CITY OF COUNCIL BLUFFS

SPECIAL PROVISIONS

FOR

TRAFFIC SIGNAL

SPECIFICATIONS

APRIL 2020

Purpose: to give technical guidance for equipment specified in the **TRAFFIC SIGNAL SPECIFICATIONS 2020** document.

A. TRAFFIC CONTROLLER UNIT

No supplemental information. Contact City Traffic Engineer for comments/questions.

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 ordered 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 signal inputs 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 MICROPROCESOR 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^{o}C to +74^{o}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 ECcom 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 the 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 ECcom 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 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.

The cabinet shall have an internally mounted document drawer with telescopic drawer slides.

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 tithe 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.

2.0 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:

- 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.
- Type 2 Configuration - Eight load switch sockets, four flash transfer relay sockets, one flasher socket and two main panel BIU rack positions.
- Type 3 Configuration - Twelve load switch sockets, six flash transfer relay sockets, one flasher socket and two main panel BIU rack slots.
- 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:

Type	Wire Color	Size
Green/Walk switch output	GREEN	16 gauge
Yellow load switch output	Yellow	16 gauge
Red/Don't Walk load switch output	Red	16 gauge
MMU (other than AC power, for greens and yellows)	RED	22 gauge
MMU (other than AC power, for reds)	YELLOW	22 gauge
Controller I/O	Blue	22 gauge
AC Line (power panel to main panel)	Black	*varies
AC Line (main panel)	Black	*varies
AC Neutral (power panel to main panel)	White	*varies
AC Neutral (main panel)	White	*varies
Earth ground	Green	*varies

*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.

3.0 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:

- 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.
- A 15-amp auxiliary breaker. This breaker shall supply power to the fan, light and GFI outlet.
- A 15-amp, shall supply power to the cabinet flasher
- A 15-amp breaker shall be labeled as “SPARE”.
- A 115V/ 75A Crydom A-2475 solid state contactor or equivalent shall be used instead of a mercury contactor
- A neutral bus bar capable of connecting one (1) #6 stranded wire in each position with a minimum of 15-positions.

4.0 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.

5.0 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.

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

- One (1) BIU slot.
- Sixteen channels of NEMA TS2 type detection (2 and 4 channel detector cards).
- 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.

5.1 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.

6.0 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:

- 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.
- 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.
- 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:

- 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.
- 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.
- 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.

7.0 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.

8.0 COMBINATION PREEMPT INTERFACE AND SDLC PANEL

A panel shall be provided for railroad preemption 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 preemption 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.

9.0 AUXILIARY DEVICES

9.1 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.

9.2 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.

9.3 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.

9.4 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.

9.5 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.

9.6 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.

9.7 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 Engineer.

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

Each Ethernet switch shall be equipped with a minimum of 1 Ethernet cable. The Ethernet cable shall have 24 AWG Bonded-Pairs, solid bare copper conductors, polyolefin insulation, polymer gel water-blocked, with a sun resistant LLPE jacket. Cable will have sequential marking at two foot intervals. Cable shall be Belden 7934a or equivalent.

10.0 TESTING AND WARRANTY

10.1 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.

10.2 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

No supplemental information. Contact City Traffic Engineer for comments/questions.

E. TRAFFIC SIGNAL BATTERY BACKUP SYSTEM (BBS)

1.0 GENERAL

This specification establishes the minimum requirements for a complete emergency battery back-up system for use at traffic signals utilizing Light Emitting Diodes (LED) signals and pedestrian heads. The Battery Back-up System (BBS) shall include, but not be limited to the following:

- BBS with Inverter, Charger, Tap Switching Transformer and Internal Power Transfer Switch.
- Automatic and Manual Bypass Transfer Switch units.
- Batteries

- Cabinet
- Wiring

The BBS shall provide reliable emergency power to a traffic signal in the event of a power failure or interruption.

2.0 OPERATION

2.1 GENERAL

The BBS shall provide the following operational modes when operating on battery power:

- Full operation of all traffic signal devices
- Flash operation
- Combination of full and flash operation

2.2 RUN TIME

The BBS shall provide a minimum of 8.0 hours of full-time operation with a 450 watt load @ 25°C. The minimum battery size requirement is listed in section 8.0, Battery Type.

2.3 COMPATIBILITY

The BBS shall be compatible with Model 30X, 33X, and 34X cabinets; the ITS cabinet; model 170 and 2070 controllers and any NEMA style cabinet, enclosures and controllers; the Advanced Transportation Controller; and all cabinet components for full time or flash operation.

2.4 OUTPUT CAPACITY

The BBS shall be rated at a minimum of 1100W/1100VA@25°C active output capacity with 82 percent minimum inverter efficiency with 30% minimum loading.

2.5 OUTPUT VOLTAGE

When operating in backup mode, the BBS output shall be 120VAC ± 2%, pure sine wave output, ≤3%THD, 60Hz ± 5%.

2.6 DC SYSTEM VOLTAGE

The BBS DC system voltage shall be 48VDC nominal.

2.7 TRANSFER TIME

The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 5 milliseconds (ms). The same maximum allowable time shall also apply when switching from the inverter line voltage to utility line voltage after the line has been qualified. Transfers to and from battery operation shall not interfere with the operation of the other equipment in the intersection.

2.8 LINE QUALIFY TIME

The BBS shall have a user definable line qualify time. The user shall be able to set a time within the range of 3s-999s. The default line qualify time shall be 3 seconds.

2.9 OPERATING TEMPERATURE

The BBS and all components shall operate without performance degradation over a temperature range of -40°C (-40°F) to +74°C (+165°F) with a maximum load of 70% of rated output of the BBS inverter.

2.10 FEEDBACK LEVEL

The BBS shall be tested and certified to Electrical Standards UL 1778 and CSA 107.3.

2.11 SURGE PROTECTION

The BBS shall have surge protection compliant with IEEE/ANSI C.62.41 Cat. A & B.

2.12 POWER AND CONTROL CONNECTIONS

The BBS shall be easily installed, replaced, or removed by using easily removable cables for AC input, AC output, DC input, and battery temperature sense.

2.12.1 AC CONNECTION

The AC input and output hardwired connections shall be separate 3-position euro style terminal blocks mounted on a rotatable panel as part of the front of the BBS.

2.12.2 DC CONNECTION

The DC connection shall be a recessed one-piece Gray Anderson style connector rated to handle the maximum DC current required by the inverter while running on batteries.

2.12.3 TEMPERATURE PROBE CONNECTION

The battery temperature sense inputs shall be panel-mounted Telco style connector.

2.13 AC INPUT CIRCUIT BREAKER

The BBS shall be equipped with a flush mounted AC Input circuit breaker that protects both the BBS and the loads connected to the output. Should the AC Input breaker on the BBS trip, it shall allow the BBS to go to inverter mode to power the intersection off batteries. Should an overload condition still exist when the inverter is energized the inverter will revert to its internal electronic protection, preventing damage to the inverter due to the overload or short circuit condition, on the output.

2.14 AC OUTPUT CIRCUIT BREAKER

The BBS shall not have an AC Output circuit breaker or combination Input/Output breaker. An AC output breaker prevents the inverter from powering the load from batteries when tripped.

2.15 BATTERY CIRCUIT BREAKER

The BBS shall have a flush mounted Battery circuit breaker installed on the front panel of the BBS inverter module.

