of the fault.

1.4.2 CABINET CONTROL SIGNAL VOLTAGES DISPLAY

A mode shall be provided to display the RMS voltage of the AC Line and Red Enable, the frequency of the AC Line, and the ambient temperature measured at the MMU. If the MMU is not in the fault mode, the displayed values will be the currently applied values. If the MMU is in the fault mode, the displayed values will be the applied values at the time of the fault.

1.4.3 FIELD CHECK STATUS DISPLAY

When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Field Check status.

1.4.4 RECURRENT PULSE STATUS DISPLAY

When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Recurrent Pulse status.

1.4.5 CONFIGURATION DISPLAY

A display mode for the front panel display shall be provided that allows the setting and viewing of all MMU configuration parameters. The configuration parameters provided on the program card shall be viewable only. A PC shall not be required to completely program or view the MMU configuration parameters.

1.4.6 EVENT LOGS DISPLAY

A display mode for the front panel display shall be provided to review all details of the Previous Fail log, AC Line log, and the Monitor Reset log.

1.4.7 CLOCK SET DISPLAY

A display mode for the front panel display shall be provided to view and set the time and date of the MMU real time clock.

1.5 OPERATING MODES

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

1.5.1 TS-1 TYPE 12 WITH SDLC MODE

The MMU shall be capable of operating in the Type 12 mode with SDLC communications enabled on Port 1. The Channel Status display shall operate in the Type 12 configuration and provide the Field Check function for up to four pedestrian Walk inputs.

2.0 HARDWARE

2.1 ENCLOSURE

2.1.1 SIZE

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

2.1.2 MATERIAL

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

2.2 ELECTRONICS

2.2.1 MICROPROCESSOR MONITOR

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 illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within a defined period not to exceed 500 ms. Only an MMU Power Failure shall reset the DIAGNOSTIC fault state of the monitor.

2.2.2 RMS VOLTAGE MEASUREMENT

High speed sampling techniques shall be used to determine the true RMS value of the AC field inputs. Each AC input shall be sampled a minimum of 32 times per line cycle. The RMS voltage measurement shall be insensitive to phase, frequency, and waveform distortion.

2.2.3 SOCKETS

In the interest of reliability, no IC sockets shall be used.

2.2.4 BATTERY

All user programmed configuration settings shall be stored in an electrically erasable programmable read-only memory (EEPROM). Designs using a battery to maintain configuration data shall not be acceptable. If a battery is used, it shall provide power only to the real time clock.

2.2.5 FIELD INPUT TERMINALS

All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater.

2.2.6 COMPONENT TEMPERATURE RANGE

All electrical components used in the MMU except the front panel Status LCD shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34°C to +74°C.

2.2.7 PRINTED CIRCUIT BOARDS

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

- a) Both sides of the printed circuit board shall be covered with a solder mask material.
- b) 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.
- c) All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

2.3 FRONT PANEL AND CONNECTORS

2.3.1 MMU STATUS DISPLAY

A four line by 20 character alpha-numeric LCD display shall be provided to report MMU status, time and date, menu navigation, etc. This display shall be separate from the full intersection channel status display.

2.3.2 FULL INTERSECTION CHANNEL STATUS DISPLAY

A separate Red, Yellow, and Green indicator shall be provided for the channel status LCD display for each channel to show full intersection status simultaneously. For Type 12 mode operation a separate Red, Yellow, Green and Walk indicator shall be provided for each channel to show full intersection status simultaneously. Individual icons shall also be provided to indicate channels involved in a fault.

2.3.3 LED DISPLAY INDICATORS

The following LED display indicators shall be provided:

2.3.3.1 POWER INDICATOR

The green POWER indicator shall flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It shall illuminate steadily when the AC LINE voltage returns above the restore level. It shall extinguish when the AC Line voltage is less than 75 Vrms.

2.3.3.2 FAULT INDICATOR

The red FAULT indicator shall illuminate when the MMU is in the fault mode and the OUTPUT relay has transferred to the Fault position.

2.3.3.3 PORT 1 RECEIVE INDICATOR

The yellow RECEIVE indicator shall illuminate for a 40 msec pulse each time a Port 1 message is correctly received from the Controller Unit.

2.3.3.4 PORT 1 TRANSMIT INDICATOR

The yellow TRANSMIT indicator shall illuminate for a 40 msec pulse each time a Port 1 message is transmitted from the MMU.

2.3.3.5 COMM RECEIVE INDICATOR

The yellow COMM indicator shall illuminate for a 40 msec pulse each time a message is correctly received on the ECom communications port (Ethernet or EIA-232).

2.3.3.6 DIAGNOSTIC INDICATOR

The red DIAGNOSTIC indicator shall illuminate when the MMU has detected an internal diagnostic failure.

2.3.4 CONTROLS

All displays, controls, and connectors shall be mounted on the front panel of the MMU.

2.3.4.1 HELP BUTTON

A momentary contact button shall be provided that initiates the context sensitive help system described in 0.

2.3.4.2 MS CONNECTORS

The MS connectors on the MMU shall have a metallic shell and be attached to the chassis internally. The connectors shall be mounted on the front of the unit in accordance with the following: Connector A shall mate with a MS 3116 22-55 SZ, and Connector B shall mate with a MS 3116 16-26 S.

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

2.3.4.3 ETHERNET PORT

An Ethernet port capable of a minimum 10 Mbps operation shall be provided on the front panel. The Ethernet port shall be electrically isolated from the MMU electronics and shall provide a minimum of 1500 Vrms isolation. The connector shall be an RJ-45 eight pin connector.

2.4 MONITOR CONFIGURATION PARAMETERS

All NEMA standard configuration parameters shall be provided by a program card meeting the requirements of clause 4.3.6 of NEMA TS-2. All configuration parameters for functions and options beyond the requirements of the standard shall be stored in non-volatile memory within the MMU. This memory shall be programmable from the front panel menu driven interface, data downloaded via the ECom port, or loaded from shadow memory located on the program card (see 0).

2.5 PROGRAM CARD MEMORY

The program card supplied with the MMU shall provide non-volatile memory that contains the configuration parameters for the enhanced features of the MMU, such that transferring the program card to a different MMU completely configures that MMU. The non-volatile memory device used on the program card shall not utilize any I/O pins designated as "Reserved" by NEMA TS-2.

3.0 EVENT LOGGING FUNCTIONS

3.1 GENERAL

The MMU shall be capable of storing in non-volatile memory a minimum of 100 events. Each event shall be marked with the time and date of the event. These events shall consist of fault events, AC Line events, reset events, and configuration change events. The capability to assign a four digit identification number and 30 character description to the unit shall be provided. The event logs shall be uploaded to a PC using the serial port of the MMU and Windows based software provided by the manufacturer.

Each event log report shall contain the following information:

- a) Monitor ID#: a four digit (0000-9999) ID number and 30 character description assigned to the monitor.
- b) Time and Date: time and date of occurrence.
- c) Event Number: identifies the record number in the log. Event #1 is the most recent event.

3.1.1 WAN NETWORK DISCOVERY

The communications software running on the PC shall be able to search the network and display a list of IP addresses and Monitor IDs of MMUs responding on the network. The communications software shall also be capable of making changes to the MMU network parameters such as IP address and subnet mask.

3.1.2 ETHERNET PORT HTML INTERFACE

An HTML based capability shall be provided in the MMU to configure the network parameters of the MMU Ethernet port using a standard HTML browser.

3.2 REPORTS

3.2.1 MONITOR STATUS REPORT (CS)

The Current Status report shall contain the following information:

- a) Fault Type: the fault type description.
- b) Field Status: the current GYR(W) field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.
- c) Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.
- d) AC Line Voltage: the current AC Line voltage and frequency if the monitor is not in the fault state, or the AC Line voltage and frequency at the time of the fault.
- e) Control Input Status: the current state and RMS voltages of the Red Enable input & Load Switch Flash bit input if the monitor is not in the fault state, or the status latched at the time of the fault.

3.2.2 PREVIOUS FAULT LOG (PF)

The Previous Fault log shall contain the following information:

- a) Fault Type: the fault type description.
- b) Field Status: the latched field status with RMS voltages, fault channel status, RP Detect status and Field Check status at the time of the fault.
- c) Cabinet Temperature: the latched temperature at the time of the fault.
- d) AC Line Voltage: the AC Line voltage & frequency at the time of the fault.
- e) Control Input Status: the latched state of the Red Enable input at the time of the fault.

3.2.3 AC LINE EVENT LOG (AC)

The AC Line log shall contain the following information:

- a) Event Type: describes the type of AC Line event that occurred.
Power-up - AC on, monitor performed a cold start
Interrupt - AC Line < Brownout level
Restore - AC restored from AC brown-out or AC interruption (AC Off), no cold start
- b) AC Line Voltage: the AC Line voltage & frequency at the time of the event.

3.2.4 MONITOR RESET LOG (MR)

The Monitor Reset log shall contain the following information:

- a) The monitor was reset from a fault by the front panel Reset button, or External Reset input, or a no latched event clear.

3.2.5 CONFIGURATION CHANGE LOG (CF)

The Configuration Change log shall contain the following information:

- a) The status of all configuration programming including the contents of the Program Card.
- b) Any configuration programming inputs such as 24V Inhibit, Port 1 Disable, Type Select.
- c) Configuration Check Value: A unique check value that is based on the configuration of items #a and #b above.

The log shall also indicate which items have been changed since the last log entry.

3.2.6 SIGNAL SEQUENCE LOG (SSQ)

A minimum of five logs shall be provided that graphically display all field signal states and Red Enable for up to 30 seconds prior to the current fault trigger event. The resolution of the display shall be at least 50 milliseconds.

3.3 REMOTE MONITOR CONFIGURATION

3.3.1 SETUP WIZARD

A setup mode shall be provided by the Windows based software that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, fya, etc.) responses.

3.3.2 UPLOAD FROM FILE

All configuration parameters for functions and options beyond the requirements of the standard shall be programmable by transferring a file from a PC to the MMU via the front panel Ethernet port. These parameters shall be stored in nonvolatile memory in the MMU.

3.3.3 DOWNLOAD TO FILE

All configuration parameters for functions and options beyond the requirements of the standard shall be downloadable to a PC by transferring a file from the MMU to a PC via the front panel Ethernet port.

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. TS2-2003 Where differences occur, this specification shall govern. The controller cabinet shall meet the following functional requirements:

2.0 CABINET DESIGN AND CONSTRUCTION

The cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of 0.125 inches (3.175mm).

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.

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.

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

Unless otherwise specified, the cabinet shall be supplied with a natural aluminum finish outside. 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.

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

All cabinets shall be supplied with two removable shelves manufactured from 5052H32 aluminum. Shelf shall be a minimum of 10 inches (254mm) deep.

One set of four (4) vertical "C" channels shall be mounted on each interior side wall of the cabinet for the purpose of mounting the cabinet components and 2 on the back wall. The channels shall accommodate spring mounted nuts or studs. All mounting rails shall extend to within 7 inches (178mm) of the top and bottom of the cabinets.

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 (4.775mm) thick by 1.00 inch (25mm) wide. The gasket material for the police door shall be a minimum of 0.188 inches (4.775mm) thick by 0.500 inches (13mm) wide. The gaskets shall be permanently bonded to the cabinet.

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.

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 (3.175mm) in diameter.

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

The handle of the door shall utilize a shank of 5/8 of an inch 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.

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.

The main door shall include a mechanism capable of holding the door open at approximately 90, 120, and 150 degrees under windy conditions.

The main door shall be equipped with a Corbin tumbler lock No. 2. Two keys shall be supplied. The police door-in-door shall be provided with a treasury type lock Corbin No. 2 or exact equivalent and one key.

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.

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" H x 24" W x 16" D (1,296mm x 610mm x 406mm)
- Size 5 (M) cabinets – 51" H x 30" W x 16" D (1,296mm x 762mm x 406mm)
- Size 6 (P) cabinets - 56" H x 44" W x 24" D (1,422mm x 1,118mm x 610mm)
- Size 7 (R) cabinets - 77" H x 44" W x 24" D (1,956mm x 1,118mm x 610mm)

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.

3.0 TERMINALS AND FACILITIES/MAIN PANEL DESIGN AND CONSTRUCTION

The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches (3.175mm) minimum thickness and formed so as to eliminate any flexing when plug-in components are installed.

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.

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.

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.

Up to sixteen-load switch sockets positioned horizontally.

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

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.

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.

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

Load switch outputs shall be routed to terminals on a series of 12 position set screw terminal blocks in one row for all sixteen load switches.

All field input/output (I/O) terminals shall be identified by permanent alphanumeric-Silkscreen. All Silkscreen shall use standard nomenclature per the NEMA TS2 specification. Each signal output channel on the loadbay shall incorporate a removable and hot-pluggable module providing capacitive loading if required, and MOV protection. MOV protection shall be provided for each output. Capacitive loading shall be available for each output or for green and yellow outputs only. Capacitive loading shall provide an AC impedance equivalent to the DC resistance provided by a 1.5 K-ohm resistor. Modules shall be accessible from the front of the loadbay and easily replaceable, at the field terminals. This is to provide surge protection.

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

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

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.

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

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.

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 TS2-2003 Standard document (Section 5).

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

Green/Walk load switch output	GREEN 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, for greens and yellows)	RED wire 22 gauge
MMU (other than AC power, for reds)	YELLOW 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

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 (0.254mm) thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall have UL listed THHN/THWN 90 degrees Celsius, 600V, 0.020 inches (0.508mm) thick PVC insulation and clear nylon jacketed.

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.

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.

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.

All connecting cables and wire runs shall be secured by tie wrapping.

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.

All pedestrian pushbutton inputs from the field to the controller shall be opto-isolated through the BIU and operate at 12 VAC.

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.

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

4.0 POWER PANEL DESIGN AND CONSTRUCTION

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 (2.286mm), 5052-H32 aluminum.

The panel shall be protected with a removable clear plastic front cover which forms a 90 degree lip at the top whereby prevent falling objects from making accidental contact with the electrical components of the power panel. The cover shall be secured with three (3) bolts using threaded thumb screw design nuts. Two (2) spare thumb screw nuts shall be provided in the cabinet drawer. The cover shall be constructed to permit the operation of the main and auxiliary breakers without removing the cover

The power panel shall house the following components:

- a) 16 position cabinets shall have 30-amp breaker. 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 15-amp, shall supply power to the cabinet flasher
- d) A 15-amp breaker shall be labeled as "SPARE".
- e) A 115V/ 75A Crydom A-2475 solid state contactor or equivalent shall be used instead of a mercury contactor
- f) A neutral bus bar capable of connecting one (1) #6 stranded wire in each position with a minimum of 15-positions.

5.0 AUXILIARY CABINET EQUIPMENT

The cabinet shall be provided with a thermostatically controlled (adjustable between 27-66 degrees Celsius) 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 (2.83 cubic meters) of air per minute.

LED light panels shall be mounted on the inside top of the cabinet and on the bottom side of the bottom cabinet shelf. The LED light panels 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 an 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.

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.

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

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

A permanent graphics identification template with a minimum dimension of nine inches (229mm) by eleven inches (279mm) 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

See section G for vehicle detection system specifications. All signal cabinet equipment specified or required by the manufacturer of the vehicle detection system shall be installed.

