TRAFFIC SIGNAL CABINET ASSEMBLIES

Cabinet Assembly. Cabinet Assemblies shall include a Type 1 actuated controller, MMU2, four (4) loop detector amplifiers, adequate number of flash transfer relays, PS175 power supply, NEMA load switches, load switch arrestors, loop detector arrestors and anything else required for a fully operational traffic signal cabinet.

Cabinet Assemblies shall meet the NEMA 3R requirements and be constructed principally of 0.125-inch thick, 5052-H32 aluminum. The aluminum shall have a mill finish per NEMA TS 2 7.7.3. Intermittent welds may be used for construction and any un-welded cabinet seams shall be sealed with clear RTV silicone. All external fasteners shall be stainless steel and no holes will be allowed in top of cabinet.

The door handles shall be stainless steel or cast aluminum. Door hinges shall be of the continuous type with a stainless steel hinge pin. Rivets are not be used to attach the hinge. The main door stop rod shall be constructed using stainless steel. The door stop mechanism shall be adjustable and capable of being securely latched in multiple opened positions including 90 degrees and a maximum of 120 degrees. The brackets attaching the stop rod to the door and cabinet shall be aluminum and welded in place. The main door cylinder lock shall be a #2 key type lock. Two (2) traffic industry standard No. 2 keys shall be provided with each cabinet and shall be made using heavy duty key blanks.

Extruded aluminum channels permanently attached to the right and left cabinet sides shall be provided for attaching adjustable shelving and mounting of other component panels. The cabinet shall have two (2) shelves installed. Both shelves shall be provided with the front edge pre-drilled with 0.25-inch holes located twelve (12) inches apart.

Physical Features.

Pull Out Drawer. A pull out drawer shall be installed and centered under the bottom shelf. The drawer shall be made of 0.080-inch thick, 5052-H32 aluminum and come out on full extension drawer slides. The pull out drawer shall provide an approximate
16-inch x 14-inch working area and have the ability to bear a constant 25 pound burden. There shall be a compartment for document storage. The lid shall be hinged at the rear, to gain access to the storage area. The drawer will be used to store documents as well as support a notebook computer. The drawer slides shall be of the full extension ball bearing type. Dimensions of the drawer shall be large enough to support a notebook computer and a drawer of sufficient size to hold at least two (2) copies of the cabinet drawings and other related cabinet documentation. The surface of the lid shall have a non-slip surface.

Cabinet Lighting. Cabinets shall be provided with a minimum of two (2) white light LED modules. One (1) lighting module shall be installed along the front top section of the cabinet and the second lighting module shall be installed underneath the bottom cabinet shelf in such a location as to provide direct lighting of the load bay area of the cabinet but must not interfere with the cabinet drawer operation.

Both LED lighting modules shall be controlled by a NEMA rated, commercial quality, pushbutton door switch. The cabinet lighting shall turn on when the cabinet main door is opened and shall turn off when the main door is closed or an ON/OFF NEMA rated, commercial quality, toggle switch mounted on the inside cabinet door service panel shall be provided to turn both LED lighting modules on or off.

Police Panel Switches. Police panel switches shall be provided with all controller cabinets. All switches shall be hard wired and labeled as to their function.

NORMAL-FLASH: When this switch is in the FLASH position, all signal indications shall transfer to the flashing mode. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode.

The controller unit shall operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the NORMAL position, transfer from the flash mode to normal operation shall be made in accordance with uniform code flash requirements.

SIGNAL ON-OFF: AC power shall be removed from the signal heads and the intersection will become dark when this switch is in the OFF position.

MANUAL CONTROL ON-OFF: When this switch is in the ON position, a logic ground shall be applied to the manual control enable input of the controller unit.

INTERVAL ADVANCE INPUT JACK: A manual jack shall be installed on the police panel. The jack shall inter-mate with a 3-circuit, ¼-inch diameter phone plug. The tip and ring (middle) circuits of the jack shall be connected to the logic ground and the interval advance inputs of the controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground shall be connected to the interval advance input of the controller unit.

When specified in the contract documents, an interval advance cord shall be provided. The cord shall have a minimum length of three (3) feet. It shall have a ¼-inch diameter, three circuit plug connected to one end and a manual pushbutton enclosed in a hand-held enclosure at the other end. A complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval which is active except the vehicular yellow and red clearance intervals. Cycling the push-button during the vehicular yellow or all red clearance intervals shall not terminate the timing of those intervals.

Service Panel Switches. Service panel switches shall be hard wired and clearly labeled to identify as to their functions. Service panel switches shall be mounted on the service panel located on the inside of the main cabinet door. Alternate switch locations may be described in the plans or contract documents but final switch design and location shall be approved by the Engineer prior to cabinet fabrication.

NORMAL-FLASH: When this switch is in the FLASH position, all signal indications shall transfer to the flashing mode. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode.

The controller unit shall operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the NORMAL position transfer from the flash mode to normal operation shall be made in accordance with uniform code flash requirements.

CONTROLLER ON-OFF: When this switch is in the OFF position, AC power shall be removed from the controller. When this switch is returned to the ON position, the controller unit shall perform normal start up functions and resume normal operation in accordance with the applicable specification.

STOP TIME-RUN-NORMAL: A 3-position manual switch shall be provided which places the controller into Stop Time mode manually or through remote input.

VEHICLE DETECTORS: A 3-position switch shall be provided for each vehicle and pedestrian detector circuit. All switches shall be located on a panel mounted on the inside of the main cabinet door. The switch panel shall be labeled CALL SWITCH. Labeling of phase number and intended function (vehicles or pedestrian calls) shall be provided for each switch.

The vehicle detector switch functions are defined as follows:

Locked Call	Call is continually placed into the controller unit.
Off (center)	Vehicle detector is connected to the controller unit vehicle detector input, i.e. normal detector operation.
Momentary Call	Call is continuous as long as the switch is manually held in this position.

Police and Service Panel Locations. The police and service panels shall be constructed of 5052-H32 0.125-inch thick aluminum.

The police panel shall be located behind the police door which is enclosed within the main door. The police door shall be hinged and provided with a neoprene gasket seal. Access to any portion or equipment contained behind the main cabinet door shall not be accessible through any part of the police panel. The police panel shall be of appropriate dimensions to accommodate all switch or devices described within this specification, the plans or contract document. The police door shall be provided with a treasury #2 key type lock and two (2) keys for the police door lock shall be provided with each cabinet.

The service panel shall be mounted on the inside portion of the main cabinet door, adjacent to the back side of the police panel or on the left hand side of the cabinet.

Cabinet Ventilation. Cabinets shall be vented to allow dissipation of the heat generated by the equipment contained within. All cabinets shall have a thermostatically controlled exhaust fan located at the top of the cabinet that is capable of 100 cubic feet per minute air displacement. The thermostat shall be mounted on the inside top of the cabinet and shall have a nominal temperature range from 80°F to 170°F.

The intake vent shall be louvered or equivalent design to prevent rain infiltration. The vent area will be located along the bottom portion of the cabinet door. A 16-inch x 12-inch x 1-inch disposable pleated air filter shall be provided on the inside portion of the cabinet and shall fully cover the vent area.

Air Filter Assembly. Air filters shall be one piece and shall be held firmly in place against the cabinet door in order to prevent dust from bypassing the perimeter of the filter and shall fully cover the vent area. Wing nuts or thumbscrews are preferred. Air filter shall be a 16-inch x 12-inch x 1-inch disposable pleated filter.

Cabinet Sizes.

Type I Cabinet. A Type I cabinet, 51”H x 30”W x 18”D, may be used for both pole and base mounted cabinets that require a maximum eight (8) position load bay. Pole mounted cabinets do not require rear access.

Type II Cabinet. A Type II cabinet, 51”H x 36”W x 18”D, may be used for both pole and

base mounted cabinets that require a maximum twelve (12) position load bay. Pole mounted cabinets do not require rear access.

Type III Cabinet. A Type III cabinet, 56”H x 44”W x 27”D, shall be used for base mount installations and shall require a sixteen (16) position load bay and rear access door.

Type IV Cabinet. A Type IV dual chamber cabinet, 56”H x 57”W x 29”D, shall be used for base mount installations and shall require a sixteen (16) position load bay, rear access door, and external generator plug. When called for in the plans, a UPS shall be housed inside this cabinet.

Type V Cabinet. A Type V cabinet, 77”H x 44”W x 27”D, shall be used for base mount installations and shall require a sixteen (16) position load bay and rear access door.

Power Distribution Panel. The power panel shall be wired to provide the necessary power to all equipment. It shall be manufactured from 0.125-inch thick, 5052- H32 aluminum. The power panel shall house the following components: Main Breaker, Auxiliary Breakers, and Terminal Block. The panel shall be of such design so as to allow a technician to easily access the main and auxiliary breakers.

A 3-position terminal block with a removable insulated cover accepting up to AWG #4 stranded wire shall be supplied for accepting only the incoming power lines. This terminal block shall be in advance of and supply only the 30-amp main breaker, 10-amp and 5-amp Auxiliary breakers, AC neutral buss and earth ground buss.

Ground and Neutral Busbars. A solid copper ground busbar shall be mounted on the side of the cabinet wall adjacent to the power panel for the connection of chassis ground wires. If more than one (1) ground busbar is used in a cabinet, a minimum of a AWG #6 copper wire shall be used to bond them.

The copper ground busbar shall have a minimum of thirteen (13) connector points, each capable of securing at least one (1) AWG #6 conductor.

A solid copper neutral busbar shall be mounted on the side of the cabinet wall adjacent to the power panel for the connection of AC neutral wires.

The copper neutral busbar shall have a minimum of thirteen (13) connector points, each capable of securing at least one (1) AWG #6 conductor.

Grounding and Ground Rods. Ground rods used shall be copper clad, steel rods of the diameter and length shown on the plans. Ground rods shall conform to the requirements of UL-467. Grounding rod couplers shall be UL approved, made from bronze, stainless steel or copper clad with a solid center providing 100 percent conductivity.

Single ground rods shall be driven vertically until the top of the rod is at least 12 inches below the finished ground.

Bare solid conductor copper wire, AWG 6 shall be used for grounding conductor and bonding jumpers unless otherwise stated in the plans. Bare solid conductor copper wire shall meet the requirements of ASTM B2.

The grounding conductor shall be continuous and shall be connected to a common ground system between all supporting poles and structures, to each transformer, to each sign support assembly, to each gate, and to each grounding conductor in a multi-conductor cable assembly.

Additional grounding rods electrodes (up to four (4) rods) shall be installed to obtain a maximum value of five (5) ohms to ground.

Bolted grounding connections of solder-less type made of the high strength electrical bronze with silicon bronze clamping bolts and hardware may be used; designed such that, bolts, nuts, lock washers and similar hardware that might nick or otherwise damage the ground wire will not directly contact the ground wire. Grounding splices shall not be insulated.

Exothermic welded ground connections shall be use where specified.

Terminal Strips. Conductors shall be terminated on terminal strips with insulated terminal lugs. When two (2) or more conductors are terminated on field wiring terminal strip screws, a terminal ring lug shall be used for termination of those conductors. The voltage and current rating of terminal strips shall be greater than the voltage and current rating of the wire which is terminated on the terminal strip.

Cabinet Receptacles. A 3-wire 115 Volt AC (15A) Ground Fault Circuit Interrupt (GFCI) duplex receptacle shall be provided in the cabinet for maintenance use. It shall be securely mounted near the bottom right side of the cabinet and easily accessible.

Two (2) 3-wire 115 Volt AC (15A) non-GFCI protected outlets shall be installed, one on each side of the cabinet. These two (2) outlets are used for communication or other auxiliary equipment.

Operating Line Voltage. All equipment shall be designed to operate from a 120 volt, 60 cycle AC supply. Operation shall be satisfactory at voltages from 105 volts to 130 volts. All operating voltages into and out of the controller shall be NEMA level DC voltages except for the controller AC power source (Connector A, Pin p – AC-Control and Pin U – AC Common).

Circuit Breakers. A 30-amp main breaker, with a minimum of 10,000 amp interrupting capacity, shall be provided for all cabinets to supply power to the controller, MMU, signals, and rack power supply.

Two (2) auxiliary breakers shall be provided. The first breaker, 10-amp, shall supply power to the fan, light, GFCI utility receptacle and two (2) auxiliary standard receptacles. The second breaker, 5-amp, shall be installed to supply power for the Controller Unit and MMU2. The above circuit breakers line side shall be jumpered together and will be fed from an external main circuit. A third 5-amp breaker shall be required if an ITS camera panel is called for in the plans.

Circuit breakers shall be a fixed mount, instantaneous magnetic trip-only type, fully enclosed in a molded case of insulating material rated according to the UL 489 Standard. The current carrying parts, mechanisms and trip devices shall be completely contained within the molded case of insulating material.

Each AC circuit breaker used shall interrupt the specified amperage at various voltages. Each circuit breaker shall be independently removable from the enclosure for inspection or replacement. The ON and OFF positions on each circuit breaker shall be clearly labeled. The operating handle shall be trip-free so that contact cannot be prevented from tripping by holding the operating handle in the ON position.

The circuit breakers maximum rating should always be in excess of the utilization equipment rating to provide for a short-time overload capability. The short circuit current shall be rated

at the breaker's maximum voltage (ANSI) or voltage class (IEC). The continuous current rating shall be at the rated voltage for ANSI breakers or the normal current on IEC breakers.

Circuit breakers shall be such that their current rating and the instantaneous trip point and the continuous current rating are unaffected by ambient temperature variations. The instantaneous trip point shall be no greater than eight (8) times the continuous current rating. Circuit breakers shall have built in arc flash boundary protection and quick break when tripping automatically.

Expansion Fittings. Expansion fitting shall be made from exterior and interior zinc galvanized, ductile iron, fixed and expansion jointed by rigid steel conduit sleeves. The fitting may be constructed such that disassembly is not required for installation. The fixed head may be integral with the sleeve, forming a one (1) piece body of galvanized malleable iron. Tin copper braid jumpers shall be provided.

Miscellaneous Hardware. All bolts, nuts, washers and other hardware shall be galvanized steel, stainless steel, or aluminum unless otherwise specified on the plans. Steel hardware that is galvanized shall be coated through hot-dip process in accordance with ASTM A153.

Surge Suppressors. This section describes the minimum requirements for surge suppressors including surge suppressors for electrical power and data cabling.

Transient Voltage Surge Suppressor (TVSS). The Contractor shall provide TVSS on all electrical service points and the input side of all transformers.

The Contractor shall install TVSS as follows:

(a) The placement of equipment and wiring within an outside enclosure shall be arranged so that the surge suppressors are located near the conductor's point of entry.
(b) Surge suppressor shall be located as far as possible from electronic equipment.
(c) TVSS shall be mounted on the underside of riser and ground-mounted demarcation point breaker panel enclosures and on the underside of transformers.
(d) The surge suppressors grounding conductor shall be free from sharp bends.