2.16 OVERLOAD

The BBS Inverter Module must be able to shut down in order to protect against internal damage in the event of an overload at the output. The Inverter shall support an overload up to 110% for 2 minutes and then turn off the inverter output. The fault recovers when the overload is removed and line power returns. There shall not be an AC output circuit breaker.

2.17 AC FEEDBACK

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

2.18 BBS FAILURE MODE

In the event of BBS failure (inverter/charger or battery) or complete battery discharge, the internal power transfer relay shall revert to Normally Closed (de-energized) state and provide utility power to the intersection when utility line power is available to the cabinet.

2.19 AUTOMATIC SHUTDOWN

The BBS shall initiate an automatic shutdown when battery output reaches 42.0VDC.

2.20 DESTRUCTIVE DISCHARGE OR OVERCHARGE

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

2.21 BATTERY TEST

The BBS Inverter Module shall be programmable to perform automatic battery tests at user defined intervals to meet specific requirements or manufacturer's recommendation.

- Intervals are set in days between tests
- Programmable start hour
- Programmable test timeout range 6 minutes to 10 days 10 hours
- Programmable test termination voltage
- Web browser to show battery test time remaining, elapsed time, error condition, last test completed date/time, and days until next test
- During self-test the BBS Inverter Module shall identify a weak battery string and initiate an Alarm.

2.22 SCHEDULER – TIME OF DAY SCHEDULE (TOD)

The BBS shall provide a scheduler with settings programmable by the user.

- The scheduler shall allow the user to program at least five (5) time spans with start and end times
- Each time span shall be selectable as to whether it is applicable All Days, Weekdays, or Weekends
- The scheduler shall allow the user to schedule operational modes as required, per intersection.
- A dry contact relay shall be programmable to use a programmed time span to prevent a relay from being energized during the time span

2.23 BATTERY STATE OF HEALTH (SOH)

The SOH is a percentage estimate of the state of health of the battery. The BBS shall show the approximate SOH of the battery when discharges of greater than 20% are done during a battery test.

2.24 USER CONFIGURABLE ALARMS

The BBS shall have at least 70 user configurable alarms. Each alarm shall be configurable as to:

- Enabled or Disabled
- Alarm Priority levels – Settable to Warning, Minor, Major, and Critical
- Parameter – Customizable user value for filtering

- Custom Name
- Dry Contact Relay – User can select which relay will be controlled by the alarm

2.24.1 ALARM CUT-OFF

If an alarm is triggered the user can select the alarm window and click, “Alarm Cut-Off” to cut off the alarm for the set period and the system will show the alarm(s) as “Acknowledged” and deactivate any assigned relays.

2.24.2 COLOR SEVERITY

The alarm window background on the LCD and web browser interface shall be color coded with the highest active alarm severity level:

- LCD – No Alarms/Warning = Green, Minor = Yellow, Major/Critical = Red
- Web – No Alarms/Warning = Blue, Minor = Orange, Major/Critical = Red

2.25 CUSTOM DATA AND CUSTOM ACTIONS

The BBS shall have the ability to capture custom data by either numeric or state value. These values can then be used in user created formulas to produce a numeric or Boolean output. The output can be used for reporting or for controlling dry contact relays by creating Custom Actions. In addition, counters and timers can be created to further custom data and actions.

- Counters – An Up or Down counter can be created to count how many times an event has happened and drive a custom action.
- Timers - The Delay Timer can be used with Custom Data to produce a programmable delay when a certain event happens. The Interval Timer can be used with Custom data to measure the time between two events.

2.26 OPTIONAL ANALOG DIGITAL INPUT OUTPUT (ADIO) DEVICE

An optional ADIO device can be connected to the BBS for external control of devices via additional dry contact relays or for monitoring current, DC volts, temperature, and digital input (contact closure). The ADIO communicates with the BBS via the CAN bus.

3.0 AUTOMATIC VOLTAGE REGULATION (AVR) – BUCK/BOOST

3.1 AVR

The BBS shall include AVR (Auto Voltage Regulation) Functionality. The BBS shall be Double Buck/Double Boost (two steps of each) – Line-Interactive, True BBS.

- The Double Buck/Double Boost mode shall have a minimum input range of 85 - 171 VAC.
- There shall not be any user definable transfer set points for the buck or boost modes.
- Whenever AVR mode is selected, the output of the system shall be regulated between 108-130VAC. When the output of the system can no longer be maintained with this range, the BBS shall transfer to Inverter or Backup Mode.

4.0 BATTERY CHARGER

4.1 BATTERY CHARGER

The BBS shall have an integral three (3) stage charger that is compatible with Gel and AGM battery topology. The charger shall be an intelligent charger with control systems that automatically incorporates bulk, absorption and float charging modes. Two stage chargers are not allowed.

The integral intelligent charger shall use temperature compensation. The charging system shall compensate over a range of -100.0 – 0.0 mV/°C/Cell (-55.6 - 0.0mV/°F/Cell), user adjustable when required. Default setting shall be -2.5 mV/°C/Cell (-1.4 mV/°F/Cell). Temperature compensation shall occur during absorption and float modes.

A temperature probe which plugs into the front panel of the BBS shall be used to monitor the internal temperature of the batteries. The Temperature sensor shall be 2 meter in length, external to the inverter/charger module and have a 3/8" lug for attaching to the negative terminal of the battery string.

If the temperature probe fails or is not connected to the BBS, the charger shall still charge the batteries but to a maximum of 52.5VDC.

The batteries shall not be recharged whenever the battery temperature exceeds 50°C (122°F).

The recharge time for the batteries from "protective low-cutoff" to 80 percent or more of full charge capacity shall not exceed 8 hours if the charger is set to maximum. The BBS charger shall be capable of providing 15 amps at 54VDC depending on load.

5.0 USER INTERFACES AND DISPLAYS

5.1 INVERTER/CHARGER DISPLAY

The BBS inverter/charger unit shall include a 4.3" backlit LCD Touchscreen display for viewing all status and configuration information. The screen shall be easily viewable in both bright sunlight and in darkness. The screen assembly shall be rotatable.

5.2 LCD SCREEN LAYOUT

The screen shall have different sections that contain:

- System Status Dashboard – Shows six I/O values or configuration
  - Dashboard Paging – Allows navigation to all four user configurable System Status panels
    - Total of 24 user configurable System Status fields displayed
- Alarms – Shows highest level active alarm. Color coded based on severity. Touching takes user to see all active alarms and allows for alarm cutoff
- Maintenance – Access to alarm cutoff, battery testing, and relay testing
- Information – Access to serial number and software and OS version
- Menu – Access to all controller menus
- Shortcuts – Access to most often used areas
- Login/Logout – For permissions to edit settings

At a minimum the LCD screen and web pages can show any of the following active real time readings and information:

- Operating mode (Line, Standby, Backup, Buck / Boost)
- Utility input voltage
- BBS output voltage and current
- Battery voltage, Temperature, SOH, SOC
- Input Frequency

- Output Power
- Charger Voltage, Current, Mode
- Battery mode
- Timer Relays delay remaining
- IP Address
- Accumulated output power in kW hours
- Battery Runtime Remaining
- Unit Serial number
- Unit Firmware Version
- Any alarms

The Menu shortcut layout shall follow the web browser interface menu navigation and allow for full programmability of the BBS.