DETECTOR RACKS

One (1) vehicle detector amplifier rack shall be provided in each cabinet. The configuration for each rack shall be as follows:

- a) One (1) BIU slot.
- b) Sixteen channels of NEMA TS2 type detection (2 and 4 channel detector cards).
- c) Two (2) optical preemption slots, 2-channel or one (1) 4-channel phase selector unit.

The detector rack shall, as a minimum, meet the requirements of all applicable sections of the NEMA Standards Publication No.TS2-2003 v02.06 Traffic Controller Assemblies.

The detector rack frame shall be constructed of aluminum. The frame material shall be of sufficient thickness to prevent bending or flexing when detector or other cards are inserted or removed.

All vehicle detector card slots shall be capable of accepting 2 channel detector cards.

The second, fourth, sixth and eighth vehicle detector card slots shall be capable of accepting both 2 and 4-channel detector cards.

Pristine circuit boards shall be used in the construction of the detector rack. No hand wired jumpers to connect or re-route PCB traces shall be allowed.

6.1 Field Loop Interface Panel

One (1) 16 channel field loop interface panel shall be mounted on the left wall of the cabinet and connected to the card rack and back panel.

The panel shall be constructed of aluminum, silk-screened, and contain two (2) 16-position terminal blocks, with minimum 8-32 binder head screws for loop termination.

Provisions shall be made to terminate eight (8) pedestrian push button inputs, and appropriate power connections.

Terminals shall also be provided for detector outputs. When logic ground is applied to these terminals a call shall be placed via the BIU on the proper controller channel.

The panel shall contain 16 technician operated vehicle detection switches meet the following criteria:

Up Position - Holding call (labeled "CALL")

Middle Position - No call (labeled "AUTO")

Down Position - Momentary call (labeled "TEST")

The panel shall contain eight (8) technician operated pedestrian switches meeting the following criteria:

Up Position - Holding call (labeled "CALL")

Middle Position - No call (labeled "AUTO")

Down Position - Momentary call (labeled "TEST")

All terminals shall be silkscreen as to designate function on both the front and rear of the panel.

7.0 CABINET TEST SWITCHES AND POLICE PANEL

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 vehicular signal heads shall display the programmed flashing red or amber indications generated by the flasher unit. Pedestrian indications, if any, shall be dark. . The controller shall not be stop timed when in flash. The MMU shall not be used to accomplish this task. When placed in the "NORM" position, the vehicular and pedestrian signal heads shall resort to the controllers programmed operation. This will not force the controller to initiate the startup sequence when exiting flash.
- b. STOP TIME SWITCH. This switch shall apply stop time to the Controller via the main back panel. When in the "ON" position the Controller will enter stop time operation. When placed in the "OFF" position the Controller shall resort to normal operation.
- c. CONTROL EQUIPMENT POWER ON/OFF. This switch shall control the AC voltage supplied to the Controller, MMU, and the cabinet Power Supply. When placed in the "OFF" position voltage shall be removed from the listed equipment. When placed in the "ON" position voltage shall be supplied to the listed equipment.

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.

The police door switch panel shall contain the following:

- a) SIGNALS ON/OFF SWITCH. This switch shall control all AC voltage to the vehicular and pedestrian signal head displays. When placed in the "ON" position AC power is supplied to the field indications. 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) EMERGENCY FLASH MODE switch labeled AUTO/FLASH. When placed in the "FLASH" position, the vehicular signal heads shall display the programmed flashing red or amber indications generated by the flasher unit. Pedestrian indications, if any, shall be dark. Power shall not be removed from the controller. Stop time shall be applied. When placed in the "AUTO" position, the controller shall initiate the start-up sequence and enter the normal controller operating parameters.
 - 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 be provided unless it is called for in the special provisions of this specification.

8.0 SWITCHES - GENERAL

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

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

All switch functions must be permanently and clearly labeled.

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.

9.0 COMBINATION PREEMPT INTERFACE AND SDLC PANEL

A panel shall be provided for railroad preempt interface terminals. The panel shall be located on the inside left wall of the cabinet.

The railroad preempt interface panel shall provide six (6) momentary push-button test switches for preempts 1, 2, 3, 4, 5 and 6.

The railroad preempt interface panel shall provide a switch labeled "Free / System" to set the controller to manual free operation.

The panel shall also provide six (6) SDLC cables to service two (2) terminal facility (back panel) BIU's, the TS2 controller, one (1) detector racks and Malfunction Management Unit (MMU). The SDLC cables shall attach to the panel. One (1) of the six (6) SDLC cables shall be coiled and attached to the panel as spares.

There shall be a 10 position terminal block for termination of optical preempt field connections. This shall be connected to the main preempt panel.

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

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 "DB" 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.

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.

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.

10.0 AUXILIARY DEVICES

10.1 LOAD SWITCHES

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

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

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

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

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

10.2 FLASHERS

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.

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

10.3 FLASH TRANSFER RELAYS

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

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

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

10.4 MALFUNCTION MANAGEMENT UNITS

Each cabinet assembly shall be supplied with one Malfunction Management Unit (MMU). The MMU shall meet all specifications of the NEMA Standard TS2-2003 (R2008) for the MMU configuration while maintaining compatibility with NEMA TS1-1989 Assemblies. Malfunction Management Units shall provide an Ethernet interface for system communications and status.

Malfunction Management Units shall be a Type 16. The MMU shall be an EDI Model MMU2- 16LEip, or equivalent.

10.5 BUS INTERFACE UNITS

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

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.

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

10.6 CABINET POWER SUPPLY

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

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

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

One NEMA TS2 power supply shall be supplied with each cabinet assembly.

10.7 ETHERNET SWITCH

Each cabinet shall be equipped with a minimum 8 port managed Ethernet switch. The Ethernet switch shall be NEMA TS-2 rated. The switch will have at least six 10/100 Ethernet ports and two Single Mode Fiber ports. SFP's shall be 1000BASE-LX. The switch shall be powered by AC line voltage. To maintain compatibility with existing City Traffic Signal Network equipment, the Ethernet switch shall be a GarrettCom model 6KQE, or equivalent approved by the City Traffic Supervisor.

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

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

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

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.

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

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

D. ELECTRICAL DESIGN

1.0 Description

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 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 -40C to +85C 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.

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.

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.

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.

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.

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.

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

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, automatic Bypass Switch, 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"H x 20"W x 17"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" 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

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

Batteries shall be maintenance free, type AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid).

The batteries must be designed for stand-by applications.

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

Batteries shall have a minimum Manufacturer's Warranty of 4 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

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).

The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 40 milliseconds. 40 milliseconds maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

The BBS shall include a rack mounted Fail Safe Automatic Bypass Switch and a Manual Bypass Switch for bypassing the UPS for maintenance. The FS-ATS bypass switch will be a 2-stage configuration, UPS Normal mode, and UPS bypass. The Bypass Switch shall mount in a rack inside of the BBS side mount enclosure.

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

- One output to indicate the system is "on battery".
- One output to indicate a programmable low battery condition.
- One output that energizes after a programmable period after the unit switches to battery operation.
- An indication of a fault or alarm condition.

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

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

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

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

The BBS shall use a temperature compensated charging system. For 48 Volt systems, the BBS shall employ a charging system that balances the charge across all the batteries.

The Buck / Boost mode of the BBS shall have a minimum range of 85 – 160 VAC. Whenever in Buck / Boost mode, the output of the system shall be regulated between 108 – 131 VAC at 60Hz. When the output of the system can no longer be maintained within that range, the BBS shall transfer to Backup Mode.

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

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.

BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service.

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.

Recharge time for the battery, from “protective low-cutoff” to 90% or more of full battery charge capacity, shall not exceed eight (8) hours, unless limited by the Temperature Regulated charger due to excessive battery heat.

The battery charger will be compatible with the specified batteries.

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

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

7.0 MAINTENANCE, DISPLAYS, CONTROLS AND DIAGNOSTICS

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

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

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.

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.

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.

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

8.0 MATERIALS WARRANTY

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 four (4) 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.

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

F. ELECTRICAL SERVICE PEDESTAL

1.0 DESCRIPTION

When a ground mounted service enclosure is specified in the plans, these specifications 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 one-eighth (1/8) inch aluminum. Fabricate the interior of the service enclosure using fourteen (14) gauge, cold-rolled steel. Paint the interior of the service enclosure white. The interior dimensions of the service enclosure shall be twelve (12) inches wide, forty-three (43) inches high and seven and one-half (7 ½) inches deep. The service enclosure shall have continuously welded seams, a full-length dead front 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 dead front with a one-fourth (1/4) turn latch and knurled knobs. Hinge the dead front door on the same side as the exterior door. The dead front door shall open a minimum of one hundred (100) degrees. Mount a removable back pan on four (4) welded one-fourth (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

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.

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

G. VEHICLE DETECTION SYSTEM

1.0 GENERAL

Where designed, a vehicle detection system shall be provided with each new traffic signal. The vehicle detection system shall be an Aboveground Radar System for both presence and advanced detection, unless otherwise specified in the signal plans. Other acceptable systems shall include a.) wireless pod magnetometers b.) Video systems, and c.) loop detectors.

2.0 RADAR PRESENCE DETECTION

2.1 General

This item shall govern the purchase of aboveground radar presence detector (RPD) equivalent to the Wavetronix SmartSensor™ Matrix.

2.2 Sensor Outputs

The RPD shall present real-time presence data in 10 lanes.

The RPD shall support a minimum of 16 zones.

The RPD shall support a minimum of 16 channels.

The RPD shall support user-selectable zone to channel mapping.

The RPD shall use AND logic to trigger channels when all selected zones are active.

The RPD shall use OR logic to combine multiple zones to a channel output, and shall have channel output extend and delay functionality.

The RPD algorithms shall mitigate detections from wrong way or cross traffic.

The RPD system shall have fail-safe mode capabilities for contact closure outputs if communication is lost.

2.3 Detectable Area

2.3.1 Detection Range

The RPD shall be able to detect and report presence in lanes with boundaries as close as 6 ft. (1.8 m) from the base of the pole on which the RPD is mounted.

The RPD shall be able to detect and report presence in lanes located within the 140 ft. (42.7 m) arc from the base of the pole on which the RPD is mounted.

2.3.2 Field of View

The RPD shall be able to detect and report presence for vehicles within a 90 degree field of view.

2.3.3 Lane Configuration

The RPD shall be able to detect and report presence in up to 10 lanes. The RPD shall be able to detect and report presence in curved lanes and areas with islands and medians.

2.4 System Hardware

For each approach to be detected, one RPD corner radar shall be used.

2.4.1 Preassembled Backplate

Each RPD shall have a traffic cabinet preassembled backplate with the following:

- AC/DC power conversion
- Surge protection
- Terminal blocks for cable landing
- Communication connection points

The preassembled backplate for the RPD shall be a cabinet side mount or rack mount.

2.4.2 Contact Closure Input File Cards

The RPD shall use contact closure input file cards with 2 or 4 channel capabilities. The contact closure input file cards for the RPD shall be compatible with industry standard detector racks.

2.5 Maintenance

The RPD shall not require cleaning or adjustment to maintain performance.

The RPD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement. Once the RPD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes. The mean time between failures shall be 10 years, which is estimated based on manufacturing techniques.

2.6 Physical Properties

The RPD shall not exceed 4.2 lbs. (1.9 kg) in weight.

The RPD shall not exceed 13.2 in. by 10.6 in. by 3.3 in. (33.5 cm x 26.9 cm x 8.4 cm) in its physical dimensions. All external parts of the RPD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.

2.6.1 Enclosure

The RPD shall be enclosed in a Lexan EXL polycarbonate.

The enclosure shall be classified "f1" outdoor weather ability in accordance with UL 746C.

The RPD shall be classified as watertight according to the NEMA 250 standard.

The RPD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)
- 4X corrosion protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The RPD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

The RPD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

2.7 Electrical

The RPD shall consume less than 10 W.

The RPD shall operate with a DC input between 9 VDC and 28 VDC.

The RPD shall have onboard surge protection.

2.8 Communication Ports

The RPD shall have two communication ports, and both ports shall communicate independently and simultaneously.

The RPD shall support the upload of new firmware into the RPD's non-volatile memory over either communication port.

The RPD shall support the user configuration of the following:

- Response delay
- Push port

The communication ports shall support a 9600 bps baud rate.

2.9 Radar Design

The RPD shall be designed with a matrix of 16 radars.

2.9.1 Frequency Stability

The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any up conversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

The RPD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

The bandwidth of the transmit signal of the RPD shall not vary by more than 1% under all specified operating conditions and over the expected life of the RPD.

2.9.2 Antenna Design

The RPD antennas shall be designed on printed circuit boards.

The vertical beam width of the RPD at the 6 dB points of the two-way pattern shall be 65 degrees or greater.

The antennas shall cover a 90 degree horizontal field of view.

The sidelobes in the RPD two-way antenna pattern shall be -40 dB or less.

Low sidelobes ensure that the performance from the antenna beam widths is fully achieved.

2.9.3 Resolution

The RPD shall transmit a signal with a bandwidth of at least 245 MHz.

2.9.4 RF Channels

The RPD shall provide at least 8 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

2.9.5 Verification

The RPD shall have a self-test that is used to verify correct hardware functionality.

The RPD shall have a diagnostics mode to verify correct system functionality.

2.10 Configuration

2.10.1 Auto-configuration

The RPD shall have a method for automatically defining traffic lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RPD and shall not require an external PC or other processor.

The auto-configuration process shall work under normal intersection operation and may require several cycles to complete.

2.10.2 Manual Configuration

The auto-configuration method shall not prohibit the ability of the user to manually adjust the RPD configuration.

The RPD shall support the configuring of lanes, stop bars and detection zones in 1-ft. (0.3-m) increments.

2.10.3 Windows® Mobile-based Software

The RPD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation.

The RPD shall include the ability to do counting and pulsed channels.

The graphical interface shall operate on Windows Mobile, Windows XP, Windows Vista and Windows 7 in the .NET framework.

The software shall support the following functionality:

- Operate over a TCP/IP connection
- Give the operator the ability to save/back up the RPD configuration to a file or load/restore the RPD configuration from a file
- Allow the backed-up sensor configurations to be viewed and edited
- Provide zone and channel actuation display
- Provide a virtual connection option so that the software can be used without connecting to an actual sensor
- Local or remote sensor firmware upgradability

2.11 Operating Conditions

The RPD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.

RPD operation shall continue in rain up to 1 in. (2.5 cm) per hour.

The RPD shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F (-40°C to 74°C).

The RPD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

2.12 Testing

2.12.1 FCC

Each RPD shall be certified by the Federal Communications Commission (FCC) under CFR 47, part 15, section 15.249 as an intentional radiator.

The FCC certification shall be displayed on an external label on each RPD according to the rules set forth by the FCC. The RPD shall comply with FCC regulations under all specified operating conditions and over the expected life of the RPD.

2.12.2 NEMA TS 2-2003 Testing

The RPD shall comply with the applicable standards stated in the NEMA TS 2-2003 standard. Third party test results shall be made available for each of the following tests:

- Shock pulses of 10 g, 11 ms half sine wave
- Vibration of 0.5 g up to 30 Hz
- 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
- Cold temperature storage at -49°F (-45°C) for 24 hours
- High temperature storage at 185°F (85°C) for 24 hours
- Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC

- Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

2.13 Manufacturing

The RPD shall be manufactured and assembled in the USA.