All electrical interconnects shall be protected from transient over-voltages (surges) including lightning and external electromagnetic fields coming into the cabinet. All cables shall be protected from a surge coming in on the ground and load side of the cabinet. The surge protection requirements include:

(a) Surge suppressors shall be furnished for all non-dielectric cable and conductors (video, data/signal and device/assembly power) between the equipment and the equipment cabinet.
(b) The surge suppressors shall have leads that are kept to a minimum length as recommended by the surge device manufacturer.
(c) All surge suppressor devices shall be designed and selected to meet the temperature and humidity requirements expected in this type of outdoor application. Surge suppressors including variable temperature components (i.e., PTCs) shall not impede signals at any elevated temperatures.
(d) All surge suppressors shall be UL listed (UL 1449 3rd Edition, UL 497, 497A, 497B,) and bonded to the same single-point ground point. Any DIN rail mounted SPDs shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.
(e) Any directional SPDs shall be clearly marked as "Protected Side" and "Unprotected

Side" and installed such that the Protected Side faces the equipment and the Unprotected Side faces the conductors coming into the cabinet.

(f) Low Voltage/Signal Cable Surge protectors for data/signal/control cable shall meet/provide the following functionality:
   (i) Peak Surge Current: 10,000-amperes for an 8x20 microsecond waveform.
   (ii) Shall be rated for the appropriate voltage.
   (iii) Response Time: one (1) nanosecond or less.
   (iv) Life Expectancy: capable of surviving at a minimum of 25 occurrences at 2,000 amperes.
   (v) Surge suppressor shall be self-resetting.

(g) Power surge protectors for power from equipment cabinet power distribution to the System shall meet/provide the following functionality:
   (i) Frequency: DC to 10MHz.
   (ii) Clamping Voltage: < 30VAC (rms) or 42VDC.
   (iii) Insertion Loss: < 0.2dB
   (iv) Input/Output Impedance: 75 ohms, typical.
   (v) Peak Surge Current: 3,000-amperes. (vi) Response Time: 1 nanosecond or less.
   (vii) Surge suppressor shall be self-resetting.

(h) Coaxial cable surge protectors are used from acceptance by the Engineer, the Coaxial Cable Surge suppressors for coaxial cable shall meet/provide the following functionality:
   (i) Attenuation: 0.3dB @ 10 MHz, typical.
   (ii) Input/Output Impedance: 75 ohms nominal.
   (iii) Operating Voltage of the surge protector shall match characteristics of the ITS device/assembly.
   (iv) Peak Surge Current: 5,000-amperes for an 8x20 microsecond waveform.
   (v) Response Time: 1 nanosecond or less.
   (vi) Surge suppressor shall be self-resetting.
   (vii) Coaxial SPDs shall be installed in a manner that prevents ground loops and resulting signal deterioration. This is usually caused where the cable has different references to ground at either end and connecting SPDs at both ends that have only Pin to Shield protection completes a ground loop circuit through the Shield. SPDs having Pin to Shield protection, and separate Shield to Ground protection are acceptable to eliminate ground loops.

Main Line Arrestors. Surge protection shall be provided that meets the requirements set forth in the above section. A main line arrestor shall be provided to reduce the effects of voltage transients on the AC power line. It shall be installed after the circuit breaker. The main line arrestor shall be sufficient to protect all equipment and devices as per the plans and the following minimum specifications.

- Multi-stage Hybrid Design
- Series induction filtering
- Thermally protected Metal Oxide Varistors (TMOV's)
- Operating Voltage: 120 VAC
- Clamping Voltage: 395 VAC
- Operating Current: 15 A
- Peak Surge Current: 50 kA/Mode, 100 kA/Phase
- Operating Frequency: 47-63Hz
- EMI Attenuation: 40 dB Typ
- SPD Technology: TMOV's w/ W-C Filter

- Modes of Protection: L-N, L-G, N-G
- Status Indication: Power On & TMOV's Functional
- Connection Type: ¼-20 Stainless Steel Stud
- Operating Temperature: -40°F to +185°F

Solid State Main Line Relay (SSR). A normally-open, 75-amp, hybrid SSR shall be provided on the power distribution panel. The relay shall include a LED indicator to verify circuit power.

Terminal Facilities Board. The Terminal Facility shall be a hardwired load bay for NEMA TS 2 Type 1 actuated controllers. The load bay shall include either eight (8), twelve (12) or sixteen (16) load switch positions, as specified by the plans, and shall be centered along the back of the cabinet below the bottom shelf.

All wires terminated behind the backboard, as well as any additional panels, shall be soldered. No pressure or solderless connectors shall be used, unless they are soldered to the wire and tab after connection.

Terminal Blocks. Each field wiring terminal block shall be a heavy-duty or industrial rated UL and NEMA Class 600 volt, direct mount barrier type device. Terminal blocks shall be constructed of a single piece molded phenolic base with a twelve (12) double point, corrosion resistant, strap screw configuration. Terminal screws shall be binding head type, no smaller than size 10-32 with no less than 9/16 inch center to center spacing. Terminal block slots shall fit spade lug type terminating devices. Waterproof labeling strips shall be provided on all terminal blocks.

All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side.

Load Switches and Flashers. Solid State Load Switches, compatible with low wattage LED signals, shall be provided for the sequence called for on the plans. The load switch sockets shall be wired for triple-signal load switches conforming to NEMA TS 1-1994 and NEMA TS 2-2003 requirements.

The flasher socket shall be wired for and provided with a Type 3, two (2) circuit Solid State Flasher conforming to NEMA TS 1-1994 and NEMA TS 2-2003 requirements. It shall be possible to flash either the amber or red indication on any load switch outputs. It shall be possible to easily change the flash indication from the front side of the panel using readily available tools such as a screwdriver. A nominal flash rate of 50 to 60 FPM shall be provided. Flash rate shall be stable when used with generators or inverters.

Support(s) shall be provided to support the Flasher and Load Switches at some point approximately half of the total length from the panel surface. Sufficient area beneath the Load Switch or Flasher shall be clear in order to allow for free flow of air across the Load Switches or Flasher. Load Switches and Flashers must be provided with LED indicator lights on the side facing the cabinet door.

Flash Transfer Relay. All flash transfer relays, as a minimum, shall meet NEMA TS 1 requirements. The number of relays that shall be supplied with each cabinet shall accommodate the number of signal phases as indicated in the project plans. The coil of the flash transfer relay must be de-energized for flash operation.

Cabinet Wiring. Controller cabinets shall be wired in accordance with the signal phasing plans. If phases are indicated as omitted for future use, or if phases are not shown to be used in the plans, the cabinet shall be wired for use of the phases shown as future or unused. Load Switches shall not be provided for future or unused phases.

Wiring in the cabinets shall conform to the requirements of the National Electrical Code (NEC) and all of these specifications. All conductors in the cabinet shall be stranded copper. All wiring shall be laced. All wiring shall be in accordance as specified by the Electrical Cable Section of these specifications and by Electric Cable and IMSA Specification 19 and/or 20 for Signal Wiring.

Connector harnesses for controller, conflict monitor, vehicle detectors, and accessory equipment (including NEMA defined Card Rack with power supply and pre-wired optical detection slots) shall be provided and wired into the cabinet circuitry. Connecting cables for controller and conflict monitor harnesses shall be sleeved in a braided mesh. All wires shall be securely terminated on terminal strips. The lay of the interconnect cable between the components must be such that when the door is closed, it does not press against the cables or force the cables against the various components inside the cabinets.

All communication wiring shall be bundled and routed independently of all other wiring. All live conductors shall be covered with suitable insulating material. All equipment grounds shall run directly and independently to the grounding bus.

All wires shall be cut and terminated as close as possible to the proper length before assembly. Consideration of equipment location adjustments must be made when determining appropriate wire lengths. Excessive lengths of wire or cable shall not be allowed. All line voltage conductors used in controller cabinet shall conform to the following color code:

AC Neutral: White
AC Hot: Black
Safety Ground: Green

Signal Terminal Arrestor Grounding Bar. A field terminal arrestor grounding bar shall be provided along the back portion of the cabinet for the installation of signal arrestors. This bar shall be attached using a AWG #10 stranded copper to the earth ground circuitry.

Signal Terminal Arrestors. The field terminal arrestor shall be a three (3) circuit protective device intended for use on traffic control load relay outputs. The arrestor shall be furnished with three (3) leads and a grounding stud which will be used to attach the arrestor to the grounding bar. The field terminal arrestor shall meet the following minimum specifications:

- Operating Voltage: 120 VAC
- Clamping Voltage: 475 VAC
- Peak Surge Current: 10 kA
- Operating Frequency: 47 – 63 Hz
- SPD Technology: MOV’s
- Connection Type: Wire Leads
- Lead Wire: 14 AWG 12” Length
- Ground Stud: 10 x 32 5/8” Length
- Operating Temperature: -40°F to +185°F

Communications Arrestor. The Controller Cabinet network shall consist of an SDLC connection between the Controller Unit and MMU2. Surge suppression for this network shall meet the requirements set forth in in the Surge Suppressors section above and the following minimum requirements below:

- Operating Voltage: 5 VDC
- Clamping Voltage: 8 VDC
- Operating Current: 1.5 A
- Peak Surge Current: 47 A (10x1000 μs)
- Frequency Range: 0 to 20 MHz
- Insertion Loss: < 0.1 dB at 20 MHz
- SPD Technology: SAD
- Connection Type: DB-15
- Operating Temperature: -40°F to +185°F

Traffic Signal Ethernet Switch. When specified in the plans or contract documents, a traffic signal Ethernet switch shall be installed in the cabinet assembly. Ethernet patch cables of sufficient length shall be provided for all supplied Ethernet ready cabinet components. The switch and all components shall be connected and configured.

Fiber Optic Patch Panel. When specified in the plans or contract documents, fiber optic attenuator patch cords shall be installed in the cabinet assembly.

Wireless Communications. When specified in the plans or contract documents, wireless communication components shall be installed in the cabinet assembly.

Serial Port Server or Terminal Server. When specified in the plans or contract documents, serial port servers shall be installed in the cabinet assembly.

Power-Over-Ethernet Arrestor. Surge suppression that meets the requirements set forth in the Surge Suppressors section above shall be provided. In addition, the following minimum specifications shall be supplied for loads that require Power-Over-Ethernet with isolated shielded or non-shielded cable:

- Operating Voltage: 48 VDC
- Clamping Voltage: 68 VDC
- Operating Current: 0.75 A per Pin Continuous
- Peak Surge Current: 10 kA
- Insertion Loss: < 0.1 dB
- SPD Technology: GDT, SAD, with series PTC
- Modes of Protection: All Lines (1-8) Protected (L-L) and (L-G): Signal High-Low; High-Ground; Low-Ground
- Transmission Speeds: 10BaseT; 100BaseT; 1000BaseT
- Connection Type: RJ-45
- Operating Temperature: -40°F to +185°F

Detector Panel. A vehicle detector harness shall be provided to connect the detector panel to the card rack. The detector panel shall accept the connection of sixteen (16) field loop inputs and four (4) pedestrian detector inputs.

Detector Input Arrestors. Field Loop and Pedestrian input arrestors shall meet the requirements set forth in the Surge Suppressors section above. Field loop arrestors shall have differential and common mode protection and be provided with the following minimum specifications:

- Operating Voltage: 75 VDC
- Clamping Voltage: 130 VDC
- Peak Surge Current: 250 A
- SPD Technology: Silicon Break-Over
- Operating Temperature: -40°F to +185°F

Pedestrian input arrestors shall be a four (4) circuit device provided with the following minimum specifications:

- Operating Voltage: 30 VDC
- Clamping Voltage: 36 VDC
- Operating Current: 0.15 A
- Peak Surge Current: 10 kA (8 x 20 μs)
- Frequency Range: 0 to 20 MHz
- Insertion Loss: < 0.1 dB at 20 MHz
- SPD Technology: GDT, SAD, with Series PTC
- Connection Type: Terminal Block with compression lugs; Terminals accept up to 10 AWG
- Operating Temperature: -40°F to +185°F

System Detectors. The controller shall have the ability to receive input data from up to eight (8) special system detectors in addition to the normal actuated controller unit phase detectors. The user shall have the option to assign any of the phase detectors as "system detectors".

Preemption. The cabinet shall be completely wired to accept and service calls from preemption phase selector modules, associated optical detector units and GPS units. Optical detector units and GPS unit cabinet components shall be as specified in the Traffic Signal Preemption Systems section of this specification. Provision for two (2) standard card modules shall be accommodated in a separate card rack for preemption. The preemption card rack shall provide a minimum of eight (8) channels.

Provisions shall also be made in the cabinet to accommodate Railroad Preemption when specified in the plans or contract documents. Railroad Preemption shall meet the requirements set forth in the Traffic Signal Preemption Systems section of this specification. While it is not necessary that a Railroad Preemption interface board be provided with the cabinet, the cabinet and back panel shall be designed so that a Railroad Preemption interface panel that uses a relay to isolate the track switch from the controller cabinet circuitry can be installed. Preempt 1 and 2, in the case of gate down preemption, shall be reserved for Railroad Preemptions; all subsequent preemptions shall be reserved for Emergency Vehicle, Fire Station, or Police Preemption.

Uninterruptable Power Supply. When specified in the plans or contract documents an Uninterruptable Power Supply (UPS) System shall be installed in the cabinet assembly. The UPS shall be installed in the cabinet and meet the requirements set forth in the Uninterruptable Power Supply section of this specification.

Documentation. Documentation packages shall be delivered for each unit at the same time as the equipment to which it pertains.

A minimum of two (2) sets of complete schematic drawings and equipment documentation shall be supplied with each cabinet. The first copy shall be placed in a clear re-sealable print pouch of sufficient size to accommodate one (1) complete set of folded cabinet prints and placed in the pull-out drawer of the cabinet and the second copy shall be provided to the Department. Comprehensive controller data shall be included as part of the cabinet documentation package and shall be placed in the cabinet drawer pouch. Digital copies of all cabinet documentation shall be provided to the Department before final acceptance.

The documentation packages shall contain a schematic wiring diagram of the controller cabinet assembly and all auxiliary equipment. The schematic wiring diagram, including a symbols legend, shall show in detail all integrated circuits, transistors, resistors, capacitors, inductors as well as switches and indicators. All parts shown shall be easily identified on both in the cabinet and on the schematic diagram. Model numbers shall be used on schematic diagram when available.

A complete physical description of the signal cabinet assembly shall be provided to include at least the physical dimensions of the unit, weight, temperature ratings, voltage requirements, power requirements, material of construction, and complete performance specifications.

A complete set of operation guides, user manuals, and performance specifications shall be provided.

Detailed programming instructions, preventative maintenance requirements, and troubleshooting procedures shall also be provided for the controllers. These documents shall fully cover all programming procedures and programmable options capable of being made to the controllers and associated traffic control equipment. Instructions for modifications within the range of the capabilities of the unit such as changes in phases or sequences and programming matrix boards shall be included.

An intersection diagram shall be provided on the cabinet door showing geometric configuration, lane use assignments, controller cabinet and signal pole locations, vehicle and pedestrian signal head locations, vehicle and pedestrian detector zone locations, ring- barrier phasing diagram, and detector channel assignments. The intersection diagram shall be labeled with, at a minimum, a North Arrow, main street name(s), side street name(s), signal pole numbers, vehicle and pedestrian head type(s), detector zone designations, volume density and phase recall requirements, flash sequence. All field wires within the cabinet shall be labeled to coincide with those shown on the intersection diagram.