5.3 WEB BROWSER INTERFACE

The BBS shall be provided with an embedded web server for user configuration and management through a web browser without needing to install computer software.

5.3.1 QUICK STATUS AREA

The quick status area shall remain at the top of all pages and show any active alarms and the first six fields of the LCD dashboard along with Battery Voltage and Battery Current. It shall also include a search field to aid the user in quickly finding the item they are looking for.

5.3.2 MENUS

The menu system shall include the following menu sections and abilities:

- Dashboard – Controller and BBS Status
- Power Flow – See 5.3.3
- Controller – Comm setup, NTP, Users & Security, Scheduler for TOD
- System – BBS Status and Configuration
- Modules – BBS Firmware upgrades
- Alarms – Configure Alarms
- Logs – Events, Alerts, Battery, Power Outage, Datalogs, and Performance Logs

5.3.3 POWER FLOW

There shall be a live Power Flow diagram that shows the active flow of power with values from the AC Source, Input Circuit Breaker, BBS, Load, Battery Breaker, and Battery. The BBS section shall show any active dry contact relays and alarms. The battery shall show any active alarms.

5.3.4 MINIMUM CAPABILITIES

The BBS shall allow the user to do the following through the web browser:

- View logs
- Configure network parameters
- Configure email
- Adjust line qualify time
- Configure dry contact relays
- Configure alarms
- Configure Time/Date, NTP
- Configure communications

- Configure users and security
- Controller and BBS firmware to be upgradeable remotely via Ethernet

5.4 STATUS LEDs

The BBS shall have discrete status LED indications on the front of the inverter/charger.

- Green Output LED shall be Solid ON any time that the output of the BBS is in Line or AVR (Buck/Boost) modes. When the BBS output is in Backup (Inverter) Mode the LED will flash On and Off.
- Red LED shall be Solid On any time there is one or more major or critical active alarms
- Yellow LED shall be Solid On any time there is one or more minor active alarms

5.5 LOGS – EVENT, ALERTS, BATTERY, AND POWER OUTAGE LOGS

5.5.1 EVENT LOG

The BBS shall maintain an event log containing a minimum of 3000 of the most recent events. The event log shall be downloadable as a csv file by web browser and exportable by USB port on the BBS. The log shall be date and time stamped. The most recent 300 events of the log shall be viewable by web browser and 25 by LCD. The event log shall capture:

- BBS System Mode
- AC Power Outage
- Configuration Changes
- Battery Mode
- Dry Contact Relay Status
- User Logon
- Firmware Updates
- Web Sessions

5.5.2 ALERT LOG

The BBS shall maintain an alert log containing a minimum of 3000 of the most recent events stored in a 'first in first out' (FIFO) buffer. The alert log shall be downloadable as a csv file by web browser and exportable by USB port on the BBS. The log shall be date and time stamped. The most recent 300 events of the log shall be viewable by web browser and 25 by LCD. The alert log shall capture all alarms.

5.5.3 BATTERY LOG

The BBS shall maintain a battery log containing a minimum of 3000 of the most recent events stored in a 'first in first out' (FIFO) buffer. The battery log shall be downloadable as a csv file by web browser and exportable by USB port on the BBS. The log shall be date and time stamped. The most recent 300 events of the log shall be viewable by web browser and 25 by LCD. The battery log shall capture:

- Duration
- Battery capacity
- Ah delivered
- Charge in SOC%
- Starting SOH%
- Change in SOH%
- Battery current average

5.5.4 POWER OUTAGE LOG

The BBS shall maintain a power outage log containing a minimum of 3000 of the most recent events stored in a 'first in first out' (FIFO) buffer. The battery log shall be downloadable as a csv file by web browser and exportable by USB port on the BBS. The log shall be date and time stamped. The most recent 300 events of the log shall be viewable by web browser and 25 by LCD. The power outage log shall capture Start Time, End Time, and Duration.

5.5.5 DATA LOGS

The BBS shall be capable of recording up to 10 data logs each with up to 20 data signals. The data logs shall be downloadable as a csv file by web browser and exportable by USB port on the BBS. User can configure the interval between the samples within a range of 2 seconds to 3 hours. User can configure the number of samples to capture from a range of 60-3600. When the maximum number of samples has been captured the newest sample replaces the oldest. Data capture can run continuously or be triggered by an equation. The BBS shall create a preview chart that shows continuous feed of data of up to 30 samples, FIFO, viewable on web browser only.

5.5.6 PERFORMANCE LOGS

The BBS shall have pre-configured performance logs that run continuously and automatically, viewable on a web browser. There shall be separate charts for Seconds, Minutes, Hours, and Days that shows the Average, Minimum, and Maximum values for each sample. A daily log that has the Average, Minimum, and Maximum values shall be logged and be downloadable as a csv file by web browser. The signals to be monitored are:

- Controller Memory in Use
- CPU Usage
- AC Output Voltage
- Battery Current
- AC Output Current
- Battery Voltage
- AC Output Voltage
- AC Output Apparent Power

5.6 COUNTERS

The BBS shall keep track of the following:

- The number of times that the unit was in Inverter, Buck, and Boost, logged separately since the last reset.
- The accumulated number of hours and minutes that the unit has operated in Inverter, Buck, and Boost, logged separately since the last reset.
- The total power consumed by the load in kWh.

5.7 PROGRAMMABLE RELAY CONTACTS

The BBS shall provide the user six dry relay contacts. Five (5) programmable and one (1) 48VDC relay contact. As a minimum, the programmable options shall be On Battery, Low Battery + No Line, Timer, and Alarms. The BBS shall also have three (3) input contacts pre-programmed for Battery Test, User Alarm, and AC Shutdown.

Relays C1-C5 shall be able to be triggered/driven by more than one condition.
Relays C1-C5 shall be able to have their default state programmed to be energized (NO contacts closed) when not triggered/driven.

The relay contacts shall be made available on the front panel of the BBS via 6, 3 position plug-in terminal blocks with screw down wiring connections.

Each relay, C1 through C6 shall have their own common and their own set of normally open (NO) and normally closed (NC) terminals. The terminals for each relay shall be oriented as NO-C-NC on the terminal block. C6 shall provide continuous 48 VDC voltage for powering of enclosure DC fan.

The contacts on the terminal block shall be labeled 1-18, left to right. Additionally, each set of contact shall be labeled with the NO-C-NC designation, as well as C1…C6 from left to right. Printed labels noting all alarms and faults shall be provided with the BBS Inverter/Charger to be installed when required.

The relay contacts shall be rated at a minimum of 1 amp @ 250 VAC.

5.7.1 ON BATTERY RELAY CONTACT

The dry relay contacts that are configured for "On Battery" shall only energize when the BBS is operating in Inverter Mode.

5.7.2 TIME RELAY CONTACTS

The BBS shall include timers that will energize the associated "Timer" dry relay contact after the user configured time has elapsed when the BBS is in Inverter mode. The timer is started when the BBS enters Inverter Mode. The user shall be able to configure the timer to the required time. The timer shall have an adjustable range of 0-720 minutes. The user shall be able to create at least 10 user settable timers.

5.7.3 LOW BATTERY + NO LINE RELAY CONTACT

The BBS shall have an adjustable low battery relay setting. This setting shall be adjustable so that the user can set the point at which the low battery relay contact is energized. The low battery setting shall be adjustable from 0-100%. Once energized, the Low Battery + No Line relay shall de-energize as soon as line power has been restored and qualified.