The internal electronics of the RPD shall utilize automation for surface mount assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

The RPD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of 48 hours' duration or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased RPD by serial number, upon request.

2.14 Support

The RPD manufacturer shall provide both training and technical support services.

2.14.1 Training

The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the RPD to ensure accurate RPD performance.

The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.

Classroom lab training shall involve presentations outlining and defining the RPD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual RPD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the RPD and its processes
- Presentation materials, including visual aids, printed manuals and other handout materials for each student
- Computer files, including video and raw data, to facilitate the virtual configuration of the RPD
- Laptop computers or Windows CE handheld devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the RPD

Field training shall provide each trainee with the hands-on opportunity to install and configure the RPD at roadside. Training shall be such that each trainee will mount and align the RPD correctly.

2.14.2 Technical Assistance

Manufacturer-provided technical support shall be available according to contractual agreements, and a technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RPD.

Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of RPDs should such services be required.

2.15 Documentation

RPD documentation shall include an instructional training guide and a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.

The RPD manufacturer shall supply the following documentation and test results at the time of the bid submittal:

- FCC CFR 47 certification (frequency compliance)
- IED 6100-4-5 class 4 test report (surge)

2.16 Warranty

The RPD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

3.0 RADAR ADVANCE DETECTION

3.1 General

This item shall govern the purchase of aboveground continuous tracking advance detector (CTAD) equivalent to the Wavetronix SmartSensor™ Advance.

3.2 Measured Quantities and Outputs

The CTAD shall detect range, speed, and vehicle estimated time of arrival (ETA) to the stop bar for vehicles or clusters of vehicles moving in the user-selected direction of travel. The CTAD shall also detect instantaneous roadway efficiency.

The CTAD shall be able to simultaneously detect and report information from up to 25 vehicles on the roadway when they are serially sequenced between the near and far boundaries.

The CTAD shall turn on a zone output when the range, speed, ETA, and qualified count or instantaneous roadway efficiency requirements for that zone are satisfied.

The CTAD shall turn on an alert output on when the user defined zone output combinational logical is satisfied.

The CTAD shall turn on a normal channel output when any of the channel's alerts is on and the channel's delay and extend time constraints are satisfied.

The CTAD shall turn on a latched channel output when the on alert is turned on and the delay time is satisfied. The CTAD shall turn off a latched channel output when the off alert is turned on or the max timer expires and the extension time is satisfied.

The CTAD shall provide vehicle call and extend data on up to eight channels that can be connected to contact closure modules compliant with NEMA TS 1, NEMA TS 2, 170, and 2070 controller cabinets.

The CTAD shall be capable of providing data for each tracked detection over the serial ports.

3.3 Detectable Area

3.3.1 Mounting Location

The CTAD shall be able to detect and report vehicle information when mounted within 50 ft. (15.2 m) of the center of the lanes of interest.

The CTAD shall be able to detect and report vehicle information when mounted at heights up to 40 ft. (12.2 m) above the road surface.

3.3.2 Detection Range

The CTAD shall be able to detect and report information on the roadway located with the near boundary at 50 ft. (15.2 m) from the base of the pole on which the CTAD is mounted.

The CTAD shall be able to detect and report information on the roadway located with the far boundary at 600 ft. (182.8m) from the base of the pole on which the CTAD is mounted.

For incoming traffic, 95 percent of large vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor. For incoming traffic, 90 percent of all motor vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor.

3.4 Performance.

3.4.1 Detection Accuracy

The CTAD shall detect at least 98 percent of large vehicles like truck-trailer combinations and at least 95 percent of all motor vehicles within the line-of-sight of the CTAD sensor where multiple detections of multiunit vehicles are

not considered false detections and merged detections of adjacent lane vehicles are not considered missed detections.

3.4.2 Range Accuracy

The CTAD shall provide range measurements in which 90% of the measurements are accurate within 10 ft. (3 m) when the vehicle is tracked independently.

3.4.3 Speed Accuracy

The CTAD shall provide per vehicle speed measurements in which 90% of the measurements are accurate within 5 mph (8 kph) when tracked independently.

3.4.4 ETA Accuracy

The CTAD shall provide estimated time-of-arrival (ETA) measurements in which 85% of the measurements are accurate within one second, when the detected vehicles are tracked independently at a constant speed above 40 mph (64 kph) and are within 2.5 and 5.5 seconds of the stop bar.

3.5 Performance Maintenance

The CTAD shall not require cleaning or adjustment to maintain performance.

The CTAD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement.

Once the CTAD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

The mean time between failures shall be 10 years, which is estimated based on manufacturing techniques.

3.6 Physical Properties

The CTAD shall not exceed 4 lbs. (1.8 kg) in weight.

The CTAD shall not exceed 14 in. × 11 in. × 4 in. (35.6 cm x 27.9 cm x 10.2 cm) in its physical dimensions.

All external parts of the CTAD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.

3.6.1 Enclosure

The CTAD shall be enclosed in a Lexan polycarbonate.

The enclosure shall be classified "f1" outdoor weather ability in accordance with UL 746C.

The CTAD shall be classified as watertight according to the NEMA 250 standard.

The CTAD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)
- 4X corrosion protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The CTAD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

The CTAD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

3.7 Electrical

The CTAD shall consume less than 4 W @ 12 VDC.

The CTAD shall operate with a DC input between 9 VDC and 28 VDC.

The CTAD shall have onboard surge protection.

3.8 Communication Ports

The CTAD shall have two communication ports, and both ports shall communicate independently and simultaneously.

The CTAD shall support the upload of new firmware into the CTAD's non-volatile memory over either communication port.

The CTAD shall support the user configuration of the following:

- Baud rate
- Communication port response delay
- Contact closure output frequency

Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200 bps.

The contact closure output frequency shall be user configurable as short as 10 ms, with a default near 130 ms for compatibility.

Contact closure data shall be reliably communicated over homerun cable connections as long as 600 ft. (182.9 m) with latency from the time of channel requirement satisfaction to the eventual reporting of the detections on the back edge of the contact closure card in 15 ms or less.

3.9 Radar Design

3.9.1 Frequency Stability

The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any up conversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

The CTAD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

The bandwidth of the transmit signal of the CTAD shall not vary by more than 1% under all specified operating conditions and over the expected life of the CTAD.

3.9.2 Antenna Design

The CTAD antennas shall be designed on printed circuit boards.

The vertical beam width of the CTAD at the 6 dB points of the two-way pattern shall be 65 degrees or greater.

The horizontal beam width of the CTAD at the 6 dB points of the two-way pattern shall be 11 degrees or less.

The sidelobes in the CTAD two-way antenna pattern shall be -40 dB or less.

3.9.3 RF Channels

The CTAD shall provide at least four RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

3.10 Configuration

3.10.1 Auto-configuration

The CTAD shall have a method for automatically configuring the sensitivity of detection in at least 5-ft. (1.5-m) increments.

The auto-configuration method shall not prohibit the ability of the user to manually adjust the CTAD configuration.

The CTAD shall support the configuration of up to eight channel outputs with up to four alerts per channel and up to four zones per alert, resulting in 32 configurable alerts and 128 configurable zones.

3.10.2 Zone Configuration

The CTAD shall support the configuring of zones in 5-ft. (1.5-m) increments.

The CTAD shall support detection zones as long as 550 ft. (167.6 m).

The CTAD shall support user configurable high-speed and low-speed detection filters for each zone.

The CTAD shall support the configuring of speed filters in 1-mph (1.6-kph) increments.

The CTAD shall support user configurable upper and lower estimated time-of-arrival (ETA) filters for each zone.

The CTAD shall support the configuring of ETA filters in increments of 0.1 seconds.

The CTAD shall provide configurable upper and lower count filters that help determine if a required number of qualified detections are present.

The CTAD shall support the configuring of qualified count filters in increments of one.

3.10.3 Windows®-based Software

The CTAD shall include graphical user interface software that displays the current traffic pattern using a graphical traffic representation.

The graphical user interface shall also display all configured alerts and provide visual representation of their actuation.

The graphical user interface shall provide a means of logging the vehicular track files with an update rate of greater than five times per second.

The graphical interface shall operate on Windows Mobile, Windows XP, Windows Vista, and Windows 7 in the .NET framework.

The software shall support the following functionality:

- Automatically find the correct baud rate
- Automatically find the correct serial communication port
- Operate over a TCP/IP connection
- Provide a virtual sensor connection for software usability without a sensor
- Give the operator the ability to save/back up the CTAD configuration to a file or load/restore the CTAD configuration from a file

3.11 Operating Conditions

The CTAD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.

CTAD operation shall continue in rain up to 2 in. (5.08 cm) per hour.

The CTAD shall be capable of continuous operation over an ambient temperature range of -40°F to 165°F (-40°C to 74°C).

The CTAD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

3.12 Testing

3.12.1 FCC

Each CTAD shall be Federal Communications Commission (FCC) certified under CFR 47, part 15, section 15.245 or 15.249 as an intentional radiator.

The FCC certification shall be displayed on an external label on each CTAD according to the rules set forth by the FCC.

The CTAD shall comply with FCC regulations under all specified operating conditions and over the expected life of the CTAD.

3.12.2 NEMA TS 2-1998 Testing

The CTAD shall comply with the applicable standards stated in the NEMA TS 2-1998 Standard.

Third party test results shall be made available for each of the following tests:

- Shock pulses of 10 g, 11 ms half sine wave
- Vibration of 0.5 g up to 30 Hz
- 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
- Cold temperature storage at -49°F (-45°C) for 24 hours
- High temperature storage at 185°F (85°C) for 24 hours
- Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
- Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

3.13 Manufacturing

The CTAD shall be manufactured and assembled in the USA.

The internal electronics of the CTAD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

The CTAD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of 48 hours' duration or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased CTAD by serial number, upon request.

3.14 Support

The CTAD manufacturer shall provide both training and technical support services.

3.14.1 Training

The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, auto configuration, and use of the CTAD to ensure accurate CTAD performance.

The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.

Classroom lab training shall involve presentations outlining and defining the CTAD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual CTAD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the CTAD and its processes
- Presentation materials, including visual aids, printed manuals and other handout materials for each student
- Computer files, including video and raw data, to facilitate the virtual configuration of the CTAD
- Laptop computers or Windows CE handheld devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the CTAD

Field training shall provide each trainee with the hands-on opportunity to install and configure the CTAD at the roadside.

Training shall be such that each trainee will mount and align the CTAD correctly.

3.14.2 Technical Assistance

The manufacturer-provided technical support shall be available according to contractual agreements and a technical representative available to assist with the physical installation, alignment, and configuration of each supplied CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of CTADs should such services be required.

3.15 Documentation

CTAD documentation shall include a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.

The CTAD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:

- Detection accuracy
- Range accuracy
- Earliest range of detection
- Speed accuracy
- ETA accuracy
- FCC CFR 47 certification
- NEMA 250 standard for Type 4X Enclosure third-party test data
- NEMA TS 2-1998 standard third-party test data

3.16 Warranty

The CTAD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

4.0 General Wireless Magnetometer Detection

This specification provides the minimum requirements for a Trafficware Pod wireless magnetometer detection system operating within the 900 MHz frequency band. Wireless magnetometers embedded in the roadway at prescribed depths and configurations detect vehicles traveling along a roadway by measuring the magnetic field distortion caused as vehicles pass through the device's detection zone. This information is then wirelessly transmitted over external 900 MHz signal collector antennas from multiple wireless magnetometer devices to an access point. This detection information is transmitted through a base station interface located in the traffic cabinet to a traffic controller or TCP/IP network-based device/application.

Vehicle detection calls through SDLC communication or simple, contact closure, serial data communications, vehicle volume, occupancy and speed as well as diagnostics for overall system performance are communicated to any number of devices or applications. The base station is compliant with applicable sections of the National Electrical Manufacturers Association (NEMA), Caltrans (Caltrans TEES 2009) and, Advanced Transportation Controller (ATC) based traffic cabinet and controller standards.

The detection architecture fully supports access to the system's user interface and data collection capability through TCP/IP (Ethernet). All data generated by the wireless magnetometer detection system shall be made available through a documented and published HTML interface.

The detection system's software and user interface shall not require the need for personal computer (PC) based software and can be viewed using standard web browsers to perform system setup, remote monitoring, data collection and system maintenance.

All components of the wireless magnetometer detection system must meet and exceed the entire NEMA TS-1/TS-2 environmental and temperature range of minus 30°F (-34° C) to 165° F (74°C) and voltages from 95 VAC to 135 VAC.

4.1 System Hardware

The wireless magnetometer detection system shall consist of four (4) primary components:

1. Wireless magnetometer and installation housing embedded in the roadway;
2. Access point mounted on a pole, mast arm or other structure within one thousand feet (1,000 ft.) proximity to the traffic cabinet;
3. External 900 MHz antennas connected to the access point in one or more of the following configurations:
 - a. Omni directional antenna - three hundred and sixty degree (360°) beam width.
 - b. Large panel directional antenna - fifteen inch (15 in.) forty degree (40°) horizontal beam width.
 - c. Small panel directional antenna - eight inch (8 in.) seventy degree (70°) horizontal beam width;
4. Base station mounted in the traffic cabinet.

4.1.1 Wireless Magnetometer

The wireless magnetometer components shall be enclosed in a hermitically sealed, non-resin filled enclosure. The form factor shall be circular three and five-eighths inches ($3 \frac{5}{8}$ in.) diameter by two inches (2 in.). The wireless magnetometer enclosure shall have a recessed lower radius with flanged struts to serve as interlocking teeth for proper alignment with the wireless magnetometer installation housing.

The wireless magnetometer shall be constructed with four (4) magneto-resistive sensors using an ultra-low-power microcontroller to implement its vehicle sensing function. It shall be possible to embed the same model of wireless magnetometer from a distance of three-eighths of an inch to five inches ($\frac{3}{8}$ in. to 5 in.) from the road surface to the top of the wireless magnetometer.

The wireless magnetometer model number, part number and serial number with a correlating 2D QR code are to be displayed on the top of the wireless magnetometer. Each wireless magnetometer shall be temperature tested in an environmental chamber by the manufacturer prior to shipment.

4.1.1.1 Installation Housing

The wireless magnetometer installation housing or shell is constructed so that the form factor nests uniformly with the wireless magnetometer form factor. The shell shall be transparent so that the wireless magnetometer's identification information is clearly visible.

The shell shall have two (2) halves that are adjoined by a self-clamping and seating surface. The shell shall not permit epoxy to enter into the interior of the housing. Three flanges integrated into the design of the shell shall allow the wireless magnetometer to hang from the roadway's surface. The distance from the top of the road surface to the top of the shell will not exceed three-eighths of an inch ($\frac{3}{8}$ in.).

Upon removal of the wireless magnetometer and shell assembly from the roadway utilizing the proper bit size, the shell's upper section will break away freely so that the undamaged wireless magnetometer can be retrieved with minimal effort.