TRAFFIC SIGNAL ACTUATED CONTROLLERS

The fully actuated controller unit shall, at a minimum, meet the requirements of both NEMA TS 1–1989 and NEMA TS 2-2003 requirements for actuated controller units. The controller shall be of the TS 2 Type 2 configuration. The controller shall be provided with the multiple communication interface devices or properties as defined below.

- 10 Base-T Ethernet with front panel RJ-45 connector
- IEEE defined MAC address
- EIA-232 port
- External Serial Fiber options for both single and multi-mode (optional as per plans)
- External FSK 1200 bps modem (optional as per plans)
- D connector with 37 pin configuration for TS 1 compatibility
- USB port for signal controller database upload/download to the controller flash
- Controller
- ECOMM Compatible

The controller unit must have an alphanumeric backlit LCD display with a minimum of sixteen (16) lines at 40 characters per line. The controller must be air-cooled with sufficient ventilation openings and capable of operating between -30°F and 165°F. The controller unit must be provided with a time-of-day clock, automatic daylight savings time adjustment and a power supply for maintaining SRAM during a power outage. The controller unit shall be capable of being used in a Closed-Loop System and must be capable of operating in the role of master controller in a Closed Loop System. The controller unit firmware shall be fully compatible with the Department's existing Traffic Signal Management Software. The Contractor shall ensure all controller firmware versions are compatible with the existing Traffic Signal Management Software that the Regional Department staff currently utilizes prior to submitting the controller for approval. The Contractor shall notify the Department if any special controller configuration or firmware is needed prior to submitting the controller for approval based on project requirements.

Where Flashing Yellow Arrow (FYA) operations are being used, all traffic signal controller firmware shall be capable of delaying the onset of the flashing yellow arrow.

All operator entered data shall be stored and backed up on to a flash memory device provided with the controller unit at no cost. This flash memory device shall require no battery to support value storage. No internal components of circuitry shall require battery support. The database shall be able to be backed up to a USB drive via the USB drive on the controller. Traffic Actuated Controllers shall be of the Type shown on the plans. Type 1 Controllers shall have a Linux based processor and a minimum of one (1) USB port. Type 2 Controllers shall have the same features as Type 1 Controllers with the addition of an ATC backplane. Type 3 Controllers shall have all features of the Type 2 Controller with the addition of the ATC module. All three (3) types of actuated controllers shall have Master controller capability, and if required shall be designated with 'M' in the plans.

Closed Loop Master Controller Unit. When called for in the plans, this work also consists of furnishing, installing and configuring the equipment, software and accessories necessary to connect one (1) traffic Closed-Loop Master Controller to its corresponding central or portable PC-based Traffic Computer Facility Control System via a communications connection. The communications or network connection device will be either existing or provided by the Contractor.

General. The Master shall monitor intersections in the system, display status and operational state and provide traffic flow data from intersection vehicle detectors. The Master shall include all communications equipment and software necessary to provide reporting to a remote terminal as well as upload/download of all local intersection data and provide timing synchronization. Communications to local controllers from the Master and from the Master to the central-office computer facility shall be by FSK, 900 MHz Radio, Broadband Radio, Serial Fiber, Ethernet, Fiber, Cell Modem or Leased Line, as indicated in the plans. The Master shall be able to run on the same controller simultaneously operating the intersection, with the local signal control software, on any given controller unit.

System Configuration. The system architecture shall be designed to minimize the effect of equipment failures on system operation and performance. The system consists of four (4) principal elements:

- Local System Intersection Controllers
- Communication (Telemetry Links)
- On-Street Master(s)
- Central-Office Computer Software

Local System Intersection Controller. The local system intersection controllers connected to the Master controller unit shall be capable of controlling a fully actuated two (2) to sixteen (16) phase intersection and shall meet or exceed NEMA TS 1-1989 and TS 2-2003 standards for fully actuated traffic control units. The local controller shall have internal communication capability with direct access to the data memory. The local system controller shall be capable of processing controller and detector data and provide all necessary intersection control functions. The local system intersection controller shall meet the requirements of the Traffic Actuated Controller Unit.

Communications (Telemetry) Links. The communications links for the "Closed-Loop" System shall perform the following functions:

- Provide the medium (radio/fiber/hardwire/etc.) for two-way communications between the On-Street Master and the local intersection controllers.
- Provide the medium for two-way communication between the On-Street Master and the central-office computer facility.
- Error checking shall be included in both mediums to assure transmission and reception of valid data.

On-Street Master. The On-Street Master may be located at an intersection and connected via the communication network to at least 32 local intersection controllers. The Master shall be capable of implementing Traffic Responsive Control, Time Base Control, Manual Control or Remote Control modes of operation.

Analysis of sampling sensor data from at least 64 system detectors and corresponding selection of the best Traffic Responsive timing pattern shall be provided by the On-Street Master during the Traffic Responsive mode of operation.

Automatic and continuous monitoring of system activity shall be provided by the On-Street Master to include both Master and intersection alarm conditions.

System parameter entry shall be provided via the On-Street Master including all Master and

local intersection assignment and group parameters. Master parameters shall include:

- System coordination setup and pattern data entry by group
- System time base event scheduler
- System traffic responsive computational and pattern selection setup by group
- Intersection system group and detector assignments

The On-Street Master shall provide comprehensive system report generation including, as a minimum: system, intersection, detector and failure status and history reports in addition to system performance reporting.

A RS-232C interface shall be provided on the On-Street Master to allow for printing of reports or for interconnecting to a remote central site.

To enhance overall system operation and increase system management flexibility, the On-Street Master shall also support two-way dial-up communications to a central office computer for control, monitoring, data collection and for timing pattern updating purposes, all from a remote central office location. Continuous, seven (7) days/week - 24 hours/day, system monitoring shall be enhanced by the On-Street Master's capability to automatically dial-up the central office computer upon detection of user defined critical alarm conditions.

System Functional Requirements.

Operator Interface. In order to provide ease in programming and operation, the system shall provide a simplified user-friendly menu format at each local, master and central office facility. No special programming skills shall be required for the user to fully access and operate this control and monitoring system at any level.

All programming, both of the local intersection controllers and the On-Street Master(s) shall be via a front panel keyboard and display, driven by English Language menus. All data change entries will be automatically verified against established ranges prior to acceptance to prevent programming data errors. Data access shall be controlled by user- definable access controls.

System Traffic Control. The system shall have the capability of controlling a minimum of sixteen (16) vehicle phases and eight (8) pedestrian phases. The
system shall have the capability of implementing a minimum of four (4) timing rings, fifteen (15) alternate sequences, and sixteen (16) offsets.

The system shall provide the capability of selecting any of the following operational modes on a group basis:

- Traffic Responsive
- Time Base (Time-of-Day/Day-of-Week)
- Remote (External Command)
- Manual (Operator Entry)

The system shall be capable of implementing system FLASH and system FREE operation. The system shall have the capability to command, on/off based on time, up to eight (8) independent special functions.

Detectors. The system shall have the capability of accepting and processing data from at least 632 system detectors for Traffic Responsive program selection.

Pattern Selection. In addition to providing Manual and Remote program selection capability, the Master shall provide for Traffic Responsive and Time Base modes of operation for timing pattern selection.

Traffic Responsive Mode. Traffic plan selection in the Traffic Responsive mode shall be user-enabled and supplied with the controller, per the plans and specifications. The pattern selection shall be based on sampling detector volume and occupancy analysis by the On-Street Master.

Time Base Mode. The system shall provide the capability of implementing time-of-day, day-of-week and week-of-year control for each of the two (2) groups using an internal time clock referenced to the 60-Hz AC power line frequency for its time base. The Time Base mode shall contain automatic adjustment for leap year and daylight savings time changes.

The system Time Base mode shall provide, as a minimum, 100 events each capable of requesting any of the 48 traffic control patterns along with Traffic Responsive override enable or auxiliary events consisting of enable/disable any of up to four (4) system-wide special functions and setting sample and log interval time periods.

System Control Priority. The system coordination control (program-in- effect) for each group shall be selected on a priority basis. The priority from highest to lowest shall be as follows:

- Manual Control Entry
- External Control (Remote Command)
- Time Base Control (Time-of-Day/Day-of-Week) (Traffic Responsive control will prevail whenever Traffic Responsive Override Enable is active and the selected cycle length is greater than that being commanded by Time Base)
- Traffic Responsive Control

Measures of Effectiveness. The system shall have the capability to report selected Measures of Effectiveness (MOE's) on an intersection basis. MOE calculations shall be made on all phases by the local system intersection controller and as a minimum shall include measures such as: volume, number of stops, delays and green utilization. These measures shall be calculated on the basis of the active timing plan. Alternate ways of reporting MOE'S may be approved on a case-by-case review.

Uploading and Downloading. The system shall provide, for any selected local system intersection controller, the capability of uploading and downloading any or all, new or modified local intersection parameters from the central-office computer and the Department Central Traffic Signal Management Software, and shall include, as a minimum, all: Phase Timing and Unit Data; Coordination Data, Time Base Data; Preemption Data, System Communication Parameters, System Traffic Responsive Data, and any other System Data residing at the intersection such as Detector Diagnostic Values, Report Parameters and Speed Parameters.

During either uploading or downloading operations, normal traffic control operations shall not be suspended. All data shall be continually accessible and may be displayed at the On- Street Master or the central office computer.

System Monitoring and Diagnostics. The system shall automatically and continually monitor system activity and log/report occurrences of Master and intersection alarm conditions. All

alarm condition events shall include at the intersection, (Master and central-office computer) an alpha-numeric description of the event as well as the time and date of occurrence.

As a minimum, monitored master alarms conditions shall include:

- Insufficient or Improper Data
- Failed Computational Channels
- Failed System Detectors
- Intersection Communication Failure
- Failed Controllers
- Minimum of six (6) special user defined alarms for user application flexibility
- Monitored intersection alarms conditions shall include as a minimum:
- Cycle Faults and Failures
- Coordination Failures
- Voltage Monitor
- Conflict, Local and Remote Flash Conditions
- Preempt
- Local Free
- Minimum of six (6) special user defined alarms for additional user flexibility.

When the Master detects a critical alarm condition, as defined by the user, it shall automatically dial-up the central office computer and report the condition. On a BUSY or NO ANSWER, the system may be programmed, at user option, to alert a secondary computer.

The system shall also automatically and continually monitor, verify and attempt to correct Sync Pulse, Time Base Clock and Pattern-In-Effect. The system shall provide capabilities to perform diagnostics on system and local detectors, communications and intersection operations. When a fault has been detected, an indication shall be provided. It shall be possible to isolate the fault to the failed unit from controls and indicators available on the Master unit. Auxiliary equipment such as a data terminal or CRT shall not be required to identify the failure.

Real Time Display. The Master shall provide for any selected local system intersection controller, real-time status information on its front panel. Real-time intersection status information shall include simultaneous display of: vehicle and pedestrian signal and detector status by phase, overlap signal status and cars waiting count by phase. Real-time controller status information shall include simultaneous display of: two (2) Ring Active timers, On/Next, Call/Recall and Hold/Omit Status by phase, Coordination, Preempt and Stop Time Status.

System Management. The system, without hardware changes but with its ability to directly modify Master and intersection parameters, shall provide the user system configuration and operational controls of the following functions: add/delete controllers and system detectors, enable Traffic Responsive mode, assign intersections to groups, assign system detectors to computational channels and channels to pattern select routines, and assign special and/or standard detectors as system detectors for use with computational channels or to track activity.

System Logging and Reports. The system shall automatically and continually process system data and log/report on occurrence of changes in intersection status, system detector status, communications status, controller status and local detector status in addition to system program changes, Traffic Responsive computations, measures of effectiveness and performance.

Security. The On-Street Master shall provide for a user-specified security code entry before any data may be altered. In order to view any parameter, security code entry shall not be required. Security access shall be automatically rescinded approximately ten (10) minutes after either access was gained or the last parameter change was entered. The Master and local controller shall have the ability via keyboard to disable security code requirements, allowing for perpetual access without requiring hardware changes.

Design Characteristics. The On-Street Master shall be designed to operate in either an office or field environment and shall be suitably housed in a separate enclosure or in a local intersection cabinet. The Master shall be designed to meet the following electrical and mechanical requirements:

Programming and Security. Operator programmable data entry shall be accomplished through panel keyboard(s). The Master shall prevent the alteration of keyboard set variables prior to the user having entered a specific access code through the keyboard. The Master shall maintain user-programmable variables in non-volatile memory with a battery-backed RAM to assure continued efficient system operation.

Test and Repair. To enhance maintenance and trouble-shooting activities, On-Street Masters shall include resident diagnostics as a standard. No extender- cards, special tools or PROMs shall be necessary to fully maintain these components. The
Master unit design shall ensure that all printed circuit boards be readily accessible for maintenance testing purposes. All fuses, connectors and controls shall be accessible from the front of the Master unit.

NEMA MALFUNCTION MANAGEMENT UNIT (MMU)

The Malfunction Management Unit (MMU2) shall be a shelf-mountable, sixteen (16) channel, solid-state, IP addressable MMU. The MMU2 shall accomplish the detection of, and response to, improper and conflicting signals and improper operating voltages in a traffic signal controller assembly, including support for four (4) section Flashing Yellow Arrow (FYA) left turn displays. The MMU2 shall be capable of running a minimum of twelve (12) different modes of FYA operation.

The MMU2 shall meet or exceed Section 4 requirements of the NEMA Standards Publication No. TS 2-2003 including NEMA TS 2 Amendment #4-2012 and provide downward compatibility to NEMA Standards Publication No. TS 1-1989: Type 12 Operation, in addition to those specifications set forth in this document.

The MMU2 shall include a graphics based Liquid Crystal Display (LCD) to view the current monitor status and navigate the unit's menus. An RJ-45 Ethernet Port shall be provided for communications.

A built-in Diagnostic Wizard shall be provided that displays detailed diagnostic information regarding the fault being analyzed. This mode shall provide a concise view of the signal states involved in the fault, pinpoint faulty signal inputs and provide guidance on how the technician should isolate the cause of the malfunction. The Diagnostic Wizard shall be automatically invoked when the MMU2 is in the fault mode and the HELP button is pressed. It shall also be automatically invoked when the MMU2 is in the Previous Fail (PF) event log display and the HELP button is pressed.

A built-in Setup Mode shall be provided 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.

The MMU2 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 (4) Pedestrian Walk inputs.

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 nineteen (19) strand AWG 22 wire.

NEMA defined Card Rack and Power Supply. A minimum of one (1) NEMA compliant detector card rack with five (5) slot positions (first slot for power supply and four (4) available slots) shall be provided in each cabinet. The detector rack shall be installed on the bottom shelf of the cabinet. The power supply for the NEMA defined card slots shall be provided as a 175W minimum with four (4) independent regulated channels of 24 VDC each rated at 0.75 amps over the full NEMA operating temperature range of -30°F to +165°F. The output should be regulated to 24 VDC +/- 15%. Each of the four (4) outputs shall be independently fused, each with a separate LED for displaying output and fuse status for each of the four (4) outputs. Each of the four (4) outputs shall be protected against voltage transients by a minimum 1500 watt suppressor. All card racks shall be wired for the type detection shown in the plan sheets.