5.8 USER INPUT CONTACTS

The BBS shall have three optically isolated, programmable user input contacts. The user input contacts shall be able to be programmed for Self Test Start, User Alarm, and UPS Shutdown.

5.9 PROBE JACKS

The BBS shall provide voltmeter standard probe input-jacks (+) and (-) to read the exact battery voltage at the inverter input.

6.0 COMMUNICATION

6.1 ETHERNET INTERFACE

The BBS shall have two (2) internal Ethernet communication interface ports for user configuration and management. One of the ports shall be static with a manufacturer set IP address of 192.168.0.90 and the other port set to DHCP. The Ethernet Ports shall be an RJ-45, EIA 568B Pin Out Connector.

- The BBS shall include remote monitoring & alarms transmission capabilities through the Ethernet RJ-45 IP Addressable Port, using SNMP v3 protocol.
- System shall have the capability of notifying Operations, Maintenance or TMC via e-mail of any alarms, user selectable.
- Emails are to be held in a batch and released after the configured interval has elapsed. Interval can be set from 5-60 minutes. Interval timer starts after first alarm trigger. Email to include:
  - Subject line with filterable text and alarm counts

    - Static title for filtering
    - Configurable name of the controller
    - A Google map link to location (if setup)
    - Time and date of notification
    - List up to 10 active alarms, sorted by priority with an active alarm count indicator showing total active alarms
    - List up to 10 cleared alarms, sorted by priority with a cleared alarm count indicator showing total cleared alarms
- All BBS configuration menus shall be accessible and programmable from the Ethernet Port.
- The BBS shall support TCP, UDP, and HTTP over IP protocol communications.

6.1.1 USER ACCOUNTS

The BBS shall have seven user accounts: one administrator, one account manager and five operators. Each account shall have five different User Roles that could be assigned to it: administrator, account manager, operator, restricted operator, and guest, each with different permission levels.

6.1.2 PASSWORDS

Password length shall be up to 32 characters (256 bit)

6.2 INTEGRATED USB HOST – USB TYPE A

The BBS shall have a USB Type A connector for firmware upgrades and file management. The USB shall support:

- Exporting and importing BBS configuration to copy configuration to other units
- Exporting log files
- Firmware and software upgrades
- Mouse and Keyboard input

6.3 SERIAL – USB TYPE MINI B

The BBS shall have a USB Type Mini B connector for soft shutdown of MegaTec protocol compliant client.

6.4 CAN

The BBS shall have an RJ12 connector for CAN bus communications to ADIO interfaces and other devices.

6.5 TIME/DATE

SNTP (Simple Network Time Protocol) - The BBS shall have the ability to synchronize with a network or internet-based time server.

The BBS shall have the ability to synchronize to web browser.

Daylight Savings – The user shall be able to choose Standard Time, US/Can Daylight Savings, or always Daylight Savings.

7.0 AUTOMATIC BYPASS TRANSFER SWITCH

7.1 RATING

The BBS shall include a rack mounted Automatic/Manual Transfer Relay rated at 120VAC/30 amps.

7.2 AUTOMATIC & MANUAL BYPASS SWITCH

The Automatic Bypass Transfer Switch shall be a combination automatic/manual bypass switch. Placing the bypass switch in the “Bypass” mode shall transfer the intersection load from the BBS output directly to commercial power. AC commercial power must still be available to the BBS input, allowing the BBS to keep the batteries charged. A UPS Supply Breaker shall be provided and located on the Bypass Switch, which allows the user to be able to manually shut off commercial power to the UPS input, allowing them to safely disconnect and remove the inverter. With the inverter turned off, the batteries can be safely disconnected from the system.

7.3 INDICATOR LIGHT

The Automatic Bypass Transfer Switch shall include a bypass indicator light that automatically notifies the user when the Manual bypass switch is in Bypass position. The indicator light shall be illuminated when in UPS mode.

7.4 INTEGRATED SWITCH

The manual bypass switch and the automatic transfer relay shall be integrated together within the Automatic Bypass Transfer Switch allowing the manual bypass switch to be rated at 10 Amps and to be integrated with the bypass indicator light.

7.5 TERMINAL BLOCKS

The Automatic Bypass Transfer Switch shall have terminal blocks capable of accepting #6 AWG wiring for the AC input and output with #10 AWG from the Automatic Bypass Transfer Switch to inverter/charger module.

8.0 AUTOMATIC GENERATOR TRANSFER SWITCH

8.1 RATING

The BBS cabinet shall include a rack mounted Automatic Generator Transfer Switch rated at 120VAC/30 amps.

8.2 AUTOMATIC & MANUAL GENERATOR TRANSFER

The Automatic Generator Transfer Switch shall be a combination automatic/manual generator switch. Placing the generator switch in the “Line” mode shall pass the utility power from the Line Input to Line Output. With the switch in “Gen” mode the transfer switch will automatically disconnect the utility and connect generator power to Line Output when the generator input voltage is approximately 102VAC or greater.

9.0 BATTERIES

9.1 BATTERY TYPE

The battery shall be virgin lead alloy, calcium based, extreme temperature, float cycle, AGM (Absorbed Glass Mat) VRLA (Valve Regulated Lead Acid). Batteries designed for Cycle applications, such as Solar or deep cycle, are not acceptable. The battery must be designed for Standby BBS applications. Individual batteries shall meet the following specifications:

- Voltage Rating: 12V
- Amp-hour rating: 100 Ah, at the 20-hour rate, to 1.75 Volts per cell, minimum battery rating.

- Group size: Case 27
- Batteries shall be easily replaced and commercially available off the shelf.
- Batteries shall provide 100% runtime capacity out-of-box. Each battery must meet its specification without the requirement of cycling upon initial installation and after the initial 24 hour top off charge.

9.2 BATTERY STRING

Batteries used for the BBS shall consist of 4 batteries configured for a 48 VDC battery buss system.

9.3 OPERATING TEMPERATURE

Batteries shall be certified to operate at extreme temperatures from –40°C to +60°C.

9.4 HANDLE

An integral lifting handle shall be provided on the batteries for ease of removal/installation.

9.5 BATTERY CABLE ASSEMBLY

The battery cable assembly shall be a two-part modular harness.

9.5.1 PART 1 – BATTERY PIG TAIL

Part I shall be equipped with red (+) and black (-) cabling that can be permanently connected to the positive and negative posts of each battery with a ¼" terminal. Each red and black pair shall be terminated into a one-piece Anderson style Power Pole connector or equivalent.

9.5.2 PART 2 – MAIN CABLE

Part II shall be equipped with the mating Power Pole style connector for the batteries and a one-piece, insulated gray Power Pole style connection to the inverter/charger unit. Harness shall be fully insulated and constructed to allow batteries to be quickly and easily connected in any order to ensure proper polarity and circuit configuration.

9.5.3 HARNESS WIRING

All battery cable wiring shall be UL Style 1015 CSA TEW all of proper gauge with respect to design current and with sufficient strand count for flexibility and ease of handling.

9.5.4 BOOTS

Battery terminals shall be covered and insulated with molded boots so as to prevent accidental shorting.