4.1.1.2 Wireless Magnetometer Functional Capability

The wireless magnetometer transmits vehicle detection and device status information to the access point over 900 MHz ISM band. The wireless magnetometer uses frequency-hopping spread spectrum techniques to co-exist with in-band RF interference. The wireless magnetometer has bi-directional wireless communication with the access point to send vehicle detection events, wireless magnetometer status and receive configuration data and firmware upgrades. Wireless magnetometers shall be of one make and model and be capable of vehicle detection, vehicle counting and speed detection.

4.1.1.3 Power

The wireless magnetometer is powered by modular and replaceable D-cell Lithium/Thionyl Chloride battery with a design life of up to a ten (10) years with an average of 700 activations per hour.

Detection Zone Programming

4.1.1.4 Optimal Detection

The wireless magnetometer is used to accurately sense the presence of a vehicle within the detection zone in any roadway condition where the roadway is sufficient for normal and safe operation. The wireless magnetometer is capable of detecting vehicles within a six by six foot (6 ft. x 6 ft.) zone such that detection accuracy is maintained within a three foot (3 ft.) lateral zone of tolerance and a three foot (3 ft.) zone of tolerance for upstream and downstream detection activation and termination. The wireless magnetometer's vehicle detection zone sensitivity is configurable such that the lateral offset and upstream and downstream detection activation and termination locations can be modified within 6 ft. x 6 ft. detection zone. Transmission of vehicle detection data from the wireless magnetometer to the access point shall not be impeded by vehicles with low ground clearance.

The wireless magnetometer will be self-monitoring and automatically adjust to changing conditions that might affect vehicle detection. Wireless magnetometers can be configured into groups of vehicle detection zones and within these groups perform independent functions for vehicle counting and speed detection. The wireless magnetometer shall have the capability to provide vehicle detection information to multiple independent purposed zones.

4.1.1.5 Demand Presence Detection Performance

The wireless magnetometer provides typical detection response time less than or equal to one hundred milliseconds (≤ 100 ms) and maximum response time less than or equal to one second (≤ 1 s).

4.1.1.6 Count Detection Performance

The wireless magnetometer is capable of providing vehicle counts within a maximum ten percent (10%) rate of error compared to visual ground truth. Vehicle counting by the wireless magnetometers is a separate and independent function from general vehicle detection or speed detection. Single wireless magnetometers support count and presence simultaneously.

4.1.1.7 Speed Detection Performance

The wireless magnetometer detection system is capable of measuring the speed of a vehicle by using two (2) wireless magnetometers identified in a detection zone with the known distance programmed through the user interface.

The wireless magnetometer can detect speed for vehicles within the vehicle detection zone, adjusted for sensitivity, and not be subjected to partially detected vehicles engaging in lane change maneuvers.

4.1.2 Access Point

A single radio-based access point shall house three (3) 900 MHz ISM band, frequency-hopping spread spectrum radios that communicate to the wireless magnetometer(s) and one (1) 2.4 GHz ISM band radio that communicates to the cabinet base station. The three (3) radios shall support any combination of external antenna configurations with optional use of an antenna splitter on individual radios. The access point is mounted at the signal pole or mast arm between a minimum height of fifteen feet (15 ft.) and a maximum height of thirty feet (30 ft.). The access point shall be constructed using a six and one-quarter inch by seven and three-quarters inch by seven and three-quarters inch ($6\frac{1}{4}$ in. x $7\frac{3}{4}$ in. x $7\frac{3}{4}$ in.) IP 67 weather proof enclosure and shall have four (4) mounting posts to accommodate traffic industry standard pole clamp assemblies.

Labels displaying the model number, part number and serial number with a correlating 2D QR code, as well as its communication identification number of the device shall be affixed to the exterior of the access point enclosure.

The access point shall utilize wired IP67 weatherproof connections for: a RJ12, EIA/RS485 serial link using three (3) twisted-pairs for transmit, receive and ground circuits as well as a three (3) wire signal conductors.

Each access point shall be environmentally temperature tested by the manufacturer prior to shipment.

4.1.2.1 Access Point Functional Capability

The access point shall communicate to the wireless magnetometer without the use of any signal repeaters.

The access point shall have the ability to communicate to the base station by:

1. Wired EIA-485 serial communications up to one thousand feet (1,000 ft.) from the base station to the radio-based device without the use of repeaters or Power Over Ethernet (POE); or,
2. Wireless 2.4 GHz ISM band link up to five hundred feet (500 ft.) from the base station to the access point without the use of repeaters or POE.

Up to two (2) access points may communicate with one (1) base station permitting up to a maximum of one hundred eighty (180) wireless magnetometers per base station.

4.1.2.2 Power

The access point is powered by standard traffic signal industry, three (3) conductor 14 AWG solid or stranded cable, rated at 120 VAC. and terminated using an IP 67 weatherproof connector. The access point can be powered with any properly grounded and available 120 VAC signal conductor originating from a signal cabinet or other power source adjacent to the access point.

4.1.2.3 External Antennas

Each external antenna shall be mounted adjacent to the access point using a locally mounted gusseted tube and bracket and shall not require additional mounting infrastructure more than twelve feet (12 ft.) from the access point. All wireless magnetometer vehicle detection information over the 900 MHz ISM band will be collected using only antennas adjacent to, and terminated directly to, the access point.

The wireless magnetometer detection system utilizes external omni directional and directional panel antennas for collecting 900 MHz vehicle detection information from wireless magnetometers. External antennas shall not use any power source other than any one of the three (3) 900 MHz ISM band, frequency-hopping spread spectrum radios contained in the access point.

External antennas shall be connected to the device using reverse TNC connectors with coaxial cable lengths of six feet (6 ft.) or twelve feet (12 ft.). Coaxial cabling slack shall be formed into a full circular drip loop secured to the respective gusseted tube, mast arm or signal pole as appropriate prior to terminating to the access point. Each external antenna terminates directly to a coaxial bi-directional forty kilo-amp (40kA) lightning suppression/surge protector providing a grounding circuit through the omni directional antenna banded mounting bracket.

Selection of external antennas shall not be limited to one singular antenna form factor but selected based on the respective traffic application.

4.1.2.4 Omni Directional Antenna

An omni directional antenna measuring one and one-half inch in diameter by two and three-quarter inches in height (1 1/2 in. x 2 3/4 in.) shall be used, if needed, to collect 900 MHz vehicle detection information.

The omni directional antenna shall be properly secured within twelve feet (12 ft.) from the access point on the mast arm or signal pole using the provided omni directional antenna banded mounting bracket.

4.1.2.5 Detection Range Omni-directional Antenna

For wireless magnetometers buried at a standard three-eighths inch (3/8 in.) depth beneath the roadway surface, omni directional antennas shall collect vehicle detection information from wireless magnetometers over a range of ten feet (10 ft.) to two hundred fifty feet (250 ft.) with a beam width of three hundred sixty degrees (360°).

For wireless magnetometers buried below standard depth to five inches (5 in.) depth beneath the roadway surface, omni directional antennas shall collect vehicle detection information from wireless magnetometers over a range of ten feet (10 ft.) to one hundred twenty-five feet (125 ft.) with beam width of three hundred sixty degrees (360°).

4.1.2.6 Large Panel Directional Antenna

A large panel directional antenna measuring fourteen and three-quarter inches by sixteen and one-quarter inches (14 3/4 in. x 16 1/4 in.) can be used, if needed, to collect 900 MHz vehicle detection information.

The large panel directional antenna shall be properly secured within twelve feet (12 ft.) from the access point on the mast arm or signal pole using standard or similar clamp and gusseted tube assemblies. The large panel directional antenna's horizontal and vertical angle of inclination shall be adjusted and antenna properly secured at the time of installation.

Up to two (2) large panel directional antennas can be mounted back to back on the same gusseted tube.

4.1.2.7 Detection Range - Large Panel Directional Antenna

For wireless magnetometers buried at a standard three-eighths inch ($\frac{3}{8}$ in.) depth beneath the roadway surface, large panel directional antennas shall collect vehicle detection information from wireless magnetometers over a horizontal range of up to seven hundred feet (700 ft.) with a beam width of forty degrees (40°).

For wireless magnetometers buried below standard depth to five inches (5 in.) depth beneath the roadway surface, large panel directional antennas shall collect vehicle detection information from magnetometers over a horizontal range of up to three hundred fifty feet (350 ft.) with beam width of forty degree (40°).

4.1.2.8 Small Panel Directional Antenna

A small panel directional antenna measuring eight inches by eight inches (8 in. x 8 in.) can be used, if needed, to collect 900 MHz vehicle detection information.

The small panel directional antenna shall be properly secured within twelve feet (12 ft.) from the access point on the mast arm or signal pole using standard or similar clamp and gusseted tube assemblies. The small panel directional antenna's horizontal and vertical angle of inclination shall be adjusted and antenna properly secured at the time of installation.

Up to four (4) small panel directional antennas can be mounted back to back, on the same gusseted tube.

4.1.2.9 Detection Range - Small Panel Directional Antenna

For wireless magnetometers buried at a standard three-eighths inch ($\frac{3}{8}$ in.) depth beneath the roadway surface, small panel directional antennas collect vehicle detection information from wireless magnetometers over a horizontal range of up to four hundred fifty feet (450 ft.) with a beam width of seventy degrees (70°).

For wireless magnetometers buried below standard depth to five inches (5 in.) depth beneath the roadway surface, small panel directional antennas shall collect vehicle detection information from wireless magnetometers over a horizontal range of up to two hundred twenty-five feet (225 ft.) with beam width of seventy degree (70°).

4.1.3 Base Station - General

The base station is a device that is installed in a traffic control cabinet and provides an interface to a traffic controller or traffic data collection device. The base station is Ethernet ready and connects to industry standard and commercially available networking equipment.

One of two base station form factor configurations shall be provided per the plans and specifications. Base station form factors, selected per traffic cabinet, shall consist of:

1. Rack Mount - A device, two (2) cards in width designed to be inserted into a standard NEMA TS1, TS2, input file rack as defined by Caltrans TEES 2009 or a card rack as defined by ATC cabinet standards, or;
2. Shelf Mount - A device enclosed in its own aluminum enclosure measuring ten and five-eighths inches by three inches by seven and one-eighths inches ($10 \frac{5}{8}$ in. x 3 in. x $7 \frac{1}{8}$ in.) and suitable for placement on a cabinet enclosure shelf or other free space in a cabinet.

The two base station form factors interface directly with the traffic cabinet and/or traffic controller using detection input cabling or expansions cards that comply with the appropriate specifications for:

1. NEMA TS1 or TS2 or Caltrans TEES 2009 for detector card racks and additionally providing delay-inhibit inputs (rack mount) with thirty-two (32) detection outputs; or
2. NEMA TS2 type 1, TS2 type 2, 2070-7B, 2070-2A or 2B Synchronous Data Link Control (SDLC) bus and cabling to provide up to 64 detection outputs and delay inhibit inputs; or

The base station shall have two (2) Ethernet RJ45 female connectors with LEDs displaying transmit and receive functionality. One Ethernet connection shall remain available for establishing a local network and the second Ethernet connection shall remain available for establishing communications via managed Ethernet network enabling remote system setup, monitoring, data collection and system maintenance.

The base station has one USB connector and one coaxial 2.4 GHz antenna connector along with active and error status LEDs.

The model number, part number and serial number, along with a correlating 2D QR code on a label shall be mounted on the exterior of the base station.

Each base station shall be environmentally temperature tested by the manufacturer prior to shipment.

4.1.3.1 Rack Mount Base station

The rack mount base station shall have two (2) female, RJ12 connectors with light emitting diodes (LEDs) to display transmit and receive functionality from the access point(s).

The rack mount base station utilizes the detector card rack for power, ground circuits and vehicle outputs in traffic industry standard NEMA, Caltrans TEES 2009, and ATC detector card rack or input file configurations.

The base station shall have at least one (1) female RJ12 expansion card connector for connecting multiple expansion cards into detector card rack configurations.

4.1.3.2 Shelf Mount Base station

The shelf mount base station shall have one (1) female 37-pin subminiature D connector with thirty-seven (37) physical pins corresponding to thirty-two (32) optically isolated open collector outputs leads and (5) logic ground leads.

A 120 VAC connector harness with a three (3) pronged grounded AC power cord shall provide power to the base station. A two (2) pin logic ground connector shall be provided and separated from the 120 VAC connector.

4.1.3.3 Expansion Card

Where additional detector channel inputs are required above and beyond the 4 standard inputs of the rack mounted base station, one or more rack mounted expansion card(s) shall be provided to place vehicle calls and/or to transmit vehicle detection information to the traffic controller. Expansion cards shall have a manually programmable binary dip switch bank to select the detector call output range.

The expansion card shall have one of two configurations depending upon the number of detector inputs required by the controller in the specification and special provisions. The card rack expansion cards shall meet the physical and environmental requirements of the NEMA TS1 or TS2 or Caltrans TEES 2009 specifications.

One of two rack mount base station expansion cards form factor configurations using one slot or two slots shall be provided per the plans and traffic signal cabinet specifications. The expansion card shall have two (2) female RJ12 connectors with light emitting diode (LED) displaying transmit and receive functionality. Expansion cards shall have power status, two-channel or four-channel operation status and channel one through four (1 – 4) LEDs displaying current status.

The shelf mount base station expansion cards are used in a TS1 cabinet or Caltrans TEES 2009 input file where SDLC communications are not present. Expansion cards shall be designed for installation in four or two channel slots of the detector rack.

Each expansion card shall be environmentally temperature tested by the manufacturer prior to shipment.

4.1.3.4 Output 1 - 32 Cable Harness

Where detector card rack inputs and SDLC inputs are unavailable the shelf mount base station shall utilize an output 1 – 32 cable harness 37-pin subminiature D connector terminated with the base station on one end and unterminated leads on the opposite end connecting to the traffic cabinet back panel's or input file's detection inputs and logic ground terminal blocks.

4.1.3.5 Base Station Functional Capability

The base station shall receive vehicle detection information collected by external antennas and routed through the access point by means of at least one of the following communication methods:

1. by wired three pair EIA-485 twisted pair low capacitance shielded cable or Cat5e four (4) pair direct burial shielded cable where one (1) pair is not used; or,
2. by direct line of sight wireless link from the access point to a 2.4 GHz Omni Antenna mounted to the exterior of the traffic cabinet and terminated to the base station through a supplied three foot (3 ft.) coaxial RF cable.

The base station shall have the ability to receive vehicle detection information from two (2) access points, one (1) wired communications link and one (1) wireless communications link simultaneously.

The base station shall be Ethernet capable, enabling remote system setup, monitoring, data collection and system maintenance through a standard web browser.

4.1.3.6 Lightning Suppression and Power Relay Panel

The wireless magnetometer detection system utilizes an EIA-485 lightning suppression device to provide high-energy transient protection for the modular traffic cabinet interface device. The lightning suppression device shall be connected to ground via the shortest path.

The wireless magnetometer detection system utilizes a power relay panel with a 10-amp breaker to supply 120 VAC power to the access point.

4.2 Base Station Software

A computer, tablet or other mobile device, capable of utilizing standard web browsers, shall be used to setup, remotely monitor, and perform system diagnostics of the detection system components. Vehicle detection information can be viewed in real-time. Wireless magnetometer system hardware shall be interchangeable to their respective functions such that all respective equipment, e.g. wireless magnetometers shall be of a uniform type for vehicle detection functions such as presence detection, counting, speed detection, etc.