Card Guides shall be provided on the top and bottom of the card rack for each connector position.

GPS CLOCK

GPS Clock. This work includes furnishing a Global Positioning System (GPS) Synchronization clock that can be used to sync the internal clocks in traffic signal controllers when coordination is desired, but communication is not necessary. The GPS Clock System shall provide GPS based time and date synchronization to provide coordination of traffic controllers to a common time base. The system shall process GPS Time data using a tamper/vandal resistant GPS antenna and correct for Time Zone, Daylight Savings Time, Leap Years, and GPS Leap Seconds. The processed time information shall be sent to the traffic controller in the native format for the respective controller. A contact closure synchronization pulse with variable pulse width shall be available for a once per day update. If the GPS antenna is blocked for up to one (1) hour prior to scheduled time of synchronization, the system shall synchronize the traffic controllers with less than 0.4 seconds variance from the accuracy provided under normal operation with GPS satellites in view.

- The GPS Clock shall also meet the following minimum specifications:
- Input Voltage: 9-24 VDC
- Current Draw: 150 mA (max) at 12 VDC: 125 mA (max) at 24 VDC
- Contact Closure: 750 mA at 30 VDC
- Temperature Rating: -29.4°F to +167°F

GPS unit shall be mounted to the traffic signal controller cabinet as per the manufacturer's recommendation. Any and all holes created in the cabinet for the purpose of mounting the GPS unit shall be sealed to the satisfaction of the Engineer at no direct pay.

BATTERY BACKUP SYSTEM AND POWER CONDITIONER

Description. The UPS system shall be a turn-key, true on-line, solid state, microprocessor controller power conditioner and/or UPS system. The system shall continuously regenerate and condition the AC sine wave, where 100% of the power to the load, whether on utility or batteries, is generated by the on-board inverter. The UPS system shall be capable of operating, up to the rated power levels, in extreme environments (-40°F to +165°F) with existing cabinet equipment, including any and all signal heads whether Incandescent, LED or Neon.

Materials. The UPS system shall consist of three (3) major components: the Electronics Module, the Manual By-pass Switch, and the Battery System.

Electronics Module. The Electronics Module shall be provided as follows:

- True Sinewave, Micro Processor controlled high frequency inverter.
- A temperature compensated battery charger.
- Local and remote control of UPS functions.
- Local and remote communication capabilities.
- Utility By-pass Switch for by-passing the UPS for repair or removal.

The Manual Bypass Switch. A Manual By-pass Switch shall be provided as follows:

- The UPS shall incorporate an automatic, internal safety by-pass capability and a Manual By-pass Switch.
- An optional interface connector shall be available that allows an external generator or vehicle inverter to supply utility power when commercial utility has failed.
- The UPS shall supply 120 VAC, 60 Hz, True Sinewave power when connected to either a generator or digital inverter power system

The Battery System. The battery shall be comprised of extreme temperature, deep cycle, AGM-VRLA (Absorbed Glass Mat – Valve Regulated Lead Acid).

UPS Operation.

UPS System. A UPS System shall be provided as follows:

1) The Unit shall be capable of on-site programming without the use of attached computers.
2) On-line technology shall be supported and 100% of the load shall flow through the inverter 100% of the time to isolate and protect the attached equipment.
3) Power connection shall be made to the front or back of the UPS chassis to support NEMA cabinetry.
4) The UPS system shall be capable of providing continuous, fully conditioned and regulated sinusoidal (AC) power to selected devices such as signal controllers, modems, communication hubs, NTCIP adapters and video equipment, for a minimum of 8 continuous hours.
5) The UPS system shall be sized with a maximum rating to be capable of supporting all cabinet systems, regardless of power factor rating, without overdriving the poorer power factor LED heads which may cause early degradation, low luminosity or early signal failure and meeting minimum run time requirements during power loss/failure of commercial power.

6) Upon loss of utility power, the UPS system shall switch to battery power. In cases of UPS system failure, while on utility, the UPS system will auto-by-pass and remain in that mode until repaired. Should the battery power deplete such that it is not sufficient to power the equipment, the unit will auto-shutdown and return to normal operating mode once the utility power is restored.
7) The By-pass Switch shall enable removal and replacement of the UPS system without shutting down the traffic control system (i.e. "hot swap" capability). The UPS system shall support generator input without going to batteries.
8) The UPS system shall be capable of starting when no utility AC is available, i.e. starting while on batteries ("cold starting"),
9) Existing cabinet Flasher Modules and Flash Transfer Relays shall be utilized.
10) To facilitate emergency crews and police activities, the UPS system shall be compatible with the police panel functions.
11) The UPS system shall not duplicate or assume Flash Operation or Flash Transfer Relay functions.
12) The UPS system shall deliver 120 VAC output when the AC input is between 75 to 175 VAC without going to batteries.
13) NEMA Style Cabinet mounting method shall be shelf mounted.

System Batteries. The system batteries shall meet the following:

a) The battery system shall consist of extreme temperature, deep cycle, Gel or AGM-VRLA (Valve Regulated Lead Acid) batteries that have been field tested.
b) The battery system may consist of one (1) or more strings (typically four (4), six (6) or eight (8) batteries per string) of extreme temperature, deep cycle, Gel or AGM VRLA (Valve Regulated lead Acid) batteries.
c) Batteries shall be capable of operating at extreme temperatures from -40°F to +165°F.
d) The batteries shall be provided with appropriate interconnect wiring and corrosion-resistant mounting trays and/or brackets.
e) The interconnect cables shall be protected with abrasion-resistant nylon sheathing.
f) The interconnect cables shall connect to the base module via a quick-release connector.
g) Battery construction shall include heavy duty, inter-cell connections for low-impedance between cells, and heavy duty plates to withstand shock and vibration.
h) The top cover shall use tongue and groove construction and shall be epoxied to the battery case for maximum strength and durability.

Electrical Specifications.

Input Specification. The following are input electrical specifications.

Nominal Input Voltage	120 VAC, Single Phase
Input Voltage Range	75 VAC to 150 VAC (without drawing energy from batteries)
Input Frequency	50 or 60 Hz
Input Configuration	3-Wire (Hot, Neutral & Ground)
Maximum Input Current	30 amps

Output Specification. The following are output electrical specifications.

Nominal Output Voltage	120 VAC, Single Phase
Power Rating	1.25 - 2.0 KVa continuous watts

Output Frequency	50 or 60 Hz
Output Configuration	Keyed, connectors and duplex receptacle
Output Wave Form	True Sine wave
Fault Clearing	Current limit and automatic shutdown
Short Circuit Protection	Current limit and automatic shutdown
Efficiency	85% at full load

Environmental Specifications. The UPS system shall meet or exceed NEMA temperature standards from -40°F to +165°F.

The UPS system shall be field proven to meet or exceed NEMA temperature standards.

Battery Specifications.
The UPS system batteries shall be field tested and proven to meet or exceed NEMA temperature standards of -40°F to +165°F. Hydrogen gas emissions shall meet Mil-Spec, MIL-B-8565J.

Communications, Controls and Diagnostics. The UPS system shall provide standard Alarm Function Monitoring indicating loss of utility power, inverter failure, low battery condition and USB connectivity for system up/down loads. An RS232 or USB Interface shall be provided that allows full interactive remote computer monitoring and control of the UPS functions. The UPS shall have an Ethernet communication interface for user configuration and management.

A Confirmation Light shall be included on the external top of the cabinet enclosure.

Warranty. The UPS System and Cabinet Assembly shall be protected by a minimum 2-year warranty.

Options. The UPS shall include an optional SNMP interface that provides Web-based Ethernet access.

INDUCTIVE LOOP VEHICLE DETECTION SYSTEMS

Materials. Materials shall include shielded cable, vehicle loop assemblies and loop detector amplifiers and shall conform to the requirements of this Section.

Inductive Loop Detection System. Inductive Loop Detection System shall consist of the following principal components: two (2) or more turns of insulated loop wire wound in shallow slot sawed in the pavement, lead-in cable from the curbside pull box to the intersection controller cabinet, and an electronics unit housed in a nearby controller cabinet. The functions intended for use with this system include Vehicle Detection and Data Collection – special detection.

Loop Detector Wire. Loop detector wire shall be cross-linked polyethylene insulated loop detector wire rated at 600 volts that meets the requirements of IMSA Specification No. 51-3.

Loop Detector Lead-In Cable and Shielded Cable. Loop detector lead-in cable shall be shielded cable conforming to IMSA Specification No. 50-2, for polyethylene insulated, polyethylene jacketed Loop Detector Lead-in Cable. Unless otherwise indicated, the cable shall be AWG # 14, 2-conductor or AWG #14, 4-conductor.

Sealant. Sealant material shall be a polyurethane sealant conforming to the requirements herein. The material shall be manufactured specifically for this use and shall be used in accordance with the manufacturer's instructions. The material shall be dielectric, have no detrimental effect on cable insulation, and bond to either portland cement or bituminous concrete paving with minimal shrinkage. The material shall, when cured, retain flexible characteristics and accommodate movement associated with portland cement and bituminous concrete pavements. The material shall not track in hot weather and shall be suitable for applying when the surface temperature is between 50°F and 130°F. The material shall be resistant to the effects of weather, vehicular abrasion, motor oils, gasoline, antifreeze solution, brake fluid, and deicing chemicals normally encountered.

The polyurethane sealant shall be a one-part moisture curing compound requiring no mixing or application of heat prior to or during installation. The sealant shall meet the following additional requirements.

Properties	Requirement	Test Procedure
Viscosity (uncured)	30,000 cps	ASTM: D 1048 (B)
Tack-Free Time (uncured)	24 hrs., maximum	ASTM: D 1640
Hardness, Shore A (cured)	85	ASTM: D 2240
Elongation (cured)	250%	ASTM: D 412
Tensile Strength (cured)	500 psi, minimum	ASTM: D 412

Packaging	Minimum Shelf Life
Liter Ply Packs	9 Months
Five Gallon Containers	12 Months

If deemed necessary during the review process, the Engineer may require the Contractor to submit manufacturer's certification to meet the above requirements.

Loop Detector Amplifiers – Card Rack Mounted. Loop Detector Amplifiers shall be rack-mounted, digital, solid-state, self-tuning inductive loop detector cards with extend and delay

output features. The Loop Detector Amplifier Card shall have the following minimum features and operational requirements.

Tuning. The amplifier card shall tune automatically upon the application of power in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.20.

Modes of Operation. Each amplifier card channel shall be capable of functioning in both presence and pulse mode in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.17.

Sensitivity Control. Each channel of the amplifier card shall meet NEMA TS 2-2003 v02.06 Section 6.5.2.15 requirements for sensitivity controls.

Crosstalk Avoidance. The amplifier card shall be capable of preventing crosstalk between channels of the same unit in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.23.

Outputs. Each output device shall conform to NEMA TS 2-2003 v02.06 Section 6.5.2.26 requirements.

Controls and Indicators. All amplifier card controls and indicators shall be in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.25.

Self-Tracking. The amplifier card shall automatically accommodate after- tuning changes in the loop/lead-in in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.21.

Detection of Continuous Traffic Queues. Each amplifier card channel shall provide unlimited detection of continuous traffic without loss of detection in long peak-hour traffic queues. Vehicle movement over the loop shall re-start presence hold time.

Built-in Noise Rejection Circuitry. The amplifier card electronics shall be adequately protected from transient voltages and currents which may occur on both power lines and loop leads.

Loop Detector Amplifier Tests. Each amplifier card shall conform to the performance requirements set forth in NEMA TS 2-2003 v02.06 Section 2.8.

Channel Labeling. A space for labeling each channel shall be provided on the front of each detector card. Each channel shall be labeled with its associated phase.

Delay and Extension Timing. When called for in the plans, the amplifier card shall contain the necessary electronics to provide delayed call and extended call operation. Timing shall be digital and selection of delayed, extension or normal detector operation shall be accomplished via front panel control. Delay and Extension timing shall be settable on a per channel basis with the timing programmed independently. Detector card delay timing capabilities shall be provided in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.24.1. Detector card extension timing capabilities shall be provided in accordance with NEMA TS 2-2003 v02.06 Section 6.5.2.24.2.

Communications. The amplifier card shall be equipped with a front panel RS232 serial port for transmission of data.

Software. The detection device shall be provided with vendor PC software necessary to completely configure the detector sensor and accessory devices. The software shall be capable

of operating on a PC operating system using the communication ports on the detector card(s). The software shall provide access to read or change configuration settings, fault identification, monitor real-time activity, and to retrieve traffic data, if present.

Vendor supplied PC software for interfacing with the amplifier card shall be capable of displaying loop system operating characteristics on a per channel basis, including collecting and sorting speed, volume and occupancy data from each channel.

Loop Detector Amplifiers – Stand Alone Shelf Mounted.

General. These units shall be designed to operate on 115 volts, 60 Hz alternating current. The unit shall be fully operable under voltage ranging from 100 to 134 volts and temperature ranging from -30°F to +165°F and shall not be affected by environmental conditions, altitude or positioning. The unit shall be of digital, solid state construction with printed circuit boards laminated from high quality glass-epoxy materials. Connections shall be made through a 10 pin MS type connector for the single channel and two channel units and a 19 pin MS connector for four channel units. A dust resistant enclosure suitably protected against corrosion and accidental damage to field wiring shall be provided to enclose all electrical parts of the unit.

Specific Requirements. The detector shall be capable of operating loop and lead-in systems with minimum composite inductance ranges from 50 to 1400 microhenries with maximum sensitivity capable of detecting 0.02 percent inductance changes.

Features and Operational Requirements. The unit shall have the following minimum features and operational requirements.

Fully Self-Tuning. The unit shall tune automatically upon the application of power. It shall achieve normal operation and at least 90% of its selected sensitivity within 30 seconds after application of power.

Modes of Operation. Each channel shall be capable of functioning in the following two front panel selectable modes: (a) Presence - When in this mode, the detector channel shall be capable of detecting the presence of a large motorcycle located in a conventional 6-foot x 6-foot, 3-turn loop, and holding the call for at least four minutes. (b) Pulse - A detection output between 75 and 150 milliseconds shall be initiated when a vehicle enters the zone of detection. If a vehicle remains in the zone of detection, the detector shall become responsive within a maximum of 30 seconds to additional vehicles entering the loop.

Sensitivity Switches. Each channel of the detector shall include means to select at least seven (7) levels of sensitivity up to a maximum sensitivity of at least 0.02 percent change in inductance.

Frequency Separation. The unit shall be capable of preventing cross-talk between channels of the same unit by sequential scanning of the various channels, and between separate units by means of a front panel mounted frequency control switch.

Output. Relay, N.O. and N.C. contacts. The relay shall furnish a continuous call in case of power failure, detector failure or an open loop.

Detection Indication. A long life LED or incandescent indicator shall be provided for each channel to give a visual indication of each vehicle detection.

Automatic Drift Compensation. The detector unit shall automatically accommodate those

after-turning changes in the loop as might reasonably occur in undamaged loops, properly installed in sound pavement without producing a false output or change in sensitivity.