10.0 CABINET

10.1 GENERAL

- The dimensions for the BBS cabinet shall be 48 inches in height, 16.5 inches in width and 16.5 inches in depth.
- The Inverter/Charger Unit shall be shelf or rack mounted on a standard EIA19" rack.
- The Automatic Transfer switch shall be mounted on EIA 19" Rail.

- All interconnect wiring shall be provided and shall be UL Style 1015 CSA TEW.

10.2 BBS REPLACEMENT

The BBS equipment and batteries shall be easily replaced and shall not require any special tools for installation.

10.3 HOT SWAPPABLE

The BBS inverter and batteries shall be hot swappable. There shall be no disruption to the Traffic Signal when removing the inverter or batteries for maintenance.

10.4 ANCILLARY INTERNAL INSTALLATION HARDWARE

All necessary internal installation hardware (bolts, fasteners, washers, shelves, racks, etc.) shall be included.

10.5 CABINET SIZING

The external cabinet shall be capable of housing four batteries up to a group 31 size, inverter/charger power module, automatic transfer switch, control panels, wiring, wiring harnesses, and all other ancillary equipment.

10.6 CABINET MOUNTING

The BBS cabinet can be installed either as:

- Free-standing base-mounted cabinet with optional 8” riser for easy cable entrance.
- Pole-mounted cabinet with optional pole mount bracket kit.
- Side-mounted to a Traffic Controller cabinet with no mounting brackets required.

10.7 RATING

All external cabinets shall be NEMA 3R rated. The enclosure shall be made of 0.125 inch (5052-H32) aluminum.

10.8 VENTILATION

The external cabinet shall be ventilated through the use of louvered vents, filter, and a minimum of one thermostatically controlled fan. The filter shall be the re-usable type and matching the dimensions of the louver with both located on the bottom half of the door.

The cabinet fan shall be DC operated for longer reliability.

10.9 ACCESSIBILITY

All components, terminations, terminal blocks, relays, etc. shall be fully accessible.

10.10 SHELVES

Two battery shelves shall be located in the bottom half of the enclosure. The bottom battery shelf shall be removable, and the top battery shelf will be welded to the enclosure sides. Air must be allowed to

flow from the bottom of the cabinet and up the back internal wall. Neither the top battery shelf nor the Power Module shelf shall inhibit the airflow to the top of the cabinet.

10.11 LOCKING

The cabinet shall include a 3-point locking system, including a Type 2 Corbin lock and utilize a handle with pad locking capability.

10.12 GENERATOR PLUG COMPARTMENT

The BBS cabinet shall include a generator plug compartment with a flush mounted and gasketed locking access door, which locks the generator power cable in place when connected. The lock shall be a Type 2 Corbin lock. The generator compartment shall include a wired NEMA L5-30P Flanged Inlet connector.

10.13 CABINET OPTIONS

The following options shall be available for the cabinet:

- On-Battery lamp mounted externally on the top of the cabinet that illuminates when the BBS is operating in inverter mode.
- Battery Heater Mats to increase battery capacity in cold climates.
- Receptacle plate assembly that mounts on the transfer switch panel to provide utility power to the battery heater mats.
- Automatic Generator Transfer switch that senses a generator is connected and automatically switches to the generator source.
- Internal lamp with door push-button switch to illuminate the interior of the cabinet.
- Status monitoring dry contacts for the Automatic Transfer Switch and the Generator Transfer Switch.

11.0 REMOTE BATTERY MONITORING SYSTEM

Remote Battery Monitor System (RBMS) shall be permanently installed into the UPS/Battery cabinet to monitor the four UPS batteries (4-12V battery blocks). The RBMS shall have the ability to monitor, read and record both the battery string and individual battery voltages, individual battery admittance (inverse of impedance), and individual battery temperatures and to provide a real-time evaluation of the battery bank health.

The device shall be hardened and operate at a temperature range of -40°C to 80°C (-40°F to 175°F). The device shall include 4 individual 12-volt battery sensors that attach to the top of the battery via adhesive backed hook-loop fasteners. Each sensor shall have an LED for status information.

The RBMS shall have a built-in web interface for communications over Ethernet which is viewable with Chrome and Edge web browsers.

- Battery voltage, admittance, and temperature shall be immediately viewable for each battery upon opening. These values shall be displayed on color coded bar graphs that represent the value. Bar graphs are to be green for no alarm, red for major alarm, and yellow for minor alarm.
- User shall be able to set major and minor, high and low alarms for battery voltage, admittance, and temperature.
- Battery string and delta voltages are to be reported and have user settable major and minor, high and low alarms.
- Baseline admittance shall be user settable. The set baseline admittance will be used by all batteries and will automatically display the percentage difference between the baseline and current state.

- There shall be a checkbox to Flash the Sensor LED on an individual battery, which aids in being able to physically identify it.

The RBMS shall be able send alarm notifications via email and SNMP.

The RBMS shall include software to automatically poll each intersection, up to 1000 devices per software program, reading individual battery voltage, admittance, and temperature, while confirming each is within its user programmable parameters and save this data to a csv file. The software communications shall be SNMP via TCP/IP. The system shall have the ability to program the intervals as to when each reading is taken, by days, weeks or months. The software shall be provided as part of the system cost.

The RBMS shall also perform as a battery balancer, continuously monitoring and balancing all batteries in the string, which can extend the life of the battery. The RBMS shall allow for any single 12V battery within the battery string to be replaced without replacing all batteries in the string during the battery warranty period.

12.0 WARRANTY

12.1 BATTERY BACKUP SYSTEM

The BBS System shall include a five-year warranty on parts and labor on BBS, Transfer/Bypass Switches, Batteries, and Enclosure System to the Agency when utilizing the BBS Manufacturers own designed enclosure, meeting the above cabinet specifications. The RBMS shall have a two-year warranty.

12.2 ENCLOSURE

Should the agency decide not to use the enclosure provided by the BBS Manufacturer, the manufacturer shall provide a three-year warranty on parts and labor only on the BBS Inverter Module.

12.3 BATTERIES

The BBS Manufacturer shall provide a 5-year unconditional full replacement warranty for every battery sold to the Agency with the BBS under this specification when the manufacturer's enclosure is used. Under the warranty time period, the battery must provide a minimum of 70% of its original capacity; otherwise it will be considered to be non-compliant to the warranty and replaced at no cost to the Agency or DOT by the BBS manufacturer.

13.0 VENDOR SUPPORT

13.1 TECHNICAL SUPPORT

The BBS manufacturer shall provide at no charge, a toll-free 24/7 technical support phone number. The toll-free phone number shall be included in the BBS manual.

13.2 LOCAL SUPPORT

There shall be a local distributor available to support the product.

13.3 DOCUMENTATION

Equipment manuals shall be provided for each BBS cabinet. Equipment manuals shall include installation, operation, programming, maintenance and troubleshooting.

14.0 QUALITY ASSURANCE

14.1 DESIGN AND PRODUCTION

Each BBS shall be manufactured in accordance with a written manufacturer's Quality Assurance program. The QA program shall include, as a minimum, specific design and production QA procedures.

14.2 ISO CERTIFIED

The BBS Power Module manufacturer shall be ISO 14001 and TL9000 certified.

14.3 UL/CSA

The BBS shall be tested to comply with UL 1778, CSA 22.2 No. 107.3 and must bear the UL CSA mark.