The wireless magnetometer detection system software is license-free and embedded in the base station. The software performs functions associated with initial system setup, graphical sensor and detection zone placement, and sensor and zone real-time active status for stopped and flowing traffic. Additionally, the system software provides volume and occupancy data per zone and per wireless magnetometer, information about health status of components, and logging of events.

4.2.1 User Interface

The interface shall provide the user with the ability to identify and setup equipment by entering the serial number of any device individually through manual key strokes or through the use of a 2D bar code scanner.

The interface software shall provide the user with a guided process and provide direction for proper setup with respect to the wireless magnetometer, access point and base station. The interface permits the user to add a wireless magnetometer and affiliate its access point radio the guided process. Upon populating wireless magnetometers and detection zones, the user will drag and drop the wireless magnetometer and/or zone in a predetermined object tree such that no further sensor-to-zone association is necessary.

The interface provides a simple way to change respective configurable parameters for wireless magnetometers, detection zones, access points, base stations and local network parameters.

The interface automatically validates and completes any changes made to systems components or zone objects and provides a list of items relating to wireless magnetometer detection status, signal strength, battery life, and detection metrics for user's review.

The user can select and configure data logging frequency pertaining to system health status, and to wireless magnetometer and zone volume/occupancy metrics where the detection system health status logging shall be configurable and wireless magnetometer and zone volume/occupancy metrics logging shall be configurable.

4.2.2 Data Storage

Data logs for system health status and detection status are reviewable for up to multiple months depending upon space available. The data logs can be output in HTML and .CSV formats.

4.3 Cable Specification

4.3.1 Communications Cable Construction

The EIA-485 Communications Cable consists of at least six (6), 24 AWG twisted pair conductors within a shielded jacket and UV-resistant low density polyethylene jacket and has the following minimum properties:

1. Conductor: Six (6) conductors, 24 AWG, copper conductor;
2. Colors: blue wire, orange wire, orange/white wire, green wire, green/white wire, blue/white wire;
3. Insulation: Conductor insulated with extruded polyethylene with 0.030 in. wall thickness;
4. Shielding: 100% aluminum foil tape conductor coverage;
5. Jacket: Extruded black polyethylene with 0.030 in. wall thickness;
6. Dimensions: Nominal .0340 in outer diameter;

4.3.2 Power Cable Construction

Signal Conductor Cable consists of at least two (2), 16 AWG jacketed conductors within a shielded jacket, and one (1) bare ground wire, all within a UV-resistant low density polyethylene jacket and shall have the following minimum properties:

1. Conductor: Two (2) conductors, 12 AWG - 14 AWG tin-plated copper conductor;
2. Colors: black wire - AC hot, white wire - AC neutral, bare wire – ground;
3. Insulation: Conductor insulated with extruded polyethylene with 0.030 in. wall thickness;
4. Shielding: 100% aluminum foil tape conductor coverage;
5. Jacket: Extruded black polyethylene with 0.030 in. wall thickness;
6. Electrical: Rated at 600 volts

4.4 System Installation & Training

The supplier of the wireless magnetometer detection system shall be present at each and every intersection to supervise the installation and testing of the entire system by agency forces or electrical contractor.

Four hours of training from a factory certified instructor shall be made available to personnel of the contracting agency in the setup, operation, and maintenance of the wireless magnetometer detection system.

4.5 Warranty, Service, & Support

Wireless magnetometer vehicle detection system shall be warranted against material and manufacturing defect for one (1) where the wireless magnetometer shall be warranted against material and manufacturing defect for five (5) years. Ongoing support for the wireless magnetometer vehicle detection system shall include software updates to the wireless magnetometer, access point and base station components. These software updates are free of charge during the warranty period. The supplier will maintain a program for technical support and software update following the expiration of the warranty period, and these services shall be available to the contracting agency in the form of a separate maintenance agreement for continuing support.

5.0 LOOP DETECTORS

5.1 PREFORMED LOOPS

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 must be readily available manufactured items. Loops built by the contractor shall not be allowed. 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.

When installed, no part of the loop shall be within two feet (2') of reinforcement rods in the surrounding pavement.

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

5.2 SAWCUT LOOPS

5.2.1 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.

5.2.2 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 (5) turns per foot (305mm), including lengths in conduits and service boxes.

5.2.3 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.

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.

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 one inch (25mm) of the outer jacket being encapsulated by the heat shrink tubing.

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

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

5.2.4 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.

5.2.5 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 three-eighth inch (9.5mm) wide saw cut without damage to adjacent areas. The depth of the saw cut shall be two inches (51mm) deep. 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 (6mm) within each loop. A diamond blade with water shall be used in the saw cut operation. Carbide blades are not acceptable.

5.2.6 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 (6,900 kPa) pressure and following, the slots shall be cleared of water and dried using oil-free air.

5.2.7 Loop Conductor Installation

Loop detector conductor shall be installed using a three sixteenth inch (4.8mm) to one-fourth inch (6.4mm) 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.

5.2.8 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.

5.2.9 Loop Detector Saw Slot Filler

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.

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.

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.

5.3 LOOP TESTING

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.

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:

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

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.

H. EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM

The Global Traffic Technologies Opticom brand of radio activated, GPS based emergency vehicle traffic signal priority control system (Preempt System) shall be installed in all traffic signal systems.

All equipment and cabling necessary for the operation of the Preempt System shall be supplied and installed by the contractor to Global Traffic Technologies specifications.

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

This item is specified to maintain compatibility with the currently installed system.

I. FIBER OPTIC INTERCONNECT

1.0 DESCRIPTION

All designed interconnect systems shall use single-mode fiber optic, interconnect cable. This work shall consist of furnishing and installing a fiber optic network for a traffic signal system 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 with the City Traffic Signal network 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 manufacturer'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. Four fibers from each cable entering the cabinet 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 specific cable used shall be specified in the project plans.

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.

6.0 TESTING

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.

7.0 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.

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.

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 two meters <6.5 feet> of slack. Controller cabinets shall be provided with a minimum of eight meters <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.

8.0 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 2700 N <600 lbs.> or the cable manufacture's recommendations, whichever 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.

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

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. TRAFFIC MONITORING CAMERA

1.0 GENERAL

All new traffic signals shall have Pan-Tilt-Zoom cameras installed. Camera shall be Axis Communications Q6052-E. This camera is required to maintain interoperability with the City's current monitoring software. It will also maintain compatibility and continuity with the City's Intelligent Transportation System.

2.0 POWER SUPPLY

Camera shall be powered by High Power over Ethernet (IEEE 802.3at). Any devices necessary for providing power to the camera shall be included.

3.0 MOUNTING HARDWARE

A mounting bracket capable of attaching the camera to the side of a steel traffic signal pole shall be included. Mounting hardware shall be supplied by the camera manufacturer.

4.0 DECODING SOFTWARE

Decoding software shall be industry-accepted and widely available.

5.0 WARRANTY

Supplier warrants that all products supplied will be free from defects in design, workmanship and materials under normal use for a minimum period of one (1) year from the date of the original purchase.

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

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.

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.

The grounding system at the service disconnect shall consist of four (4) - 5/8 inch X 10 foot (16mm x 3m) copper clad ground rods placed fifteen feet (4.6m) 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.

The Controller cabinet shall be grounded via a #6 copper wire to a 5/8 inch X 10 foot (16mm x 3m) copper clad ground rod located in a handhole a minimum distance of fifteen feet (4.6m) away from the Controller cabinet.

No ground rods may be installed within the cabinet.

A (1) -5/8 inch X 10 foot (16mm x 3m) copper clad ground rod shall be installed at each lighting standard and traffic signal pole. These rods shall be bonded to the EGC. 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" (150mm) above concrete.

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.

L. CONTRACTOR COORDINATION

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 Controller. 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 Controller. All conduit, wiring, and power service installations shall meet or exceed current National Electrical Codes and any other applicable local codes and ordinances.

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 Controller.

M. GUARANTEE

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

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.

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 or the certification shall be deemed to be compliance with all issued specifications. Should deviations from the specification 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 deviation(s) before rejection of the project and removal of the equipment.

N. TRAFFIC SIGNAL HEADS

1.0 VEHICULAR SIGNAL HEADS

All vehicular signal heads shall be constructed with 12" (305mm) 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.

Lenses shall be twelve inches (305mm) 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.

Visors shall be tunnel type and at least nine and one-half inches (241mm) 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.

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.

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.

All signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets assemblies shall be aluminum.

Side of pole signal mounting hardware shall be polycarbonate yellow saddle brackets. Brackets shall be secured to the pole by using minimum 5/8-inch wide stainless steel banding material

All signal heads placed on mast arms shall be provided with backplates. Backplates shall be of five-inch (127mm) 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 M.P.H. (161 KMPH) 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.

All vehicle signal indications (red, yellow and green) shall be the Dialight LED 12" (305mm) 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.

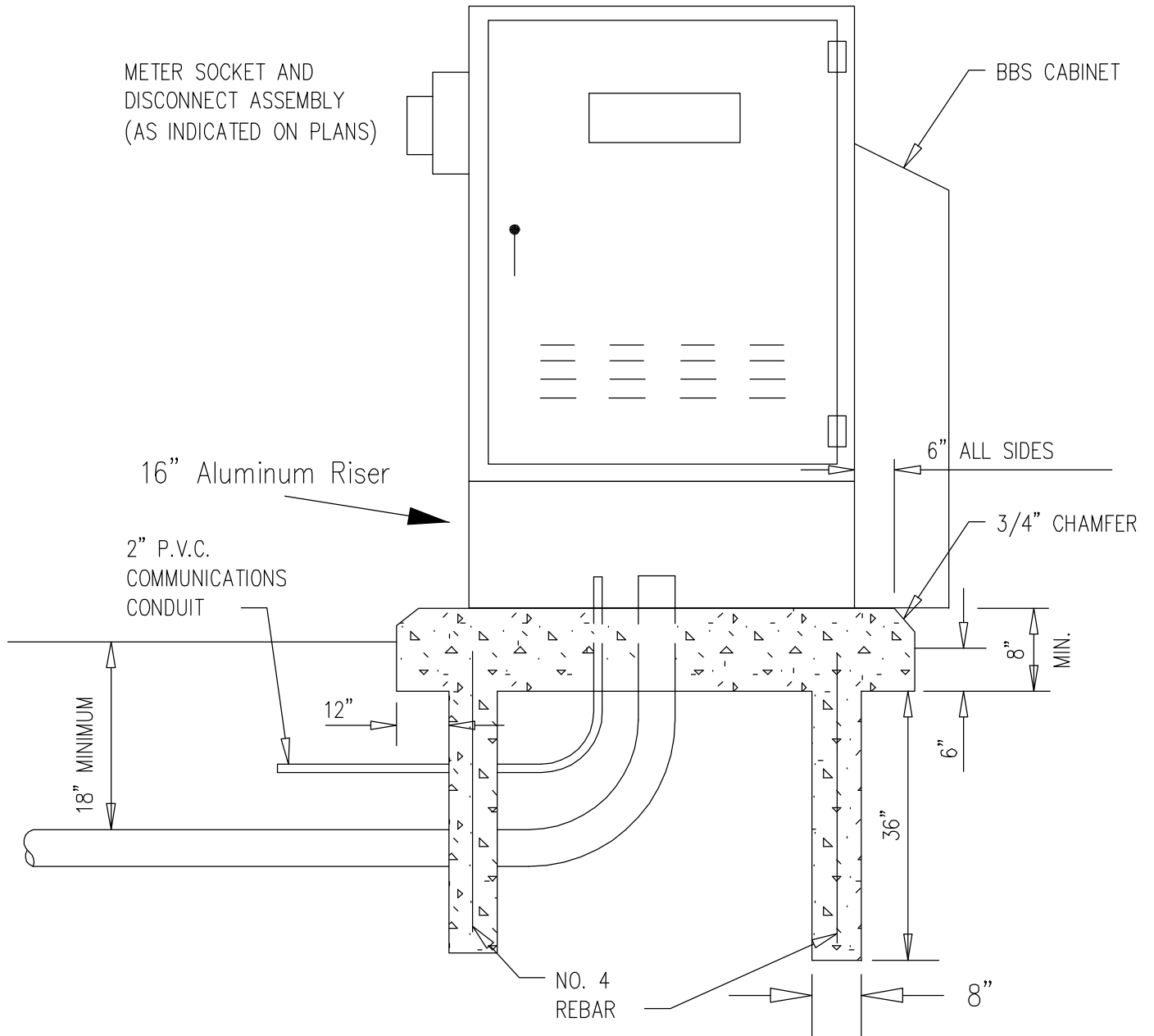
All LED Ball Signal Modules shall be fully compliant to the ITE VTCSH LED Circular Supplement specifications dated and adopted June 27, 2005.

All LED 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.

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).

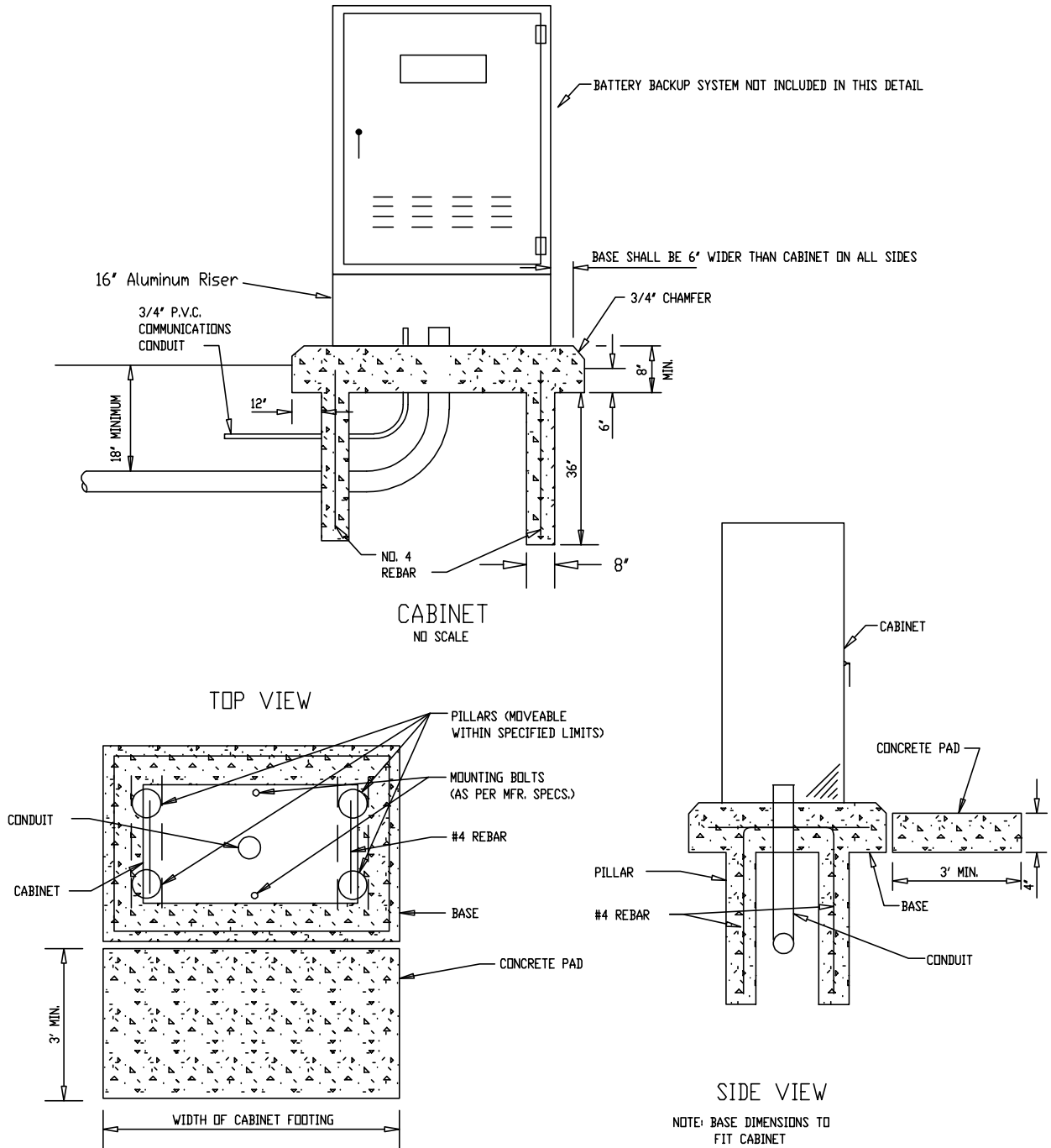
Council Bluffs Traffic Signal Standards

Cabinet shall be size 6 (P) 56"Hx44"Wx24"D
 unless noted otherwise on drawings



Standard Name: Traffic Signal Base, Cabinet, & Riser	
Detail Information:	Drawing Number: 8010.1
Revision Date: 7/26/05	Sheet: 1 of 2