Detection of Continuous Traffic Queues. Each channel shall provide unlimited detection of continuous traffic without loss of detection in long peak-hour traffic queues. Vehicle movement over the loop shall re-start presence hold time.

Built-in Noise Rejection Circuitry. The detector electronics shall be adequately protected from transient voltages and currents which may occur on both power lines and loop leads.

Write on Pads. A write on pad for each channel shall be provided on the front of the unit in order to label each channel.

Delay and Extension Timing. When called for in the plans, the detector shall contain the necessary electronics to provide both delayed call and extended call operation. Timing shall be digital and selection of delayed, extension or normal detector operation shall be accomplished via front panel control. Delay timing shall inhibit detector output until presence has been maintained for the time selected. Each new detection shall restart the delay time. Timing adjustment shall be from 0 to 31 seconds in one second increments. The detector shall be capable of disabling delay timing by external means during that detector's associated green phase. External input may be either ground active DC or line voltage AC active. Extension timing shall hold detector output for the period of time selected after the vehicle leaves the loop. Timing adjustments shall be from 0 to 7.75 seconds in 0.25-second increments. The detector shall be capable of disabling extension timing by external means during that detector's associated red phase. External input may be the absence of either ground active DC or line voltage AC active.

Surge Protection. Each detector input circuit shall be equipped with a three terminal surge protection device capable of protecting the detector amplifier against differential mode surges and common mode surges. The unit must withstand six 400 Amp (8 x 20 μs) differential mode surges and six 1000 Amp (8 x 20 μs) common mode surges. The unit shall clamp these surges at 35 volts maximum in less than 40 nanoseconds. Differential capacitance shall be less than 50 picofarads. The unit shall be epoxy encapsulated.

TRAFFIC SIGNAL HEADS

Materials. Traffic signal heads shall consist of all component materials necessary to form heads as specified on the plans and shall be complete with attachments for pole mounting, span wire mounting or mast arm mounting, as indicated, and for tie-ins to the feeder cable.

These signal heads shall meet the requirements of the latest ITE standards for Adjustable Face Vehicle Traffic Control Signal Heads, the National Electrical Code and the MUTCD, where applicable.

No splicing of electric cables will be allowed exterior to the signal head. Quick disconnect hangers will be required where electric cables are too large to enter and leave the normal wire entrance fitting. However, in any signal installation, if one (1) signal head requires quick disconnect hangers, then all heads on that installation shall be furnished with quick disconnect hangers.

Housing.

Materials. Each housing shall be made of one of the following materials:

a) Cast from aluminum alloy. Material for die cast housings shall be aluminum alloy S-12A, S-12B, SC-84A, SC-84B, or SG-100B, conforming to the specifications in ASTM B 85, or the latest revision thereof. Material for permanent mold castings shall be aluminum alloy S-5A or CS-72A conforming to the requirements of and as listed in ASTM B 108.

b) Polycarbonate resin material. Material for this type housing shall be fabricated from corrosion resistant U.V. stabilized polycarbonate resin material. The moldings shall be a minimum of 0.090 inch thick and be ribbed for additional strength at point of high stress. Additional thickness shall be provided as necessary to eliminate light transmission through the housing, door, visor, or back plate. The housing of each section shall be a one-piece, corrosion resistant, molding with integral sides, top and bottom, free of voids, cracks, inclusions, or blow holes.

Features. Each housing shall be furnished with provisions for mounting of a back plate. The top and bottom of the housing shall have an opening two inches (2") in diameter to accommodate standard 1½-inch pipe, with no other opening in the top or bottom of the housing. Individual signal sections shall be fastened together, one above the other into a complete signal face, by means of plated nuts, bolts and washers in such a manner that any section may be rotated about a vertical axis and positioned at an angle with respect to any adjacent section. The opening hub shall have 72 circumferential serrations to secure each section in its orientation, adjustable in five (5) degree increments, and prevent its inadvertent rotation. A minimum 6-position labeled barrier terminal block shall be provided in each signal face for the purpose of field connections. The barrier terminal shall be installed in the circular yellow or yellow arrow section of each signal face. If the face has both of these sections, the terminal block shall be installed in the circular yellow section. There shall be provisions for the attachment of a 3/16-inch tether line to the bottom of each span wire mounted signal head. A pinnacle shall be provided to close all 1½-inch holes in each housing that will not otherwise be sealed from the weather when installed with the specified mounting hardware.

Door. Each door shall be made of a material that is one of the above materials and that is compatible with the material of the housing, except that doors for plastic housings shall be

plastic. The outer face of the door shall have four (4) holes equally spaced about the circumference of the lens opening to accommodate the secure mounting of the signal head tunnel visor. The visor shall fit flush against the door and no light shall leak between the door and the visor. Two (2) stainless steel hinge pins shall attach the door to the housing, one (1) in the upper left corner and one (1) in the lower left corner of the door. Two (2) stainless steel wing screws, one (1) in the upper right corner and one (1) in the lower right corner of the door, shall be used for opening the door and closing it tight against the housing. The wing screws shall be installed through the door with keepers to prevent their accidental removal or falling out. The removal of the hinge pins and the operation of the wing screws shall not require the use of tools.

Optical System. The optical system shall consist of LED signal modules that shall be sealed units comprised of an outer lens, an optical lens, a printed circuit board for LEDs and entirely enclosed power supply, a back cover and a gasket.

The assembly and manufacturing process for the LED signal modules shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources as per MIL-STD-883.

The LED signal module shall be rated for use in the ambient operating temperature range of -40°F to +165°F.

The LED signal module lens shall be UV stabilized and shall have a uniform incandescent, non-pixilated appearance.

The light distribution of each LED shall be maximized by an internal beam controlling optical faceted lens designed and patented to meet the 44 points measurement of the VTCSH standard, Part 2. The outer cover made of ultraviolet stabilized polycarbonate shall be convex with a smooth outer surface and be an integral part of the module.

The chip in the ultra-bright 1/5-inch LEDs shall be made using AlInGaP for red and amber, and InGaN technology for the green, and be rated for 100,000 hours of continuous operation by the LED manufacturer.

Enclosures containing either the power supply or electronic components of the signal module shall be made of UL94VO flame retardant materials.

The measured chromaticity coordinates of LED signal modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard. The LED manufacturers indicate the following X-Y coordinates for their respective LEDs. The X value for red LEDs varies from 0.690 to 0.708 and the Y value varies from 0.292 to 0.306. The value X for amber LEDs varies from 0.554 to 0.575 and the Y value varies from 0.424 to 0.445. The X value for the green LEDs varies from 0.1090 to 0.1138 and the Y value varies from 0.5673 to 0.5830.

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH standard. Two (2) secured, color-coded, three feet (3') long, 600 V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +221°F, shall be provided for electrical connection.

The module shall operate on a 60 Hz AC line voltage ranging from 80 volts rms to 135 volts rms with less than ten percent (10%) light intensity variation. Nominal rated voltage for all measurements shall be 120±3 volts rms. The circuitry shall prevent flickering over this

voltage range.

The individual LEDs shall be wired so that a catastrophic failure of one (1) LED will result in the loss of only that one (1) LED, and not the entire string of LEDs or the entire module.

The power supply must permit the regulation of the current supplied to the LEDs to maintain a constant current.

The LED signal and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Sub-Part B, Section 15 regulations concerning the emission of electronic noise.

The LED signal module shall provide a power factor of 0.90 or greater at 77°F and at the nominal operating voltage.

Total harmonic distortion (THD), current and voltage, induced into an AC power line by a signal module shall not exceed twenty percent (20%), over the operating voltage range specified in Section 14 and within the ambient temperature range specified in Section 4.

The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS 2, 1992.

The LED signal module shall operate from a 60±3 Hz ac line power over a voltage range from 80 VAC rms to 135 VAC rms. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units the procuring traffic authority customer has in use. Load switches shall be compatible with NEMA TS 1 or later, or Model 170-1989 or later.

All LED signal modules shall be energized for a minimum of 24 hours, at 100 percent on-time duty cycle, in an ambient temperature of 140°F.

Each socket shall be provided with one (1) black lead from the socket and one (1) white lead from the shell. Terminal blocks shall be a 6-position, 12-block, terminal barrier strip placed in the top or red section of all traffic signal heads. Terminal blocks shall be secured on both ends

The manufacturer shall warranty the LED module for a minimum of five (5) years. The LED modules shall be replaced if the module fails to function as intended due to workmanship or material defects or if the module exhibits luminous intensities less than the minimum specified values within the first five (5) years from the date of delivery.

Visors. Each signal door shall be fitted with a tunnel visor. Eight-inch signals shall have visors a minimum of seven (7) inches long, 12-inch signals shall have visors a minimum of nine and one half (9 ½) inches long. The outside of the visor shall be black or federal yellow as directed by Engineer. The inside of the visor shall be flat black. The visors shall be attached to the door at four (4) equally spaced locations with four (4) placed screws or four (4) bayonet type self-locking tabs integrally formed with the visor. Visors for polycarbonate signal heads shall be made of a corrosion resistant polycarbonate resin at least 0.100 inch thick. Visors for metal signal heads shall be made from 0.064-inch minimum thickness aluminum alloy sheet.

Back Plate. Each signal head assembly shall be equipped with a back plate with a minimum width of five (5) inches with radius corners. Steel rivets shall be provided for mounting to the

signal housing. All back plates shall be fabricated from a one (1) piece vacuum formed corrosion resistant, flat polycarbonate resin material at least 0.125 inch thick or 0.064-inch minimum thickness aluminum alloy sheet.

Where specified in the plans, a 2-inch retroreflective yellow tape shall border the back plates.

Lenses. Traffic signal lenses shall be circular, red, yellow, or green in color, and 8-inch or 12-inch nominal diameter, as shown on the plans. No legend shall be permitted. Arrow lenses shall be circular, 12 inches in diameter, green or yellow in color, and be opaque except for the arrow legend. The lenses shall conform to all the applicable sections of the latest edition of ITE's Standard on Adjustable Face Vehicular Traffic Control Signal Heads.

Mounting Hardware. Span wire suspension fitting with cable entrance shall be a one-piece malleable iron casting, minimum wall thickness of 3/16 inch, and free of flash and voids. The cable entrance shall have a plastic bushing with a minimum inside diameter of one and one-quarter inches (1¼"). The suspension fitting shall provide six (6) separate, clevis pin positions for balancing the signal assembly. The thickness of the solid casting in this suspension area shall be a minimum of 5/8 inch. A hex head threaded malleable iron lock nipple shall be provided for attaching the signal head to the bottom of the suspension fitting for one face signals or to the top bracket of multiface signal brackets. The mounting hardware for each signal face shall include a nylon, serrated, 72-tooth lock ring with full locking pins and a circular neoprene gasket for weather sealing.

Span wire suspension clamp assembly, consisting of a galvanized, malleable iron span wire clevis saddle, 5/8-inch diameter plated steel clevis pin with cotter key, two (2) ½-inch plated steel "U" bolts with nuts and washers, no "J" bolts are permitted, and a galvanized malleable iron cable locking bar, all fitted for 3/8-inch guy span. Galvanizing is to meet ASTM A 153.

Brackets shall consist of a malleable iron center outlet body, schedule 40 pipe, elbows, serrated fittings, and other hardware as required to provide a multi-face signal head assembly with internal wiring raceways to each face as specified.

Color, Finish and Painting. Polycarbonate resin hardware shall have color impregnated throughout the material. The finish shall be smooth and unflawed. All metal hardware, except those specified as galvanized, plated, or stainless steel shall be painted with a primer coat and a finish coat of the best quality oven baked enamel. Lenses, reflectors, gaskets and polycarbonate parts shall not be painted. The following signal head parts shall be colored either black or federal yellow as directed by Engineer: Vehicle Head: Housing; Door; Tunnel Visor; Back Plate; and Pole Bracket.

Traffic Signal Heads - Optically Programmed. Optically programmed traffic signal heads shall be so constructed, programmed, and operable, as to limit the visibility of the indication exclusively to the area where it is desirable that the indication be seen. This is to be accomplished with a built-in High Resolution Optical System designed for the purpose and can be accomplished by an arrangement of hoods, louver, or other external means as directed by the plans or Engineer.

Pedestrian Signal Heads. Pedestrian signal heads shall consist of all component materials necessary to form heads as specified in the plans and shall be complete with attachments for pole or post mounting. Heads shall conform to the applicable parts of the MUTCD.

Single section pedestrian heads shall be constructed of die cast aluminum. The housing shall be painted black or federal yellow as directed by the plans or Engineer. The housing and

door shall be designed such that when properly assembled, they shall provide a waterproof and dustproof enclosure. All screws, bolts, hinge pins and other necessary fasteners shall be stainless steel. Prior to assembly, the housing and door frame shall be painted with one (1) coat of primer and two (2) coats of enamel. Color shall be black or federal yellow as directed by the plans or Engineer.

An "egg crate" or "Z" crate type visor constructed of 0.030-inch minimum thickness and 100% impregnated black polycarbonate strips shall be provided with the signal head. The visor assembly shall be at least 1½ inches deep and shall be bordered by a 0.040-inch minimum aluminum frame.

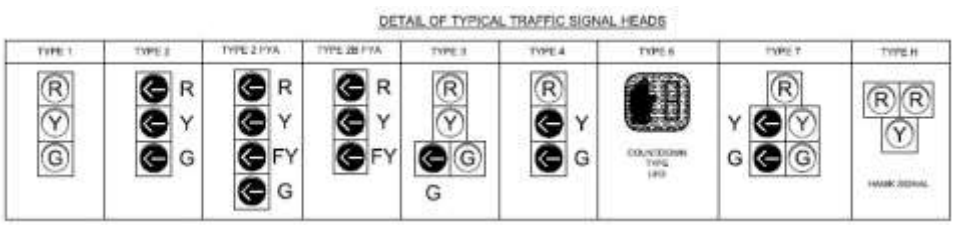
The design, manufacture and testing of lenses shall conform to the parts concerning "Traffic Signal Lenses" as set forth in "A Standard for Adjustable Face Traffic Control Signal Heads" as published by the Institute of Transportation Engineers. Individual letters of the legend shall be 4½ inches high. The LED signal module lens shall be UV stabilized and shall have a uniform incandescent, non-pixilated appearance

All pedestrian signal heads shall be “Countdown Type” and meet the requirements of the MUTCD. All pedestrian signal heads shall be LED modules fully compliant to the latest adopted version as listed, at time of bid, ITE PTCSI Part-2: LED Pedestrian Traffic Signal Modules. Additionally, prior to bid award, the manufacturer shall submit to purchaser, reports from ETL/Intertek that certify full compliance of LED signal modules, to these specifications. Evidence of full compliance to all required testing methods, procedures and sections as outlined in the above ITE document Attachment 2, “Design Qualification Testing Flow Chart” shall be included without any exceptions, changes or omissions. The manufacturer shall also submit a data sheet showing the exact catalog number of the items submitted on the bid and the Independent Lab report must show full qualification of this catalog number. Combination hand/person pedestrian signal modules shall incorporate separate power supplies for the hand and the person icons.

The manufacturer shall warranty the LED module for a minimum of five (5) years. The LED modules shall be replaced if the module fails to function as intended due to workmanship or material defects or if the module exhibits luminous intensities less than the minimum specified values within the first five (5) years from the date of delivery.