14.4 DESIGN QUALIFICATION TESTING

The manufacturer shall be certified to carry out the CSA and UL standards testing on the BBS system.

F. ELECTRICAL SERVICE PEDESTAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

G. DETECTION SYSTEMS

1.0 GENERAL

Where designed, vehicle and pedestrian detection systems 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.) Cubic|Trafficware wireless pod magnetometers b.) Video systems, and c.) Loop detectors. The pedestrian detection system shall be: POLARA iN2 – iNavigator 2 wire push button stations with the POLARA iCCU-S – iNtelligent Central Control unit or most current model. Equivalent vehicle and pedestrian detection systems may also be approved by the City Traffic Engineer.

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^{TM} 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 30ºF (-34º C) to 165º F (74ºC) and voltages from 95 VAC to 135 VAC.

4.1 SYSTEM HARDWARE

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

- Wireless magnetometer and installation housing embedded in the roadway;
- Access point mounted on a pole, mast arm or other structure within one thousand feet (1,000 ft.) proximity to the traffic cabinet;
- External 900 MHz antennas connected to the access point in one or more of the following configurations:
  - Omni directional antenna - three hundred and sixty degree (360º) beam width.
  - Large panel directional antenna - fifteen inch (15 in.) forty degree (40º) horizontal beam width.
  - Small panel directional antenna - eight inch (8 in.) seventy degree (70º) horizontal beam width;
- 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 ($3\ ^5/_8$ 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 ($^3/_8$ 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 ($^3/_8$ 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.

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 $^{1}/_{4}$ in. x 7 $^{3}/_{4}$ in. x 7 $^{3}/_{4}$ 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:

- 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,
- 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^o).

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^o).

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 ¾ in. x 16 ¼ 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 ($^3/_8$ 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^o).

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^o).

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 ($^3/_8$ 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:

- 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;
- 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 $^{5}/_{8}$ in. x 3 in. x 7 $^{1}/_{8}$ 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:

- 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
- 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:

- 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,
- 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:

- Conductor: Six (6) conductors, 24 AWG, copper conductor;
- Colors: blue wire, orange wire, orange/white wire, green wire, green/white wire, blue/white wire;
- Insulation: Conductor insulated with extruded polyethylene with 0.030 in. wall thickness;
- Shielding: 100% aluminum foil tape conductor coverage;
- Jacket: Extruded black polyethylene with 0.030 in. wall thickness;
- 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:

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

4.4 SYSTEM INSTALLTION & 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 DETECTION

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-eight 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:

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

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

No supplemental information. Contact City Traffic Engineer for comments/questions.

I. FIBER OPTIC INTERCONNECT

No supplemental information. Contact City Traffic Engineer for comments/questions.

J. TRAFFIC MONITORING CAMERAS

No supplemental information. Contact City Traffic Engineer for comments/questions.

K. GROUNDING SYSTEM

No supplemental information. See individual plan details for further information or contact City Traffic Engineer.

L. CONTRACTOR COORDINATION

No supplemental information. Contact City Traffic Engineer for comments/questions.

M. GUARANTEE

No supplemental information. Contact City Traffic Engineer for comments/questions.

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).

2.0 PEDESTRIAN SIGNAL HEADS

2.1 OVERVIEW

2.1.1 PURPOSE

The purpose of this specification is to provide the minimum performance requirements for a 16 x 18 LED pedestrian signal module with a countdown timer (hereafter called module) with “walking person”, “upraised hand”, and “countdown digit” icons. This specification refers to definitions and practices described in **Pedestrian Traffic Control Signal Indicators - Light Emitting Diode (LED) Signal Modules Version August 04, 2010** and the 2009 Manual of Uniform Traffic Control Devices (MUTCD) and contains additional requirements to ensure optimum long term reliability and performance. Product supplied to this specification shall comply with the latest version of the ITE PTCSI LED signal specification and the additional requirements listed herein.

2.1.2 MANUFACTURERS REQUIREMENTS & APPROVALS

Manufacturers supplying products to this specification must be a registered participant and have the part numbers being provided listed on the ***Intertek-ETL LED Traffic Signal Modules Certification Program*** approved products website. Products shall be manufactured in a facility certified to the Intertek-ETL program requirements.

Must be fully compliant to the ITE PTCSI LED Spec Version Aug 4, 2010. In addition the product must also meet the additional specifications and requirements outlined in the sections below.

2.2 PHYSICAL & MECHANICAL REQUIREMENTS

2.2.1 GENERAL

Installation requirements: Installation of a module into existing pedestrian signal housings shall only require the removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector; shall be weather tight and fit securely in the housing; and shall connect directly to existing electrical wiring. Installation shall not require special tools.

2.2.2 THE LED SIGNAL MODULE

The lens shall have a textured outer surface to reduce glare. No screws shall be used to attach the lens to the housing.

Hand, Person, or Digit icons that are not illuminated shall not be readily visible to the pedestrian at the far end of the crosswalk that the pedestrian signal head indication controls. The agency reserves the right to accept or reject the unit based on the physical appearance of the unit at their sole discretion.

All icons and numbers shall have a uniform incandescent, non-pixilated appearance.

All LED utilized to illuminate the Hand and Person icons, shall be LED that have been manufactured utilizing materials that have industry acceptance as being suitable for uses in outdoor applications.

The countdown signal shall display the time remaining in seconds, beginning with the start of the pedestrian clearance interval and ending at the end of the pedestrian clearance interval. Countdown displays should not be used during the walk interval. Upon termination of the countdown sequence the countdown shall remain blank until the beginning of the next pedestrian change interval.

The countdown shall be capable of counting down from 99 to 0. There shall be no leading zeroes for numbers less than 10. The display of the “1” digit in the tens position shall be in the right hand portion of the digit.

The configurations of the walking person icon, upraised hand icon and countdown digits are illustrated in Figure 1, Figure 2, and Figure 3 respectively.