Council Bluffs Traffic Signal Standards



Standard Name: Signal Cabinet Foundations

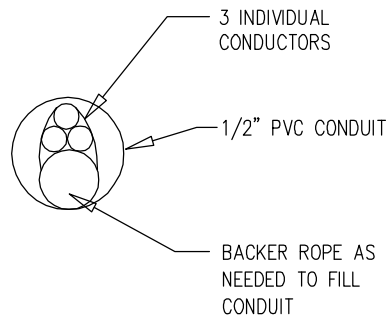
Detail Information:

Drawing Number: 8010.1

Revision Date: November 2019

Sheet: 2 of 2

Council Bluffs Traffic Signal Standards

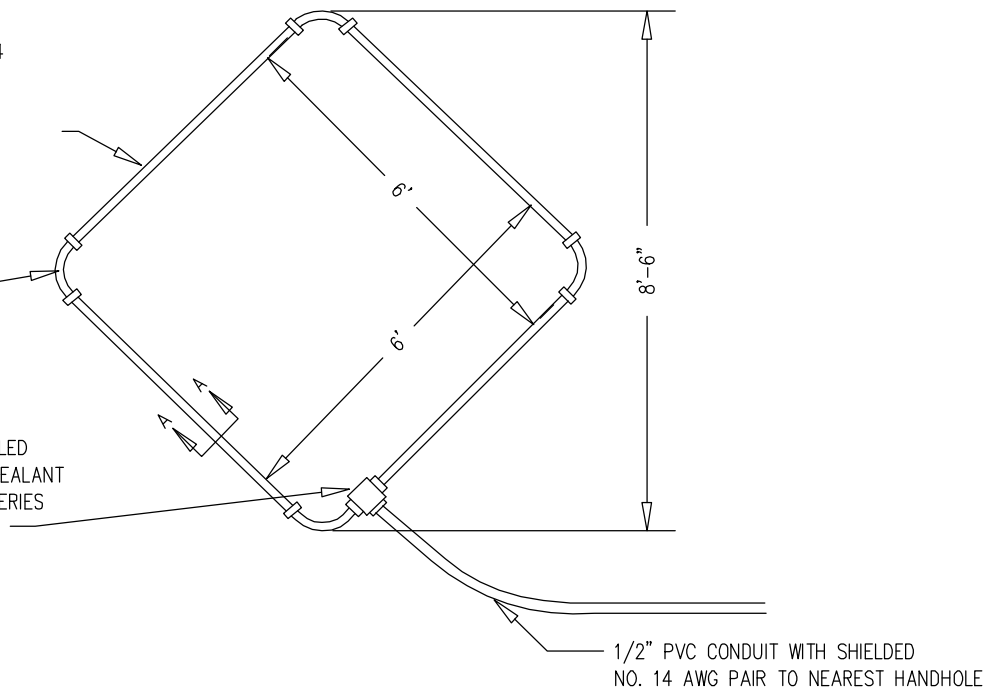


SECTION A-A
NO SCALE

1/2" PVC CONDUIT WITH THREE INDIVIDUAL NO. 14 AWG WIRES TAPED TO BACKER ROPE AND CONNECTED IN SERIES

1/2" PVC ELBOW (OPTIONAL)

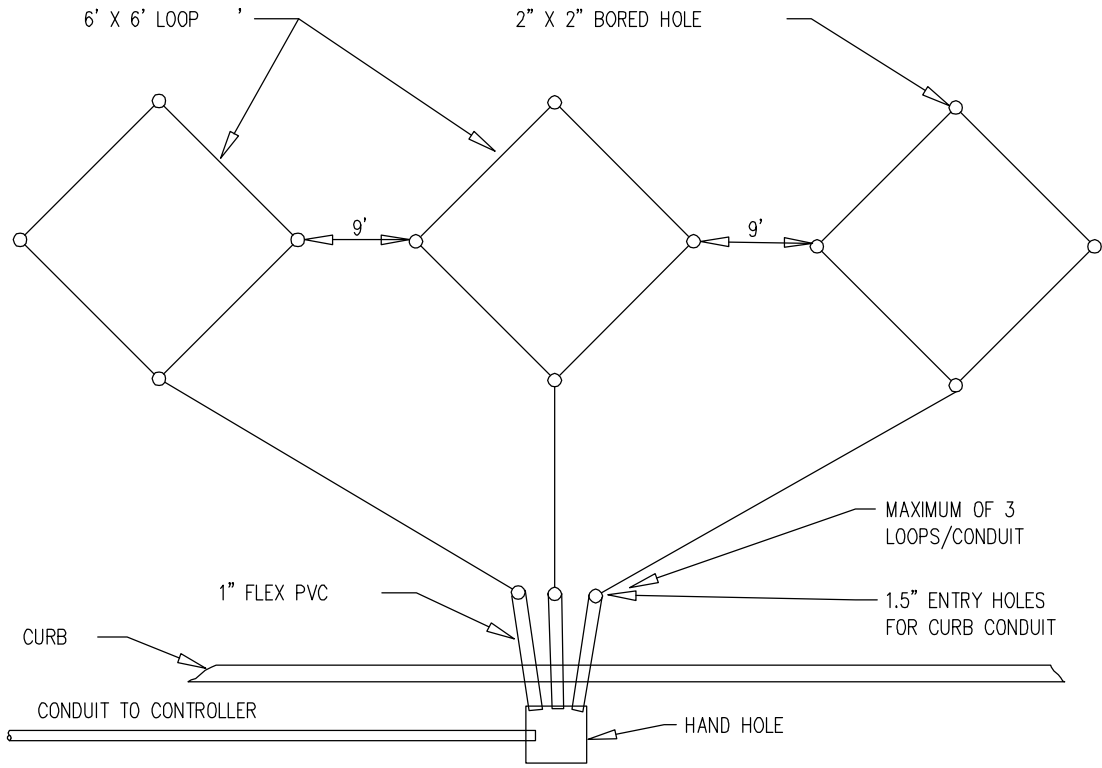
1/2" PVC CONDULET, FILLED WITH SILICONE RUBBER SEALANT (CONNECT 3 LOOPS IN SERIES TO LEAD-IN PAIR)



PREFABRICATED DETECTOR LOOP
NO SCALE

Standard Name:	Prefabricated Detector Loop	
Detail Information:	Drawing Number:	8010.5
Revision Date:	November 2001	Sheet: 1 of 4

Council Bluffs Traffic Signal Standards



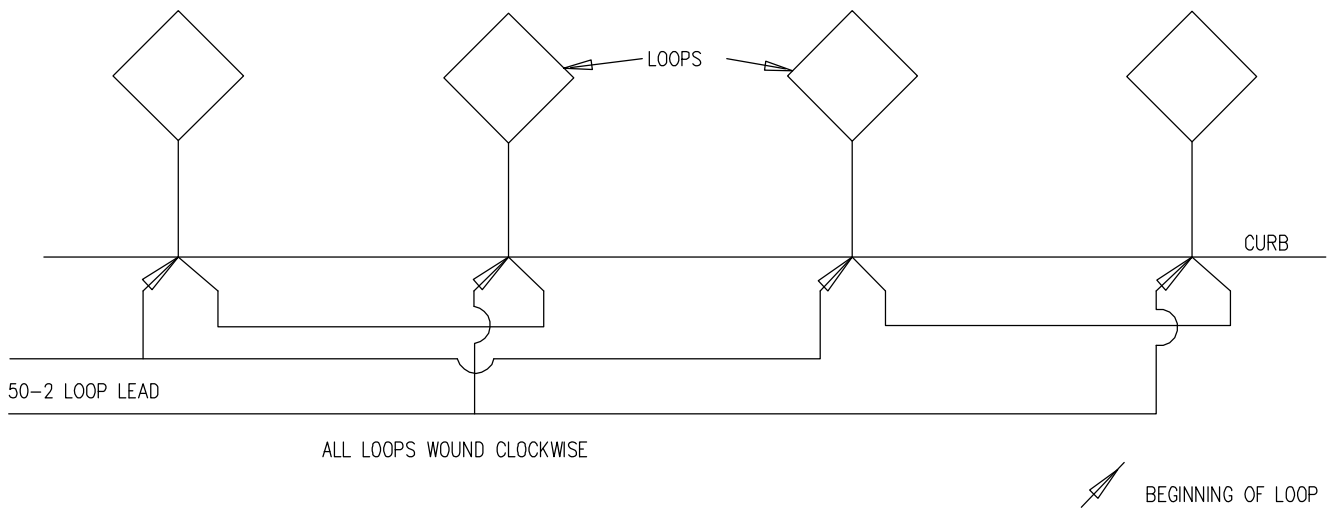
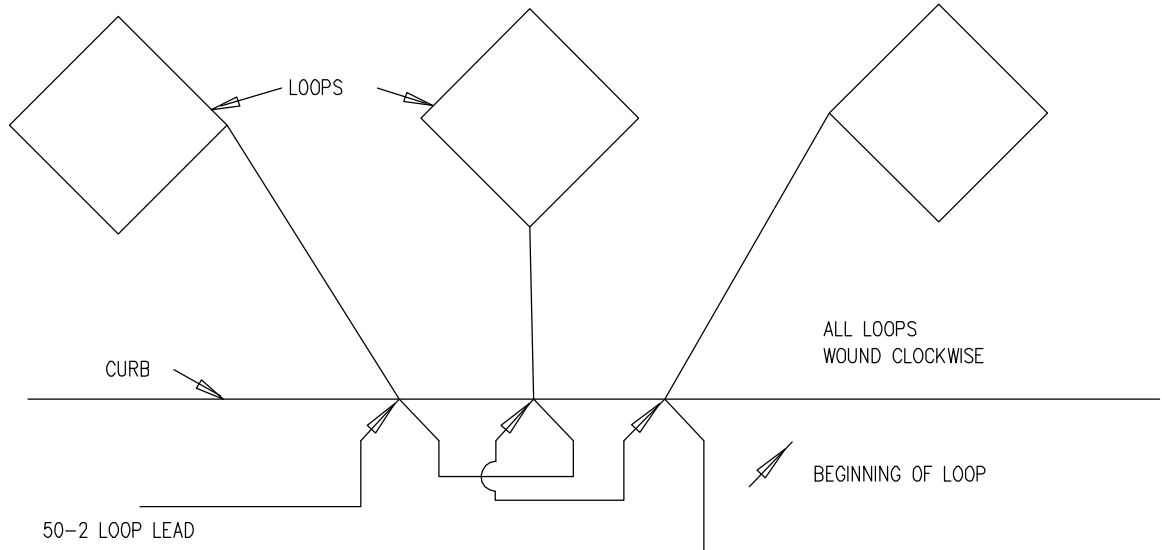
LOOP DETAIL
NO SCALE

Standard Name:	Loop Layout Detail	
Detail Information:	Drawing Number:	8010.5
Revision Date:	November 2001	Sheet: 2 of 4

Council Bluffs Traffic Signal Standards

3 LOOP PHASING DETAIL

NO SCALE



4 LOOP PHASING DETAIL

NO SCALE

Standard Name:	Traffic Signal Loop Wire Phasing	
Detail Information:	Drawing Number:	8010.5
Revision Date:	November 2001	Sheet: 3 of 4

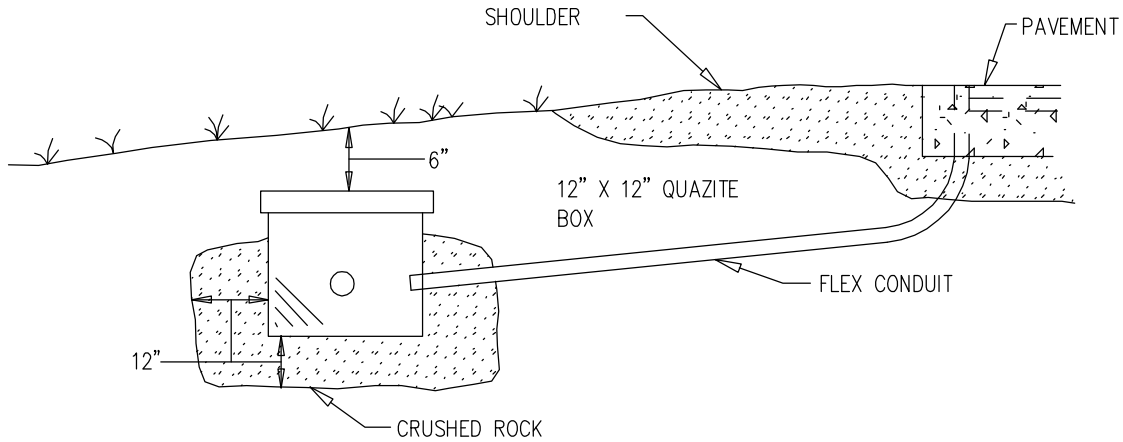
Council Bluffs Traffic Signal Standards

LOOP HAND HOLE

DETAIL

NO SCALE

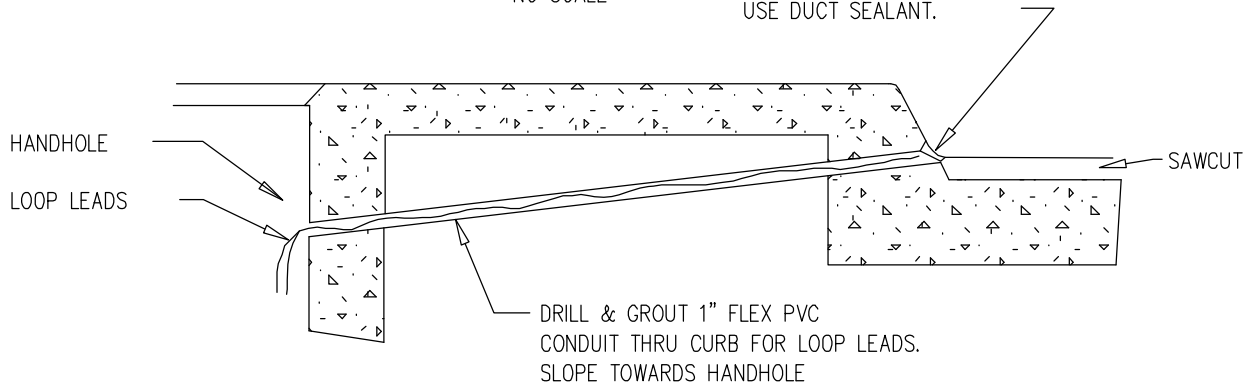
(ROADWAY WITH DITCH & NO CURB)



CURB DETAIL

NO SCALE

SEAL CONDUIT BEFORE
POURING LOOP SEALANT.
USE DUCT SEALANT.