Pedestrian Signal Heads - Optically Programmed. Optically programmed pedestrian signal heads shall be constructed, programmed, and operable as to limit the visibility of the indication exclusively to the area where it is desirable that the indication be seen.

This shall be accomplished with a built-in High Resolution Optical System designed for the purpose and is not to be accomplished by an arrangement of hoods, louvers or other external means.



FLASHING BEACONS

Operational Specifications. The two flashers on the flasher assembly shall alternate on and off when receiving a signal from the traffic controller. The flasher assembly shall have beacons that flash at a rate of not less than 50 or more than 60 times per minute. The illuminated period of each flash shall not be less than 50% of the dwell time. The yellow signals shall be flashed alternately. The beacons shall have a night dimming feature.

The School Zone Flasher Beacon assembly shall be activated by an integrated, programmable microcontroller (Time Switch Unit). The Time Switch Unit shall store at least 500 days of flash data.

Materials. Materials for the assembly shall meet the requirements set forth in the Traffic Signal Heads and Traffic Signal Pull Boxes sections of this specification.

Solar/Battery Unit. All solar/battery units associated with flasher assemblies shall include two (2) 10-watt solar panels no larger than the footprint of the housing. The solar engine shall house two (2) field-replaceable, sealed lead-acid batteries no greater than 24 Ah each. The solar panel and battery system shall be 12 Volt DC. The solar panel shall meet the design qualification and type approval of photovoltaic modules in accordance with IEC 61215. This specification includes radiation testing, thermal testing, and mechanical testing for environmental conditions such as UV-exposure, thermal cycling, as well as degradation of maximum power output.

Solar Engine. All solar engine units associated with Flasher Assemblies shall be constructed from powder coated aluminum. The solar panels shall be integrated into the solar engine. The solar engine shall have the provision to mount an external device for remote activation. The system shall have the capability to power such device. The solar engine must contain sufficient space to house a third party device inside a sealed enclosure located inside the solar engine.

Time Switch Unit. All time switch units associated with School Flasher Assemblies shall be of solid state circuitry, continuous duty with a 7-day cycle clock operating from the 120 volt AC service line. Time switch unit shall automatically compensate for daylight savings time changes.

Hardwired option. Flasher assemblies shall have the option to operate on 120 volt AC electrical service.

EMERGENCY VEHICLE PREEMPTION SYSTEMS

Description. This item consists of providing Railroad Signal Preemption, Type 1 and Type 2 Emergency Vehicle Preemption for the traffic signal controller in accordance with Plan details, the Standard Specifications, these specifications, and as directed by the Engineer.

The Type 1 Emergency Vehicle Preemption for the traffic signal controller shall use optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from phases normally available.

The Type 2 Emergency Vehicle Preemption for the traffic signal controller shall utilize Radio/GPS to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from phases normally available.

A confirmation lights and rotating beacons shall be utilized to indicate the activation of preemption call. The system shall initiate beacons indicating a priority call has been received. The system shall initiate a confirming steady white light to the approach direction from which the vehicle is approaching once the desired priority display has been received. The beacon and confirming white light shall remain energized until the preemption call is dropped.

Materials. All connections and equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance of the emergency vehicle and railroad signal preemption systems.

Type 1 Emergency Vehicle Preemption. Emergency Vehicle Preemption Systems shall consist of the following principal Intersection Equipment components: Detectors/Receivers, Multimode Phase Selectors, and Auxiliary Interface Panel. The function intended for use with this system includes Emergency Vehicle Preemption to the traffic signal.

Vehicle Equipment.

Emitter. The emitter shall include a multi-purpose communication port compliant with the SAE J1708 communication standard. This port shall enable unit configuration to be set into the emitter and read from the emitter. It also shall allow real- time communication between the vehicle and the emitter.

An ON/OFF switch (available for each emitter) shall be equipped with an indicator light providing internal diagnostics to assist in troubleshooting.

While operating, the emitter shall conduct self-diagnostics designed to monitor data transmission integrity by checking for missing pulses. Any failures of the self-diagnostic tests shall be displayed by flashing of the ON/OFF switch indicator light.

The emitter shall be equipped with a disabling input that, when activated, will cause the emitter to stop flashing. This input shall eliminate the possibility of inadvertent signal transmission after the priority vehicle has arrived at its destination. The disable input shall be programmable to operate in either a latching or non-latching mode. Operation of the disable input shall be programmable using software.

The emitter shall provide operating modes that allow it to be powered on with the strobe/LEDs

for activation of the preempt.

The emitter shall be powered by the DC voltage supplied from the battery of the vehicle, 10 to 32 volts DC.

The unit shall be equipped with a weatherproof in-line fuse holder and a weatherproof quick-disconnect plug.

The emitter shall contain visible light LEDs which may be user configured as follows:

- Flash at emitter flash rate during normal operation.
- Flash at diagnostic rate when unit has failed or is in disable mode.
- Off during normal operation, flash at diagnostic rate when unit has failed or is in Disable mode. The visible LEDs will be Off during normal operation.
- Flash once per second for ten (10) seconds at power up.
- Always Off: The visible LEDs will remain Off at all times.

The Emitter shall be supplied complete with a two (2) foot installation cable.

The flash sequence generated by the emitter shall carry three (3) types of information:

- The first type shall be one (1) of three (3) distinctly different base frequencies of:
  - 10Hz for a low priority emitter;
  - 14Hz for a high priority emitter; or
  - 12Hz for Probe frequency.
- The second type of information generated by the emitter shall be a vehicle classification and identification code that is interwoven into the base frequency flashes. Setting the vehicle classification and identification code shall be accomplished through Emitter Programming Software.
- The third type of information generated by the emitter shall be reserved for setting the intersection detection range. A specially equipped emitter control module with a range setting command switch will enable the Engineer to activate the range code from the vehicle.

The emitters shall use infrared LEDs with an angle of half intensity of ±10 degrees to provide precise directionality control. The emitter shall operate over a temperature range of -30°F to +165°F. The emitter shall operate over a relative humidity range of 5% to 95%. Windows™ based software shall be available at no charge for programming the emitter through its SAE J1708 compatible multi-purpose port.

Intersection Equipment.

Multimode Phase Selector. The multimode phase selector recognizes inputs from both infrared and Radio/GPS activation methods at the intersection and supplies coordinated inputs to the controller.

The multimode phase selector shall be designed to be installed in the traffic controller cabinet and is intended for use directly with numerous controllers. These include Type 170/2070 controllers with compatible software, NEMA controllers, or other controllers along with the system card rack and suitable interface equipment and controller software.

The multimode phase selector shall include the ability to directly sense the green traffic controller signal indications through the use of dedicated sensing circuits and wires connected

directly to field wire termination points in the traffic controller cabinet. This connection shall be made using the Auxiliary Interface Panel.

The multimode phase selector will be a plug-in, 4-channel, multiple-priority, multi-modal device intended to be installed directly into a card rack located within the controller cabinet. The multimode phase selector shall be capable of using existing infrared or Radio/GPS system card racks. The multimode phase selector shall be powered from either +24 VDC or 120 VAC.

The multimode phase selector shall support front-panel RS-232, USB and Ethernet interfaces to allow management by on-site interface software and central software. An RS-232 port shall be provided on the unit. Additional RS-232 communication ports shall be available using the Auxiliary Interface Panel.

The multimode phase selector shall have the capability of storing a minimum of 10,000 priority control calls. When the log is full, the phase selector shall drop the oldest entry to accommodate the new entry. The multimode phase selector shall store each call record in non-volatile memory and shall retain the record if power terminates.

The multimode phase selector shall support a minimum of 5,000 code pairs (agency ID, vehicle ID) for each of the priority levels, high and low, providing unique vehicle identification and system security implementation at the vehicle level.

The multimode phase selector shall include several programmable control timers that will limit or modify the duration of a priority control condition, by channel. The control timers will be as follows:

- Max call time
- Off approach call hold time
- Lost signal call hold time
- Call delay time

The multimode phase selector shall have the ability to enable or disable all calls of all priority levels. This shall be independently settable by channel.

A unique intersection name, which shall be broadcast, shall be settable for each Multimode Phase Selector.

Up to 25 different radio channels shall be available to be assigned to the multimode phase selector.

The multimode phase selector shall operate in a mode that shall vary the output based on the status of the approaching vehicle's turn signal. Additional outputs available on an auxiliary interface panel may be needed. Settings shall be available for this mode as follows:

- Output mappings for each channel.
- Separate setting for high and low priority levels.
- Separate settings for each left turn, right turn or straight signal status for each of the four (4) channels and priority levels.

The multimode phase selector's default values shall be programmable by the operator on- site or at a remote location.

The multimode phase selector shall be capable of three (3) levels of signal discrimination, as follows:

- Verification of the presence of the signal of either high priority or low priority.
- Verification that the vehicle is approaching the intersection within a prescribed Estimated Time of Arrival (ETA).
- Determination of when the vehicle is within the prescribed range, either by intensity level or distance from the intersection.

The multimode phase selector shall include one (1) opto-isolated NPN, or sinking, output per channel that provides the following electrical signal to the appropriate pin on the card edge connector:

- 6.25Hz ±0.1Hz 50% on/duty square wave in response to a low priority call.
- A steady ON in response to a high priority call.
- The multimode phase selector will also have the option of providing separate outputs for High and Low priority calls for controllers that do not recognize a 6.25 Hz pulsed low priority request.
- Additional outputs or output modes shall also be available on the Auxiliary Interface Panel in case of need for additional modes of operation.

The multimode phase selector shall accommodate the following three (3) methods for setting range thresholds for High and Low priority signals.

- Based on the approaching vehicle's Estimated Time of Arrival (ETA). This shall be settable between zero (0) and 255 seconds in one (1) second increments.
- Based on the approaching vehicle's distance from the intersection. This shall be settable in one (1) foot increments.
- Based on emitter intensity the system shall accommodate setting a separate range from 200 feet to 2,500 feet with range set points for both High and Low priority signals.

The multimode phase selector will have the following indicators:

- A status indicator that illuminates steadily to indicate proper operation.
- A link indicator on the multimode phase selector illuminates if other radios are within range.
- A radio indicator that indicates the status of the communication between the vehicle control unit and the Radio/GPS unit. The indicator illuminates to indicate that there is communication between the vehicle control unit and the Radio/GPS unit. The indicator illuminates to indicate that a GPS signal has been acquired and the 2.4 GHz radio is on the air.
- LED indicators (one (1) for high priority, one (1) for low priority) for each channel display active calls as steady ON and pulse to indicate pending preemption requests.

The multimode phase selector shall have a test switch for each channel to test proper operation of High or Low Priority.

The multimode phase selector shall utilize the time obtained from the GPS satellites to time stamp the activity logs. The user will set the local time zone (offset from GPS time) via the interface software.

The interface software shall have the capability to set the multimode phase selector to automatically adjust the GPS time offset for changes in daylight savings time.

An auxiliary interface panel shall be available to facilitate interconnections between the multimode phase selector and traffic cabinet wiring as well as provide additional outputs.

A multimode phase selector port may be configured to output GPS data at a user selectable baud rate in the NMEA 0183format. It will output the following messages depending on the baud rate:

- GGA - Global Positioning System Fix Data (2400 baud and higher)
- GSA- GPS DOP and active satellites (2400 baud and higher)
- GSV - Satellites in view (4800 baud and higher)
- RMC - Recommended Minimum Navigation Information (1200 baud and higher)

The following diagnostic tests are incorporated in the multimode phase selector:

- Power up built in test
- Communications port tests
- Preemption output test call
- Detector response test

The multimode phase selector shall be capable of call bridging.

When used with a GPS radio unit, the multimode phase selector shall relay a priority request to the next adjacent intersection based on the direction indicated by the vehicle's turn signals.

The multimode phase selector shall support evacuation mode for Low priority calls. The

multimode phase selector shall allow relative priority.

Card Rack. The required card rack shall provide simplified installation of a multimode phase selector into controller cabinets that do not already have a suitable card rack.

The card rack shall be factory wired with one (1) connector, located behind the card slot, and one (1) connector on the front of the card rack.

The card rack connector on the front shall provide for connections to the traffic controller.

The Contractor shall verify card rack requirements with the Engineer prior to submitting this equipment.

One (1) version of the card rack shall contain a 24 VDC power supply to power the phase selector. The power supply shall be capable of being powered by 100-240 VAC 50-60 Hz.

Another version of the card rack shall pass 120 VAC through to the rear card rack connector. This version shall provide labeled terminal blocks for connecting the primary infrared detectors to a phase selector.

Additionally, there shall be an optional card rack with a built-in Electromechanical Relay for use in switching high current loads such as flashers and gate operators. The relay shall be capable of switching the following loads.

Resistive:	10 A, 240 VAC 10 A, 30 VDC	General Use:	7.5 A, 120 VAC 7.5 A, 240 VAC 7 A, 30 VDC 1/6 hp, 120 VAC 1/3 hp, 240 VAC

Optical Detector.

General. The optical detector shall be a light-weight, weather proof device capable of sensing and transforming pulsed optical energy into electrical signals for use by the traffic signal phase selection equipment.

Functional Requirements. The optical detector unit shall perform the following functions and meet the requirements listed below.

a) The unit shall be high-impact polycarbonate construction with stainless steel and/or brass hardware. The unit shall be designed for easy mounting at or near an intersection on mast arm, pedestal, pole, or intersection span wire.
b) The unit shall accept optical signals from one (1) or two (2) directions and provide a single electrical output signal, as specified in the plans. The unit shall include a design feature to allow aiming of the two optical sensing inputs for hills, skewed approaches or slight curves.
c) The unit shall have built-in terminal strip to simplify wiring connections. The unit shall receive power from the traffic signal phase selector equipment and have internal voltage regulation to be operational from 16 to 40 volts AC.
d) The unit shall be responsive to the optical emitter at a distance of 1,800 feet. The unit shall deliver the necessary electrical signal to the traffic signal phase selector equipment via up to 1,000 feet of optical detector cable.
e) The unit shall employ replacement circuit board assembly and photocells to facilitate repair.

Optical Detector Cable. The optical detector cable shall meet the requirements listed below.

(a) The cable shall guarantee delivery of the necessary quality signal from the optical detector to the traffic signal phase selector equipment over non-spliced distance of 1,000 feet. The cable shall guarantee sufficient power to the optical detector over a non-spliced distance of 1,000 feet.
(b) The cable shall be of durable construction for installation by direct burial, in conduit or mast arm, or exposed overhead supported by messenger wire. The weight of the cable shall have a minimum insulation rating of 600 volts and a temperature rating of 80°C.
(c) The cable shall have three (3) conductors of AWG 20 stranded, individually tinned copper color coded as follows.

1. Orange for delivery of optical detector power (+)
2. Blue for optical detector power return (-)
3. Yellow for optical detector signal

The conductors will be shielded with aluminized polyester and have an AWG #20 stranded and individually tinned drain wire to provide signal integrity and transient protection. The shield wrapping shall have 20% overlap to ensure integrity following conduit and mast arm pulls.