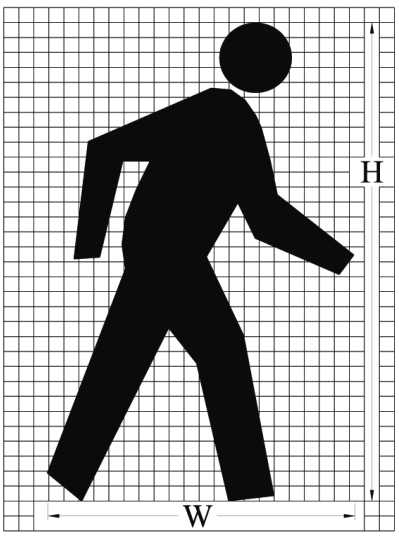

Figure 1—Walking Person icon

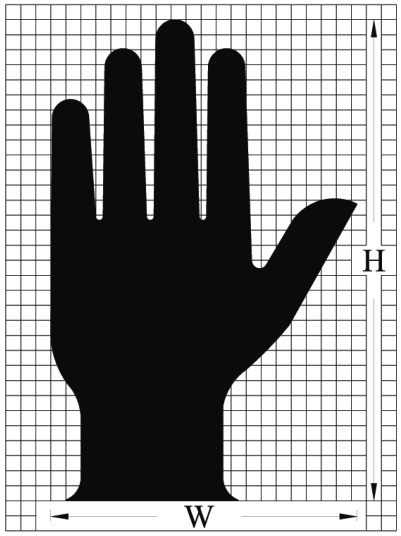

Figure 2— Upraised Hand icon

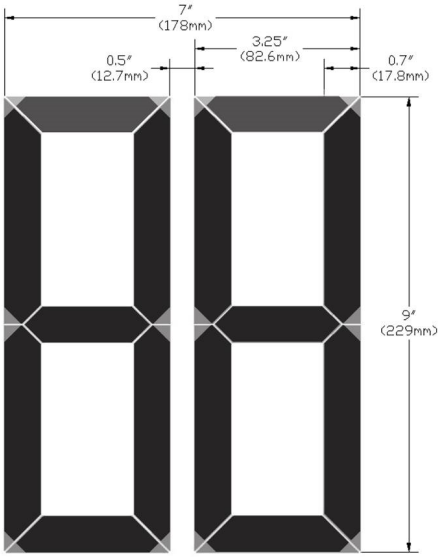

Figure 3—Countdown Display2.3 Module Identification

In addition to the labeling requirements of the ITE specification, all modules must be labeled with the ETL Verified label shown in Figure 4. This label designates the compliance and listing with the Intertek-ETL Traffic Signal Certification Program.

2.3 ELECTRICAL

2.3.1 GENERAL

The following color scheme shall be used for the module's AC power leads: Orange for the upraised hand, Blue for the walking person, and White for common.

The AC power leads shall exit the module via a rubber grommetted strain relief, and shall be terminated with insulated female quick connect terminals with spade / tab adapters. The leads shall be separate at the point at which they leave the module.

All external wiring utilized in the modules shall be anti-capillary type wire to prevent the wicking of moisture to the interior of the module.

In order to minimize the possibility of the incorrect icon being illuminated, the Hand, Person, and Countdown Icons shall utilize 3 separate power supplies. The countdown module shall be internally wired to the incoming AC power from the hand / person AC signal lines. All power supplies shall be located inside the signal module.

- All power supplies shall be conformal coated for additional protection.
- Typical Power at 25ºC (77ºF) for the Pedestrian Signal Modules shall be 11 watts for the hand, 10 watts for the person and 8 watts for the digits when the number "88" is displayed.

2.4 COUNTDOWN MODULE

2.4.1 COUNTDOWN DRIVE CIRCUITRY

The countdown portion of the signal shall have a high off-state input impedance so as not to provide a load indication to conflict monitors and interfere with the monitoring of the pedestrian signal. The input impedance of the countdown circuitry shall be sufficiently high enough to allow for up to eight units connected on the same channel.

It shall be impossible for the display to countdown during a solid Hand indication.

2.4.2 COUNTDOWN FUNCTIONALITY

Per MUTCD Manual 2009 edition, "Countdown displays should ONLY be used during the "Clearance Cycle". They should NOT be used during the walk interval or during the yellow change interval of a concurrent vehicular phase". A countdown pedestrian signal is required for all crossing with a pedestrian clearance interval of 7 seconds or greater.

The countdown timer module shall have a micro-processor capable of recording the pedestrian crossing timing when connected to a traffic controller. It shall be capable of displaying the digits 0 through 99.

When connected, the module shall blank out the display during the one (1) learning cycle only while it records the countdown time using the Walk (Person) & Don't Walk (Flashing Hand) signal indications. The hand and person icons shall be displayed as normal during this cycle.

The countdown timer module shall continuously monitor the traffic controller for any changes to the pedestrian phase time and re-program itself automatically if needed.

The countdown module shall register the time for the walk and change intervals individually and shall begin counting down at the beginning of the pedestrian change interval. The countdown module shall display the numerals in a continuous display and shall not flash during the countdown.

When the flashing Hand becomes solid, the module shall display 0 for one second and then blank-out. The display shall remain dark until the beginning of the next countdown.

In the event of a pre-emption sequence during the pedestrian change interval, the countdown module shall skip the pre-empted change time and reach "0" at the same time as the flashing Hand becomes solid and then remain dark until the next cycle.

In the cycle following a pre-emption call, the signal shall display the correct time and not be affected by the reduced previous cycle. The countdown shall remain synchronized with the signal indications and always reach 0 at the same time as the flashing Hand becomes solid.

The countdown timer shall be capable of displaying 2 consecutive complete Pedestrian Phases outputted by the traffic controller (no steady Hand signal between cycles). NOTE: When a controller is programmed with the option to serve a second consecutive pedestrian phase (walk followed by flashing don't walk) if a pedestrian activates a pedestrian button during the change interval, and the controller is set to allow a second consecutive phase, the countdown will blank out during the walk, and restart counting down the correct time during the flashing don't walk, just as in a regular PED phase.

The countdown module shall not display an erroneous or conflicting time when subjected to defective load switches. Should there be a short power interruption during the PED change interval or if voltage is applied to both the hand and person simultaneously, the display will go to "0" then blank.

The countdown module shall have accessible dip-switches for the user selectable options. The unit shall have a removable plug on the rear allowing easy access to control the user selectable functions. The unit shall be shipped from the factory with all switches in the default "off" position. With the exception of the test mode, these dip switch selectable functions would typically be set at the initial installation of the Pedestrian signal.

2.4.2.1 DIP SWITCH 1. DARK CYCLE FOLLOWING A TIMING CHANGE

Default Operation: In the default position this function is disabled. With this function disabled the countdown module will operate as follows:

- If the clearance mode is shortened for a single cycle, for example for an emergency vehicle preemption, the countdown will return to normal operation on the following cycle using the learned timing.
- If the countdown module detects two (2) consecutive shortened pedestrian clearance modes of identical length the countdown timer will display the new shorter time on the following cycle without the need for new blank learning cycle.
- If the countdown module detects a longer cycle, for example a programmed timing change, it will automatically display the lengthened time on the next cycle without the need for a new blank learning cycle.

Optional Operation: With Dip switch 1 in the "on" position the countdown module will operate as follow:

- Any time the countdown module detects a timing change, either shorter or longer the countdown will run a new "learning" cycle. It will be blank for one cycle. After this blank cycle the unit will return to normal operation on the following cycle and display the new clearance timing learned.

2.4.2.2 DIP SWITCH 2. DISABLE AUTO-SYNC MODE

Default Operation: In the default "off" position the auto-sync is enabled. With this function enabled the countdown module will operate as follows:

- Countdown start with the start of the "Flashing Hand" clearance mode.

- If in the “learning cycle” the countdown module detects a lag between the end of the walk mode and the start of the clearance mode the lag time will be measured and reduced from the first second in order to synchronize the end of the countdown “0” with the start of the solid hand signal.

Optional Operation: With Dip switch 2 in the “on” position the auto-sync is disabled. With this function disable the countdown will operate as follows:

- Countdown starts at the end of the walk signal and disregards any lag time in the start of the flashing hand signal.
- If clearance interval in not in full seconds then the final second of the countdown may be truncated as the hand signal becomes solid.
- If there is a brief power loss to the hand signal, < 1 sec, the unit may start counting for up to 2 second before it detects the power loss and goes blank.

2.4.2.3 DIP SWITCH 3. DISABLES COUNTDOWN OPERATION

Default operation: In the default position the countdown timer is enabled. With this function enabled the countdown will operate as follows:

- Countdown will function normally following either the default operation mode or if set, the selected dip switch options.