Standard Name: Loop Lead for Curb & Shoulder Sections

Detail Information:

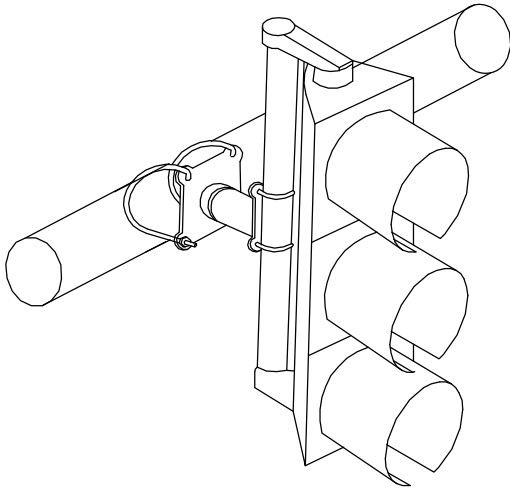
Drawing Number: 8010.5

Revision Date:

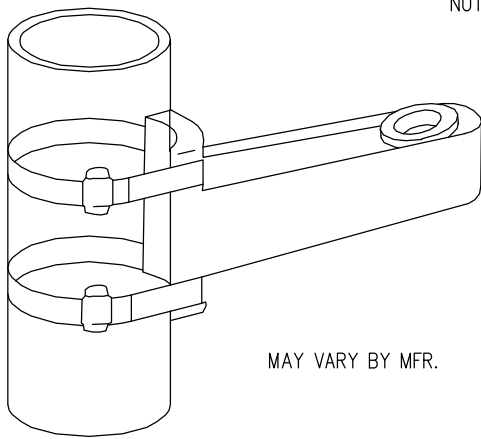
November 2001

Revision Number: 4 of 4

Council Bluffs Traffic Signal Standards



MAST ARM
MOUNTING BRACKET
NO SCALE

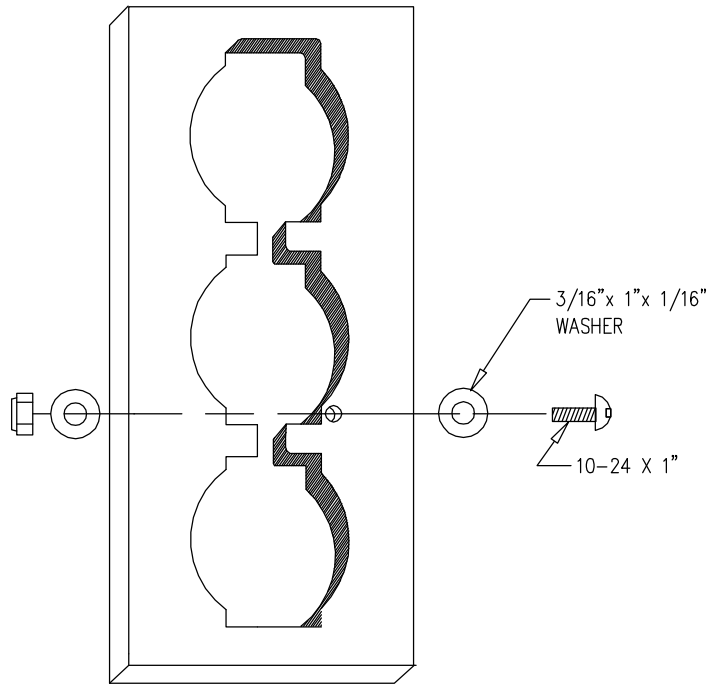


SADDLE BRACKET
POLE MOUNT HARDWARE
NO SCALE

MAY VARY BY MFR.

NOTE:
10-24
NYLON
LOCKING
NUT

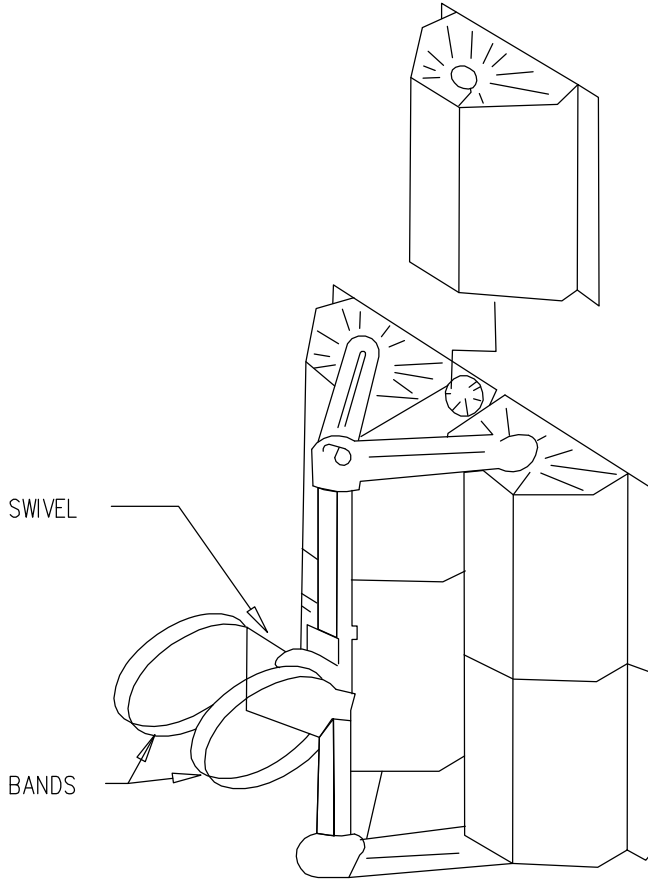
BACK PLATE
NO SCALE



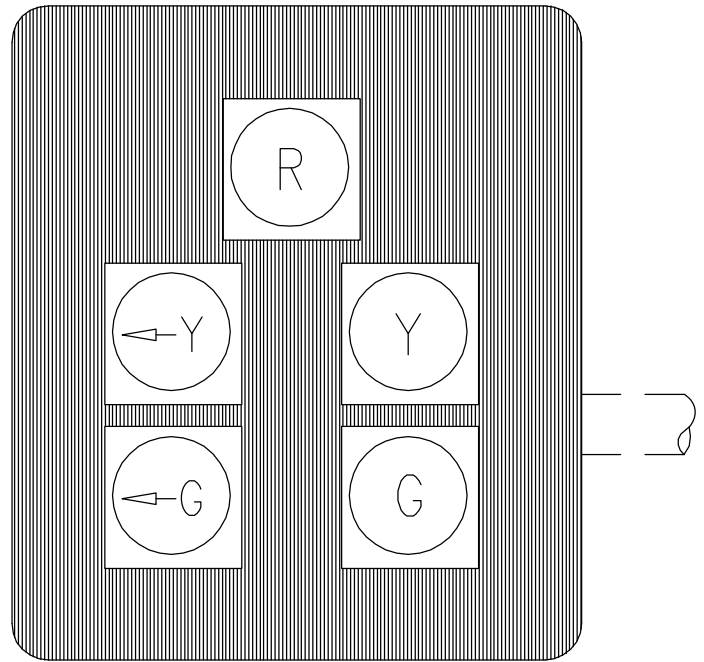
VACUUM
FORMED
ONE
PIECE

Standard Name: 3 Section Signal Head Detail	
Detail Information:	Drawing Number: 8010.8
Revision Date: November 2001	Sheet: 1 of 2

Council Bluffs Traffic Signal Standards



Typical 5 Section
Traffic Signal Head
and Support



5 Section Signal
Head Configuration

Standard Name: 5 Section Signal Head Configuration

Detail Information:

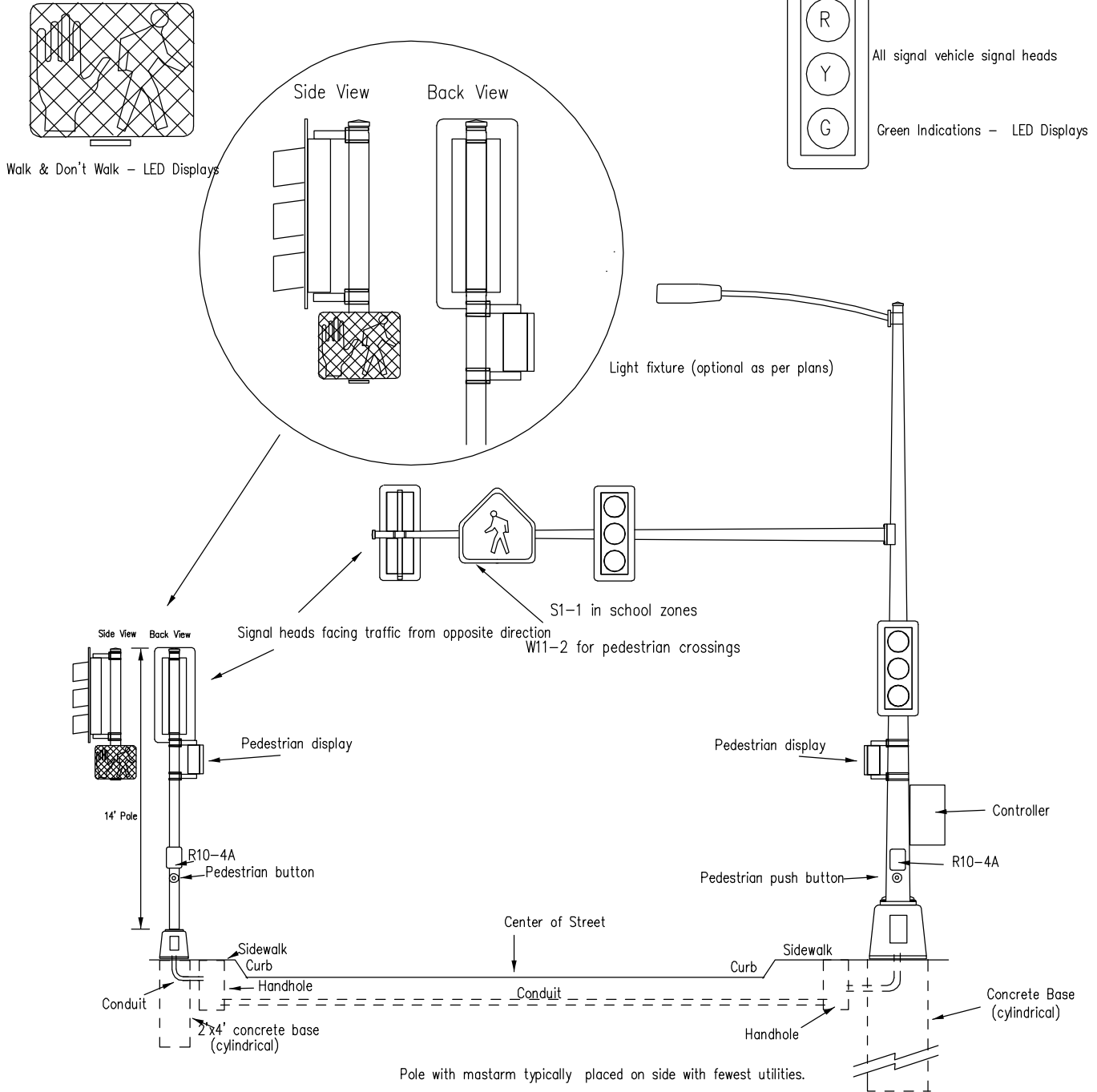
Drawing Number: 8010.8

Revision Date: November 2001

Sheet: 2 of 2

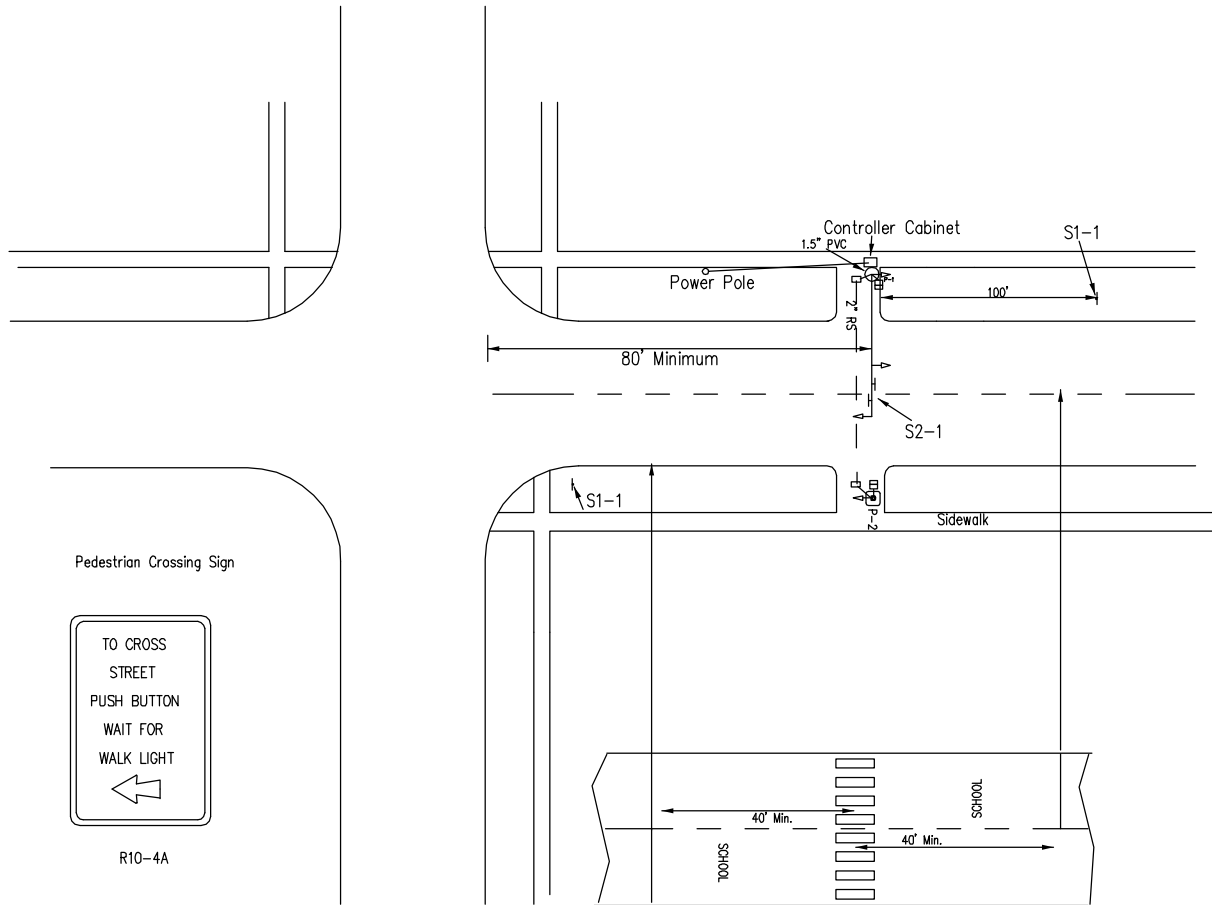
Council Bluffs Traffic Signal Standards

P-1, P-2 Standard Universal Symbol Pedestrian Heads



Standard Name: Pedestrian Crossing Signals	
Detail Information:	Drawing Number: 8010.12
Revision Date: November 2001	Sheet: 1 of 2