Electrical and Environmental Requirements. All equipment supplied as part of the priority control system intended for use in the controller cabinet shall meet the following electrical and environmental specifications spelled out in the NEMA Standards Publication TS 2-2003, Part 2: v02.06:

- Line voltage variations per NEMA TS 2-2003, Paragraph 2.1.2.
- Power source frequency per NEMA TS 2-2003, Paragraph 2.1.3.
- Power source noise transients per NEMA TS 2-2003, Paragraph 2.1.6
- Temperature range per NEMA TS 2-2003, Paragraph 2.1.5
- Humidity per NEMA TS 2-2003, Paragraph 2.1.5
- Shock test per NEMA TS 2-2003, Paragraph 2.2.9.
- Vibration per NEMA TS 2-2003, Paragraph 2.2.8
- Non-Destructive Transient immunity NEMA TS 2-2003, Paragraph 2.1.8.
- Input-output terminals NEMA TS 2-2003, Paragraph 2.1.7.
- FCC Part 15 Subpart B Class A EMC Standard
- Canada ICES-003, Issue 4:2004 Class A EMC Standard
- EN50293: 2000 Electromagnetic Compatibility–Road Traffic Signal Systems– Product Standard.
- EN 61326-1:2006 EMC Standard.
- EN 55011:2007 +A2:2007 EMC Standard.

Type 2 Emergency Vehicle Preemption. Emergency Vehicle Preemption Systems shall consist of the following principal Intersection Equipment components: Detectors/Receivers, Multimode Phase Selectors, and Auxiliary Interface Panel. The function intended for use with this system includes Emergency Vehicle Preemption to the traffic signal.

Vehicle Equipment.

Vehicle Control Unit. The vehicle control unit shall provide the interface between the vehicle and the priority control system. The vehicle control unit shall also interface with the Radio/GPS module. The vehicle control unit shall monitor the status of the vehicle turn signal via an interface cable that will connect between the vehicle control unit and the left and right turn signal lines in the vehicle. The vehicle control unit shall also monitor the disable input line as well as the remote activation input. Power to the vehicle equipment shall be provided through the vehicle control unit.

The vehicle shall transmit the following information when within range of an equipped intersection:

- The priority level of the vehicle equipment. This shall be either high priority or low priority. The priority level shall be factory set. Each vehicle control unit shall be capable of setting 254 different agency IDs and 15 different vehicle type classifications with 9,999 different identification numbers per class.
- The location, speed and heading of the vehicle.
- The status of the vehicle's turn signal.

- The radio channel as assigned by the intersection and the serial number of the Vehicle Control Unit.

The vehicle shall be capable of being wired so that the GPS data is available either while the equipment is requesting priority or when not requesting priority. The vehicle control unit shall be equipped with an ON/OFF switch to activate the system and request priority. The switch shall be depressed to activate the system. In addition, a remote activation line shall be provided to interface with other vehicle equipment. This line shall have +12 VDC applied to request priority. The equipment shall be configured to activate with the light bar/remote activation line or via the ON/OFF switch.

The vehicle equipment shall be supplied complete with a 20-foot minimum installation cable as well as a 15-foot minimum vehicle interface cable.

The vehicle control unit shall include multi-purpose communication ports compliant with the RS-232 communication standard. These ports shall enable unit configuration to be set into the vehicle control unit and read from vehicle control unit. It also shall allow real- time communication between the vehicle control unit and the interface computer as well as interfacing with other devices. One of the ports shall be configured to output GPS data at a user selectable baud rate in the NMEA format while the vehicle control unit is turned On. It shall output the following messages (depending on the baud rate):

- GGA Global Positioning System Fix Data (2400 baud and higher)
- GSA GPS DOP and active satellites (2400 baud and higher)
- GSV Satellites in view (4800 baud and higher)
- RMC Recommended Minimum Navigation Information (1200 baud and higher)

The vehicle control unit shall also have a series of indicator lights that will operate as follows:

- A power indicator as well as an indicator light in the switch will indicate that the equipment is powered On.
- A GPS indicator will indicate the status of GPS reception.
- An indicator will indicate the status of the communication between the vehicle control unit and the Radio/GPS unit.
- A disable indicator will indicate if the vehicle equipment is in a Disable mode. The disable indicator and the indicator in the power switch will flash green or any other color as approved by the Engineer.
- The indicators shall be capable of being programmed to provide feedback for the following:
    - Phase selector has received preemption request.
    - Another vehicle approaching the intersection has received the preemption request.
    - Phase selector has received preemption request and another equipped vehicle is approaching the intersection from another direction.

The vehicle control unit shall be equipped with a disable input that, when activated, will cause the radio to transmit that the vehicle is in Disable mode, thereby eliminating the possibility of the priority request continuing after the priority vehicle has arrived at its destination. The disable input shall be programmable to operate in either a latching or non- latching mode. The disable input shall be programmed so that the input may be activated by applying ground or by applying +12 VDC. Operation of the disable input shall be programmable using

software. Additional inputs shall be included to temporarily switch the vehicle control unit to low priority and to Probe Mode. The vehicle equipment shall operate over a temperature range of -30ºF to 165ºF and a relative humidity range of 5% to 95%. Windows™ based software shall be available for programming the vehicle control unit through its RS-232 compatible multi-purpose port.

Antenna. A GPS receiver and antenna shall obtain the vehicle position, speed and heading from the GPS satellite system operated by the Department of Defense (DOD). The time information from the GPS satellites shall also be used to synchronize the frequency hopping of the 2.4 GHz radio.

The Radio/GPS antenna cables shall consist of a pair of 25-foot coax cables with factory terminated SMA connectors. One of these connectors shall have a pin and the other shall have a socket.

Radio. The Radio shall operate in the reserved Industrial, Scientific and Medical (ISM) communications band, requiring no license. A 2.4 GHz spread spectrum/frequency hopping radio shall provide the communications from the vehicle to the intersection when within range of a Radio/GPS equipped intersection. The radio shall have a transmit power of not more than one (1) watt. The radio shall have an unobstructed range of at least 2,500 feet. The radio shall meet FCC Part 15 rules. Radio link association and coordination among intersections and vehicles shall be automatic.

Intersection Equipment.

Multimode Phase Selector. The multimode phase selector recognizes inputs from both infrared and Radio/GPS activation methods at the intersection and supplies coordinated inputs to the controller.

The multimode phase selector shall be designed to be installed in the traffic controller cabinet and is intended for use directly with numerous controllers. These include Type 170/2070 controllers with compatible software, NEMA controllers, or other controllers along with the system card rack and suitable interface equipment and controller software.

The multimode phase selector shall include the ability to directly sense the green traffic controller signal indications through the use of dedicated sensing circuits and wires connected directly to field wire termination points in the traffic controller cabinet. This connection shall be made using the Auxiliary Interface Panel.

The multimode phase selector will be a plug-in, 4-channel, multiple-priority, multi-modal device intended to be installed directly into a card rack located within the controller cabinet. The multimode phase selector shall be capable of using existing infrared or Radio/GPS system card racks. The multimode phase selector shall be powered from either +24 VDC or 120 VAC.

The multimode phase selector shall support front-panel RS-232, USB and Ethernet interfaces to allow management by on-site interface software and central software. An RS-232 port shall be provided on the unit. Additional RS-232 communication ports shall be available using the Auxiliary Interface Panel.

The multimode phase selector shall have the capability of storing a minimum of 10,000 priority control calls. When the log is full, the phase selector shall drop the oldest entry to accommodate the new entry. The multimode phase selector shall store each call record in

non-volatile memory and shall retain the record if power terminates.

The multimode phase selector shall support a minimum of 5,000 code pairs (agency ID, vehicle ID) for each of the priority levels, high and low, providing unique vehicle identification and system security implementation at the vehicle level.

The multimode phase selector shall include several programmable control timers that will limit or modify the duration of a priority control condition, by channel. The control timers will be as follows:

- Max call time
- Off approach call hold time
- Lost signal call hold time
- Call delay time

The multimode phase selector shall have the ability to enable or disable all calls of all priority levels. This shall be independently settable by channel.

A unique intersection name, which shall be broadcast, shall be settable for each Multimode Phase Selector.

Up to 25 different radio channels shall be available to be assigned to the multimode phase selector.

The multimode phase selector shall operate in a mode that shall vary the output based on the status of the approaching vehicle's turn signal. Additional outputs available on an auxiliary interface panel may be needed. Settings shall be available for this mode as follows:

- Output mappings for each channel.
- Separate setting for high and low priority levels.
- Separate settings for each left turn, right turn or straight signal status for each of the four (4) channels and priority levels.

The multimode phase selector's default values shall be programmable by the operator on- site or at a remote location.

The multimode phase selector shall be capable of three (3) levels of signal discrimination, as follows:

- Verification of the presence of the signal of either high priority or low priority.
- Verification that the vehicle is approaching the intersection within a prescribed Estimated Time of Arrival (ETA).
- Determination of when the vehicle is within the prescribed range, either by intensity level or distance from the intersection.

The multimode phase selector shall include one (1) opto-isolated NPN, or sinking, output per channel that provides the following electrical signal to the appropriate pin on the card edge connector:

- 6.25Hz ±0.1Hz 50% on/duty square wave in response to a low priority call.
- A steady ON in response to a high priority call.
- The multimode phase selector will also have the option of providing separate outputs

for High and Low priority calls for controllers that do not recognize a 6.25 Hz pulsed low priority request.
- Additional outputs or output modes shall also be available on the Auxiliary Interface Panel in case of need for additional modes of operation.

The multimode phase selector shall accommodate the following three (3) methods for setting range thresholds for High and Low priority signals.

- Based on the approaching vehicle's Estimated Time of Arrival (ETA). This shall be settable between zero (0) and 255 seconds in one (1) second increments.
- Based on the approaching vehicle's distance from the intersection. This shall be settable in one (1) foot increments.
- Based on emitter intensity the system shall accommodate setting a separate range from 200 feet to 2,500 feet with range set points for both High and Low priority signals.

The multimode phase selector will have the following indicators:

- A status indicator that illuminates steadily to indicate proper operation.
- A link indicator on the multimode phase selector illuminates if other radios are within range.
- A radio indicator that indicates the status of the communication between the vehicle control unit and the Radio/GPS unit. The indicator illuminates to indicate that there is communication between the vehicle control unit and the Radio/GPS unit. The indicator illuminates to indicate that a GPS signal has been acquired and the 2.4 GHz radio is on the air.
- LED indicators (one (1) for high priority, one (1) for low priority) for each channel display active calls as steady ON and pulse to indicate pending preemption requests.

The multimode phase selector shall have a test switch for each channel to test proper operation of High or Low Priority.

The multimode phase selector shall utilize the time obtained from the GPS satellites to time stamp the activity logs. The user will set the local time zone (offset from GPS time) via the interface software.

The interface software shall have the capability to set the multimode phase selector to automatically adjust the GPS time offset for changes in daylight savings time.

An auxiliary interface panel shall be available to facilitate interconnections between the multimode phase selector and traffic cabinet wiring as well as provide additional outputs.

A multimode phase selector port may be configured to output GPS data at a user selectable baud rate in the NMEA 0183format. It will output the following messages depending on the baud rate:

- GGA - Global Positioning System Fix Data (2400 baud and higher)
- GSA- GPS DOP and active satellites (2400 baud and higher)
- GSV - Satellites in view (4800 baud and higher)
- RMC - Recommended Minimum Navigation Information (1200 baud and higher)

The following diagnostic tests are incorporated in the multimode phase selector:

- Power up built in test
- Communications port tests
- Preemption output test call
- Detector response test

The multimode phase selector shall be capable of call bridging.

When used with a GPS radio unit, the multimode phase selector shall relay a priority request to the next adjacent intersection based on the direction indicated by the vehicle's turn signals.

The multimode phase selector shall support evacuation mode for Low priority calls. The

multimode phase selector shall allow relative priority.

Card Rack. The required card rack shall provide simplified installation of a multimode phase selector into controller cabinets that do not already have a suitable card rack.

The card rack shall be factory wired with one (1) connector, located behind the card slot, and one (1) connector on the front of the card rack.

The card rack connector on the front shall provide for connections to the traffic controller. The Contractor shall verify card rack requirements with the Engineer prior to submitting this equipment.

One (1) version of the card rack shall contain a 24 VDC power supply to power the phase selector. The power supply shall be capable of being powered by 100-240 VAC 50-60 Hz.

Another version of the card rack shall pass 120 VAC through to the rear card rack connector. This version shall provide labeled terminal blocks for connecting the primary infrared detectors to a phase selector.

Additionally, there shall be an optional card rack with a built-in Electromechanical Relay for use in switching high current loads such as flashers and gate operators. The relay shall be capable of switching the following loads.

Resistive:	10 A, 240 VAC 10 A, 30 VDC	General Use:	7.5 A, 120 VAC 7.5 A, 240 VAC 7 A, 30 VDC 1/6 hp, 120 VAC 1/3 hp, 240 VAC

Intersection Radio/GPS Module. A GPS receiver and antenna shall obtain the intersection position from the GPS satellite system operated by the DOD. The time information from the GPS satellites shall be used to synchronize the frequency hopping of the 2.4 GHz radio and to time stamp the activity log. The GPS receiver and the GPS antenna shall reside inside of the Radio/GPS module.

A 2.4 GHz spread spectrum/frequency hopping radio shall provide the communications from the intersection to the vehicle as well as from intersection to intersection, or as shown in the plans.

As an alternate, the following Radio/GPS unit and Radio GPS antenna may be used in the intersection.

The Radio/GPS antenna shall be a hemispherical dome with a pair of 15-foot coax cables with factory terminated SMA connectors. One (1) of these connectors shall have a pin and the other will have a socket. This antenna shall include one (1) element for receiving the GPS signal and one (1) element for transmitting and receiving the radio signal. This antenna, along with the radio/GPS module, may also be used in the intersection.

The radio shall have a maximum transmit power of not more than one (1) watt. The radio shall have an unobstructed range of at least 2,500 feet. The radio will meet FCC Part 15 rules. The radio and the radio antenna shall reside inside of the Radio/GPS module.

The Radio/GPS module shall be housed in an impact resistant polycarbonate housing that will include a water resistant wire entry point. It shall contain a water resistant access cover to facilitate cable termination.

The Radio/GPS module shall be designed for mounting at or near an intersection on mast arms and span wire poles. Additional hardware may be needed.

The Radio/GPS module shall communicate to the multimode phase selector via a Radio/GPS cable up to 250 feet in length.

Radio/GPS Cable. The Radio/GPS cable shall deliver sufficient power from the multimode phase selector to the Radio/GPS module and will deliver the necessary quality signal from the Radio/GPS module to the multimode phase selector over a non- spliced distance of 250 feet.

Coaxial cable will not be permitted for this cable.

The Radio/GPS cable shall deliver sufficient power from the vehicle control unit to the Radio/GPS module and will deliver the necessary quality signal from the Radio/GPS module to the vehicle control unit over a non-spliced distance of 50 feet.

The cable shall be of durable construction to satisfy the following installations:

- Direct burial.
- Conduit and mast arm.
- Exposed overhead (supported by messenger wire)

The outside diameter of the cable shall not exceed 0.4 inches. The insulation rating of the cable shall be 300 volts minimum.

The temperature rating of the detector cable will be -40°F to +194ºF.