Optional Operation: With Dip switch 3 in the “on” mode the countdown timer module is disabled. With this function disabled the countdown will operate as follows:

- No countdown will be displayed but the hand / person portion of the pedestrian signal will operate as normal.

2.4.2.4 DIP SWITCH 4. MEMORY MODE

Default operation: In the default position the memory, in the event of a power loss, is disabled. With the memory disabled the countdown will operate as follows:

- Countdown will maintain the learned clearance timing in memory.
- In then event of a power loss to the unit of two (2) seconds or more in duration the memory will be lost and the timer will need to enter a new “learning” cycle upon the restoration of power.

Optional operation: With Dip switch 4 in the “on” position the memory is enabled. With this function enabled the countdown will operate as follows:

- Countdown will store the information from the “learning” cycle in memory for use in case of power loss.
- Upon returning from a power loss the countdown will use the timing stored in memory and not require the need for a new “learning’ cycle.

2.4.2.5 DIP SWITCH 5. DIAGNOSTIC TEST SEQUENCE

Default Operation: With this function in the “off” position the countdown will operate as follows:

- Countdown will function normally following either the default operation mode or if set, the selected dip switch options.

Optional operation: With Dip switch 5 in the “on” position the diagnostic test mode is enabled. With this function enabled the countdown will function as follows:

- Countdown mode is disabled, to allow for diagnostic testing.
- Upon application of power to either icon the countdown module will sequentially test the individual segments of the digits.
- Upon also turning on Dip switch 4 the countdown will light up all segments to display the digit “88”.

2.5 WARRANTY REQUIREMENTS

2.5.1 WARRANTY

Manufacturers shall provide a detailed written warranty issued by the factory located in the country of module origin with the following minimum provisions:

- Modules shall, at the manufacturer’s option, be repaired or replaced if the module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.
- Modules shall, at the manufacturer’s option, be repaired or replaced if the module exhibit luminous intensities less than the minimum specified values within the first 60 months of the date of delivery.
- Upon request, the LED lamp module manufacturer shall provide written documentation of its ability to satisfy a worst-case, catastrophic warranty claim.

A current corporate annual report duly-certified by an independent auditing firm, containing financial statements illustrating sufficient cash-on-hand and net worth to satisfy a worst-case, catastrophic warranty claim is an example of suitable documentation. The documentation shall clearly disclose:

- The country in which the factory of module origin is located.
- The name of the company or organization that owns the factory of module origin including any and all of its parent companies and/or organizations, and their respective country of corporate citizenship.

For firms with business and/or corporate citizenship in the United States of less than seven years, the process by which the end-users/owners of the modules will be able to obtain worst-case, catastrophic warranty service in the event of bankruptcy or cessation-of-operations by the firm supplying the modules within North America, or in the event of bankruptcy or cessation-of-operations by the owner of the factory of origin, shall be clearly disclosed.

Figure 4.
Intertek- ETL Verified Label

O. MAST ARMS AND POLES

No supplemental information. Contact City Traffic Engineer for comments/questions.

P. POLE BASES

No supplemental information. Contact City Traffic Engineer for comments/questions.

Q. CONDUIT AND CONDUIT FITTINGS

No supplemental information. Contact City Traffic Engineer for comments/questions.

R. ELECTRICAL CABLE

1.0 POWER LEAD-IN CABLE

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

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

2.0 SIGNAL CABLE

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

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

3.0 LOOP DETECTOR WIRE (WITH PLASTIC TUBING)

The loop wire shall meet the requirements of the International Municipal Signal Association (IMSA) specification 51-5, latest revision thereof for a nylon or cross-linked polyethylene jacketed conductor, loosely encased in a polyethylene tube loop detector wire. The conductor shall be #16 A.W.G. unless otherwise specified on the plans.

4.0 DETECTOR LEAD-IN CABLE

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

5.0 ETHERNET CABLE

Ethernet cable for exterior signal devices shall have 24 AWG Bonded-Pairs, solid bare copper conductors, polyolefin insulation, polymer gel water-blocked, with a sun resistant LLPE jacket. Cable will have sequential marking at two foot intervals.

Cable shall be Belden 7934a or equivalent.

6.0 TRACER CABLE

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

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

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

7.0 GROUNDING CABLES

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.

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

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

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

S. WIRE SPLICING

1.0 GENERAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

T. STREET NAME AND REGULATORY SIGNS MOUNTED ON SIGNALS

1.0 GENERAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

U. SIGNAL HEAD COVERS

1.0 GENERAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

V. SCHEDULE OF UNIT PRICES

1.0 GENERAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

W. CONTRACTOR QUALIFICATIONS & RESPONSIBILITIES

1.0 GENERAL

No supplemental information. Contact City Traffic Engineer for comments/questions.

X. BLANK-OUT SIGNS

1.0 FUNCTIONAL DESCRIPTION

All messages shall be clearly legible, attracting attention under any lighting condition
At full intensity, the signal will be highly visible anywhere within a 15 degree cone centered about the optic axis.

Messages shall be formed by single or double rows of LED's.

All LED's will be T-1 ¾ (5 millimeters).

LED's will have an expected lifetime of 100,000 hours.

Failure of any individual LED's will not affect the performance of other LED's or the sign.

All sign message displays will comply with ITE VTCSH: LED Vehicle Arrow Traffic Signal Supplement Section 4 (Photometric Requirements) and ITE VTCSH: LED Circular Signal Supplement Section 4 (Photometric Requirements) for luminous intensity and distribution (Section 4.1), color regions (Section 4.2), and color uniformity (Section 4.2).

The sign shall be capable of continuous operation over a range in temperatures from -35F to +165F (-37C to +75C).

Sign may have optional dimming and flashing.

The sign shall comply with the MUTCD.

2.0 ALUMINUM HOUSING

Housings shall be constructed of extruded aluminum.

A flat aluminum panel shall be welded into the housing back for one-way signs.

All corners and seams shall be welded to provide a weatherproof seal around the entire case.

Continuous full-length stainless steel hinges shall connect the housing and the extruded aluminum door.

Signs shall have #3 stainless steel ¼ turn link-locks per door to tightly secure the door onto a gasket between it and the housing.

Link-locks provide tool free access to the interior of the sign.

Door gaskets shall be 3/16" x 1" neoprene to provide a weatherproof seal.

The 0.125" extruded aluminum doors have one side removable to gain access to the sign face.

Sign face shall be 0.080" aluminum or equivalent, and have the entire LED assembly mounted to it.

Each door shall be fitted with a sun hood of 0.063" aluminum. Standard length is 6".

The sign face will be protected by a polycarbonate, matte clear, lexan faceplate.

Drainage shall be provided by four drain holes at the corners of the housing.

Finish on the sign housing shall be satin black enamel. Powder coat finish preferred.

3.0 LED MESSAGE MODULES

The LED message module shall consist of the following components:

- A rigid aluminum message plate
- High intensity LED's
- LED drive electronics

The LED's shall be mounted in panel via mounted fixing clips.

Each LED shall be individually serviceable with spares included from the same batch to assure color uniformity upon replacement.

The sign shall have a separate and replaceable modular DC power supply to power the LED’s.

Door panels shall be flat black.

Electrical connections shall be made via barrier-type terminal strip.

All fasteners and hardware shall be corrosion resistant stainless steel.

4.0 WARRANTY

All products will be warranted to be free of defects due to material and workmanship for a period of two (2) years.