Council Bluffs Traffic Signal Standards



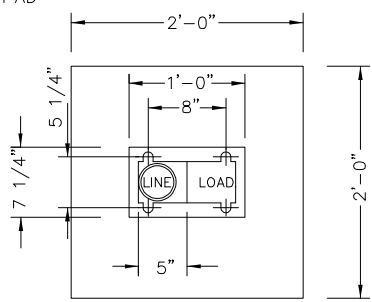
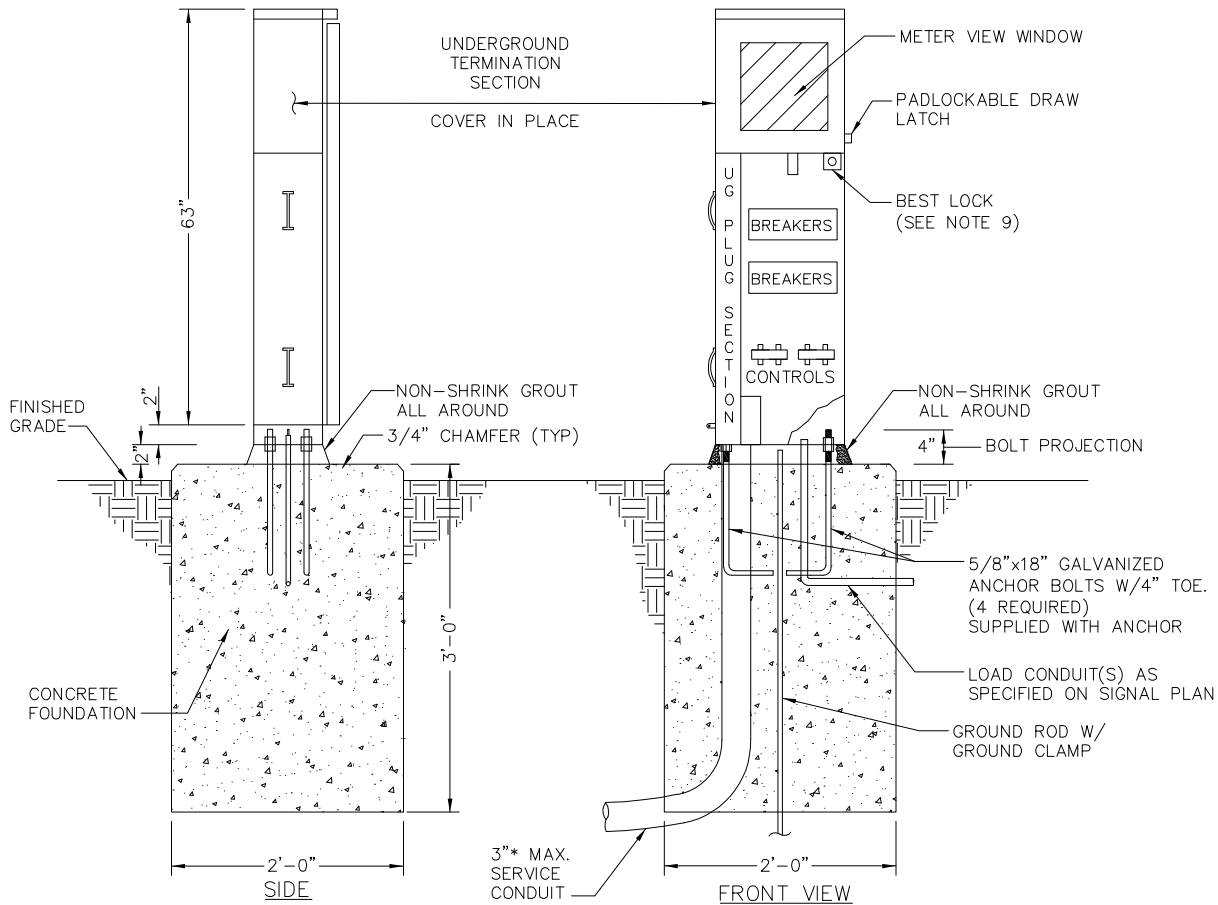
Notes

- Contractor to install pedestrian crossing equipment.
- City to supply all equipment except concrete, electrical service, and anchor bolts.
- City to supply all signs and mounting hardware.
- City to install signs located on curb area.
- City to supply and install pavement markings.
- Concrete bases and remainder of project to follow City of Council Bluffs Traffic Signal Installation Standards, latest Rev.
- All areas where grass is disturbed by the contractor will be seeded by the contractor as per City of Council Bluffs standards.

Standard Name:	Pedestrian Crossing Location & Markings	
Detail Information:	Drawing Number:	8010.12
Revision Date:	November 2001	Sheet: 2 of 2

Council Bluffs Traffic Signal Standards

Traffic Signal Electrical Service



BASE PLAN
SCALE: NONE

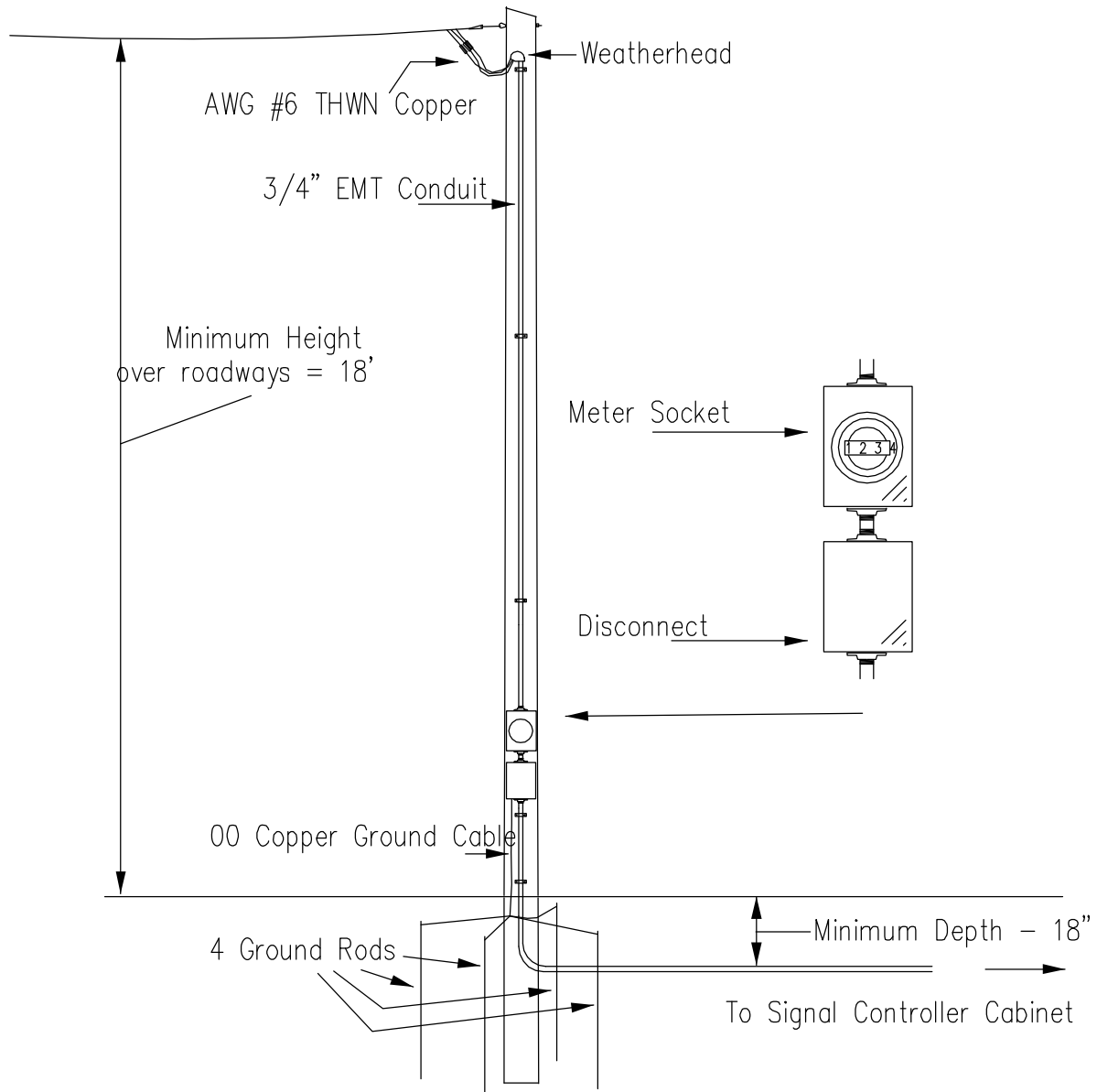
ENCLOSURE CONSTRUCTION NOTES

1. FABRICATED FROM 1/8" ALUMINUM, ELECTRICALLY WELDED AND REINFORCED WHERE REQUIRED. THE CABINET SHALL BE UNPAINTED NATURAL ALUMINUM.
2. CONSTRUCTION WILL BE NEMA 3R RAIN TIGHT.
3. ALL NUTS, BOLTS, SCREWS AND HINGES, WILL BE STAINLESS STEEL.
4. NUTS, BOLTS, AND SCREWS WILL NOT BE VISIBLE FROM OUTSIDE OF ENCLOSURE.
5. PHENOLIC NAMEPLATES WILL BE PROVIDED WHERE REQUIRED.
6. CONTROL WIRING WILL BE MARKED AT BOTH ENDS BY PERMANENT WIRE MARKERS.
7. A PLASTIC COVERED WIRING DIAGRAM WILL BE ATTACHED TO THE FRONT DOOR.
8. ENCLOSURE WILL BE FACTORY WIRED AND CONFORM TO REQUIRED NEMA STANDARDS.
9. LOCK TO MATCH CURRENT CITY COMBINATION.
10. SERVICE ENCLOSURE SHALL BE TESCO CLASS 26-100-M-A2 OR CITY APPROVED EQUAL PRIOR TO BID.
11. CONCRETE FOR FOUNDATION SHALL BE 4000 PSI.
12. ENCLOSURE SHALL BE SET PLUMB AND LEVEL.

Standard Name:	Electrical Service - Pedestal
Detail Information:	Drawing Number: 8010.15
Revision Date: December 2019	Sheet: 1 of 3

Council Bluffs Traffic Signal Standards

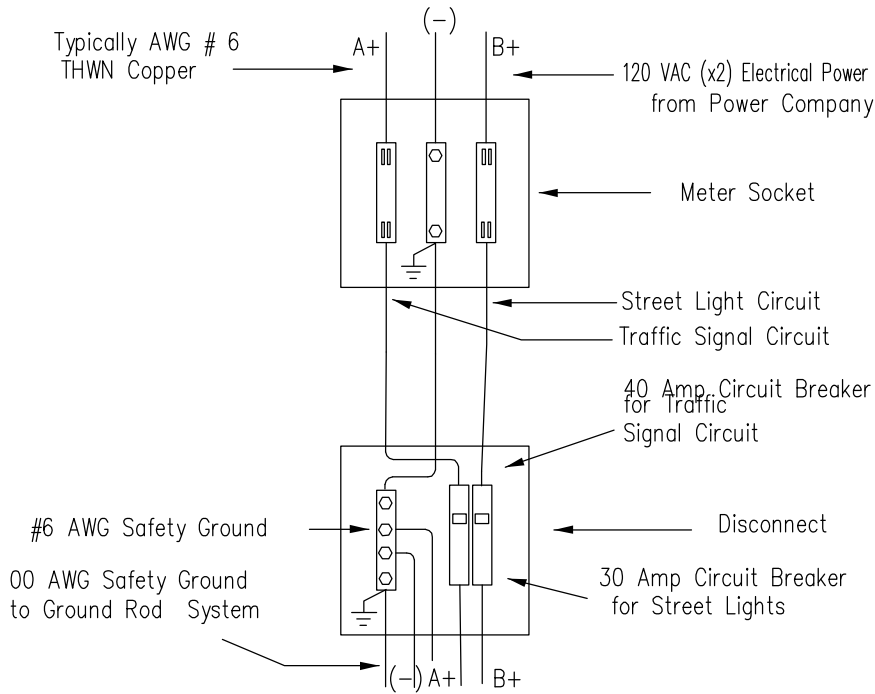
Traffic Signal Electrical Service



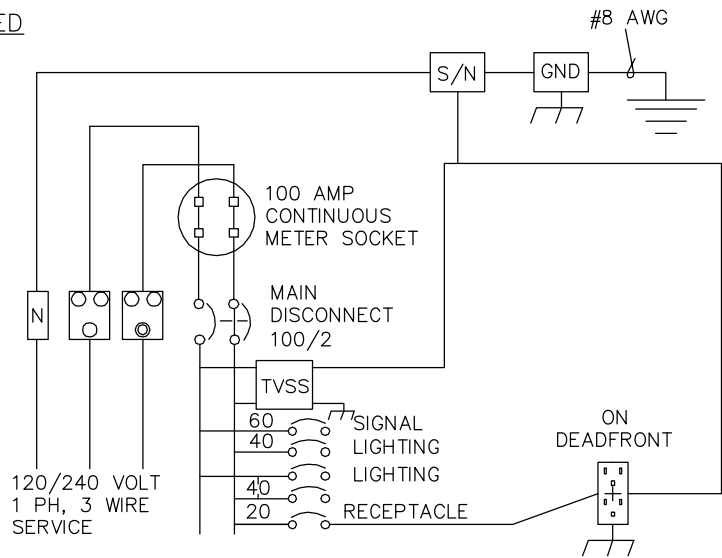
Standard Name:	Electrical Service - Pole Mounted	
Detail Information:	Drawing Number:	8010.15
Revision Date:	December 2006	Sheet: 2 of 3

Council Bluffs Traffic Signal Standards

Traffic Signal Electrical Service Schematic



WIRING DIAGRAM – POLE MOUNTED



WIRING DIAGRAM – PEDESTAL

Standard Name: Electrical Service – Electrical Schematic	
Detail Information:	Drawing Number: 8010.15
Revision Date: December 2006	Sheet: 3 of 3