The conductors shall be AWG #20 (7x28) stranded and individually tinned. The cable shall be shielded and have a drain wire to provide signal integrity and transient protection.

When the aluminum enclosure version of the Radio/GPS module is used, the Radio/GPS cable assembly shall use a 15-pin connector that will mate with the connector on the Radio/GPS module.

Electrical and Environmental Requirements. All equipment supplied as part of the priority control system intended for use in the controller cabinet shall meet the following electrical

and environmental specifications spelled out in the NEMA Standards Publication TS 2-2003, Part 2: v02.06:

- Line voltage variations per NEMA TS 2-2003, Paragraph 2.1.2.
- Power source frequency per NEMA TS 2-2003, Paragraph 2.1.3.
- Power source noise transients per NEMA TS 2-2003, Paragraph 2.1.6
- Temperature range per NEMA TS 2-2003, Paragraph 2.1.5
- Humidity per NEMA TS 2-2003, Paragraph 2.1.5
- Shock test per NEMA TS 2-2003, Paragraph 2.2.9.
- Vibration per NEMA TS 2-2003, Paragraph 2.2.8
- Non-Destructive Transient immunity NEMA TS 2-2003, Paragraph 2.1.8.
- Input-output terminals NEMA TS 2-2003, Paragraph 2.1.7.
- FCC Part 15 Subpart B Class A EMC Standard
- Canada ICES-003, Issue 4:2004 Class A EMC Standard
- EN50293: 2000 Electromagnetic Compatibility–Road Traffic Signal Systems– Product Standard.
- EN 61326-1:2006 EMC Standard.
- EN 55011:2007 +A2:2007 EMC Standard.

Confirmation Light. This indication is intended for use at traffic signal installations that employ Emergency Vehicle Preemption (EVP) systems which utilize confirmation lights to notify the emergency vehicle operators that the designated preemption display is active and from which approach direction the call activating the display was received. The indication shall be an incandescent, tungsten-halogen or light emitting diode (LED) lamp. The confirmation light lamp shall be rated for outdoor use and shall have the illumination equivalent of a 95W incandescent lamp.

Confirmation Light Lamp Holder. The confirmation light lamp holder shall meet the following.

(a) Be precision die-cast aluminum with heat sinks and ribbing to maximize heat dissipation.
(b) Be a medium base lamp holder that accepts PAR38 lamps up to 250W incandescent or Tungsten-Halogen, and will also accept LED style lamps.
(c) Have a premium porcelain socket with double reinforced screw shell and spring loaded center contact.
(d) Be suitable for wet locations.
(e) Have a gasket that consists of a thick silicone rubber seal backed up by a durable heat barrier and anchored in place with a metal lock ring to ensure unit stays weather tight in any position, above or below horizontal.
(f) Have a nominal ½-inch NPT threaded adjustable arm, locknut preinstalled, and pre-lubed to facilitate mounting.
(g) Have cast-in quadrants with serrated teeth to lock unit in place once aimed.
(h) Have extra-long wire pigtails for easy splicing.
(i) Shall be UL Listed.

Confirmation Light Mounting. The confirmation light may be mounted as an assembly with the appropriate optical detector, utilizing conventional conduit and fittings. When mast arm mounted, all wiring shall be routed internally to the mounting assembly.

Rotating Beacon. The rotating beacon indication is intended for use in traffic signal systems

that employ EVP systems that utilize rotating beacons to notify the emergency vehicle operators that a preemption call has been received.

General Construction. The rotating beacon shall be constructed with a non-corroding polycarbonate base with combination mount with a flat base and 1-inch pipe mounting. The lens shall have an elliptical dome shape and shall provide a high light transmission and light output. The outer surface shall be smooth to minimize the accumulation of dust and dirt. A gasket seal shall be provided between the dome lens and the base. The rotating beacon assembly shall be nominally six and one-half inches (6½") tall and five and one-half inches (5½") wide at its maximum width. The rotating beacon shall have a single light source and shall provide the rotating effect by a rotating refractor within the assembly. The dome lens shall be BLUE in color.

RADAR DETECTION AND EQUIPMENT

Signal Radar Vehicle Detection. SRVD provide traffic parameters necessary to the traffic signal controller operation for vehicle detection..

Type 1 SRVD shall be used for basic vehicle detection at signalized intersections as described below in this specification. Type 2 SRVD shall have all of the functionality of the Type 1 SRVD with additional features described below in this specification.

Type 2 SRVD shall utilize a matrix of radar signals for two-dimensional coverage and shall track vehicles through each type of detection's specified Area of Coverage. The Type 2 SRVD shall report real-time detection of both moving and stopped vehicles.

ITS Radar Vehicle Detection. IRVD shall provide data, including, but not limited to speeds, volume, lane occupancy and classification.

Materials.

Radar Design. The IRVD and the SRVD stop bar microwave shall operate in the 24.0 to 24.25 GHz frequency band. The advance radar has the option to either be in the 24 GHz band or in the 10.5 GHz band. Neither stop bar nor advanced radar shall interfere with any existing or proposed traffic signal control and Intelligent Transportation System (ITS) equipment. Should frequencies of other ITS equipment be in the same band, or conflict with detection, the Contractor shall move and space the less critical ITS device, as designated by the Engineer so as not to interfere with vehicle detection.

The radar units shall operate in all weather conditions and comply with the applicable standards stated in the NEMA TS 2-2003 standard for shock, vibration, and temperature. All units shall be rated for up to 95% relative humidity, non-condensing.

The radar units shall be FCC certified under CFR 47, part 15.

Cabinet Interface Unit (CIU) Design. The CIU shall be a module that provides power and communication to the radar sensors and/or signal controller through contact closure devices, Ethernet and/or the SDLC port of the signal controller. The CIU shall include all power cables, jumpers and terminal blocks needed to connect up to four (4) radar sensors to the signal cabinet. The CIU shall have a 10/100 Ethernet port to allow connection to the local network. Any variation of necessary communications ports or sensor connecting terminals shall be approved by the Engineer.

The CIU shall operate in the harsh conditions of a signal cabinet, and comply with the applicable standards stated in the NEMA TS 2-2003 standard for shock, vibration, and temperature.

Area of Coverage - SRVD.

Stop Bar Radar Vehicle Detection. Type 1 SRVD stop bar radar sensor shall track vehicles through a field of view that extends out a minimum of 100 feet

The Type 1 SRVD stop bar radar sensor shall be able to detect and report presence in lanes located within a minimum 100-foot from the face of the detector. Any variance of the detectable area shall be approved by the Engineer.

The Type 1 SRVD stop bar radar sensor shall be able to detect up to four (4) lanes with eight (8) or sixteen (16) individual zones as indicated in the plans.

Type 2 SRVD stop bar radar sensor shall have all the functionality of the Type 1 SRVD stop bar sensor with the addition of the following:

- Type 2 SRVD stop bar radar sensor shall detect true presence of vehicles whether in motion or still without using Locking or Latching Algorithms.
- Type 2 SRVD stop bar radar sensor shall report presence in lanes with a minimum 90 degree arc from the face of the detector.
- Type 2 SRVD stop bar radar sensor shall be able to detect a minimum of ten (10) lanes.

Advanced Radar Vehicle Detection. The Type 1 SRVD advanced radar sensor shall be able to detect and report vehicle information such as range and speed when mounted within 50 feet of the center of the lanes of interest. Variance of this distance shall be approved by the Engineer per the application.

The Type 1 SRVD advanced radar sensor shall be forward fired and be able to detect and report vehicle information when mounted at heights above the road surface, as per Manufacturer recommendations.

The Type 1 SRVD advanced radar sensor shall be able to detect and report vehicles on the roadway up to 600 feet from the detector.

The Type 2 SRVD advanced radar sensor shall have all the functionality of the Type 1 SRVD advanced radar sensor with the following additions:

- Type 2 SRVD advanced radar sensor shall be able to detect and report heavy vehicles on the roadway up to 900 feet from the detector.
- Type 2 SRVD advanced radar sensor shall be able to detect Estimated Time of Arrival (ETA) for vehicles. The advanced radar sensors shall support user configurable upper and lower ETA filters for each zone. The sensors shall support the configuring of ETA filters in increments of 0.1 seconds.

Area of Coverage-IRVD. The IRVD's field of view shall cover an area with a minimum detection range of six (6) feet from the IRVD and a maximum detection range of 250 feet from the IRVD.

Detection Zones--SRVD.

Stop Bar Radar Vehicle Detection. The stop bar radar sensors shall be able to detect and report presence for vehicles at the stop bar.

The sensors shall be able to detect and report presence in up to eight (8) or sixteen (16) individual zones as indicated in the plans. The number of lanes used and detection zones shall be set-up and selected from the Graphical User Interface and manually configured via software provided with the detection unit. The detection zones shall also have the ability to be auto-configured by the software tool. A minimum of one (1) separate detection zone per lane is required.

Count zones shall also be able to be set up in the stop bar radar detection unit as a 'spot' type of radar detection zone. The software configuration tool included with the sensor shall allow all zones to be set up as required by the plans.

Advanced Radar Vehicle Detection. The advanced radar sensors shall be able to simultaneously detect and report information from a minimum of 25 vehicles on the roadway when they are serially sequenced between the near and far boundaries. The number of lanes and detection zones shall be set-up and selected from the Graphical User Interface.

The advanced radar sensors 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 detector shall also detect occupancy or density of the detection zones.

The advanced radar sensors shall provide vehicle call and extend data on up to eight (8) channels that can connect to contact closure modules compliant with NEMA TS 1, NEMA TS 2, and 170/2070 controller cabinets.

Detection Zones--IRVD. The minimum number of detection zones defined shall range from twelve (12) to 22, for simultaneous detection, as indicated in the plans. The range resolution of each zone shall be no greater than 1.3 feet, and the zone width shall be user defined within a range of six (6) to twenty (20) feet for the area of coverage limits described above.

Capabilities - SRVD. Sensors shall not require roadway modification for placement. The advanced detection should provide easy integration with the stop bar detection and vice versa into the same intersection to form one (1) method/system of detection.

The radar sensors shall distinguish and omit wrong way traffic from activating an assigned detector output.

Stop Bar Radar Vehicle Detection. The stop bar radar unit shall be suitable for mounting on roadside poles or mast arms and provide the following:

1) Presence indication of moving or stopped vehicles in its detection zones, provided by contact closure to existing controllers.
2) Assign a minimum of four (4) detector outputs per radar unit and capable of using two (2) or four (4)-channel interface modules to the detector rack for contact closure activation.
3) A cabinet interface module for multiple radar units may be provided in lieu of individual two (2) and four (4)-channel contact closure interface modules, and as shown in the plans.
4) Maintain a detection accuracy of 95% for each detection zone set-up on the graphical user interface.

Advanced Radar Vehicle Detection. The advance radar unit shall be suitable for mounting on signal pole uprights or mast arms and provide the following activation within the signal cabinet:

1) Assign a minimum of four (4) detector outputs per radar unit and capable of using two (2) or four (4)-channel interface modules to the detector rack for contact closure activation.
2) A cabinet interface module for multiple radar units may be provided in lieu of individual two (2) and four (4)-channel contact closure interface modules, and as shown in the plans.

3) Maintain a detection accuracy of 95% for each detection zone set-up on the graphical user interface.

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

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

Capabilities--IRVD. The IRVD shall detect true presence of vehicles whether in motion or still without using Locking or Latching Algorithms. It shall be suitable for mounting on roadside poles or on overhead structure and provide the following:

1) Presence indication of moving or stopped vehicles in its detection zones shall be provided by contact closure to existing controllers.

2) Traffic data, periodically accumulated over user defined time intervals in a 10 to 600 second range, shall be transmitted to the TMC via the communications network.
3) Traffic data shall be available simultaneously with detection zone contact closures and serial communications.
4) Side-fired configuration data shall include the following in each of a minimum of 12 detection zones (lanes): Volume, lane occupancy, and average speed, as well as vehicle classification by length in up to six (6) user-defined classes.
5) IRVD in forward-looking configuration shall monitor traffic in one lane and be capable providing the following data: Volume, occupancy, average speed and travel direction in the lane.
6) The unit shall be furnished with the required software for data collection, processing, configuration and set-up and data logging and retrieval. An operator shall be able to use the software to set detector count periods, sensitivities and other operational features and parameters. The software shall be capable of providing both manual and automatic setup and calibration.

Measurement Accuracy. The following error levels shall be achievable and demonstrated during testing:

Parameter	**Error Percentage**
Volume	±8%
Average Speed	±10% or ±5 mph
Lane Occupancy	±20%

Environmental Conditions and Protection. The radar unit 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. All radar sensors shall not require cleaning or adjusting in order to maintain performance. Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any combination of the NEMA TS 2-2003 standard and the following:

1) Ambient temperature range of -40°F to +165°F
2) Relative humidity from 5 to 95%, non-condensing
3) Rain and other precipitation up to 1.0 inch/hour
4) Power surge protection devices (SPD) shall be included with the radar sensors and

shall meet the requirements for 24 VDC and signal/data line surge protection for Ethernet, RS-485, RS-422 and RS-232 data lines.

Mechanical. The radar sensors shall not exceed five pounds (5 lbs) in weight. All external parts of the radar sensors shall be ultraviolet-resistant, corrosion resistant, and protected from fungus growth and moisture deterioration.

The radar sensors shall be classified as watertight according to the NEMA 250 Standard. The enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures.

Each of the radar sensors shall be able to withstand a drop of up to five (5) feet without compromising its functional and structural integrity. The sensor shall not require adjustments to maintain performance unless roadway geometry changes.

The radar sensors shall be mounted directly onto a mounting assembly fastened to a pole or other solid structure. The assembly shall provide the necessary degrees of rotation to ensure proper installation. The assembly shall be constructed of weather-resistant materials and shall be able to support a 20-pound load.

Electrical. The radar sensors shall consume less than 10 W and shall operate with a DC input between 12 VDC and 28 VDC for IRVD and 9 VDC and 32 VDC for SRVD, or POE. POE injectors shall be approved by the Engineer.

Surge Protection Devices (SPD) shall be provided to protect the equipment from surges in the radar sensors 24 VDC power supply and the signal line RS232, RS 485, or Ethernet communications wiring. Surge suppression shall be UL 1449 listed and meet all requirements set forth in the Surge Suppressor section of this specification.

Radar Design. The radar units shall be designed to provide detection over a large area and to discriminate lanes. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time. The radar shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

The bandwidth of the transmit signal of the radar sensor shall not vary by more than one percent (1%) under all specified operating conditions and over the expected life of the sensor. The stop bar radar sensor shall provide at least four (4) RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

Communication Ports. The radar sensor shall have Ethernet, RS-485, or RS-232 ports for communication from the unit to the cabinet. The IRVD shall be upgradable (optional) to include integral 10/100 Base-T Ethernet supporting TCP, UDP, IP, ARP, ICMP.

Within the cabinet, all remote communications to Ethernet switches shall be IP Ethernet with RJ-45 connections. For SRVD, any external device needed to convert serial to IP Ethernet within the cabinet for remote communications shall be provided with the radar sensor unit at no additional cost.

The radar sensor shall support the upload of new firmware into the unit's non-volatile memory. The sensor shall support user defined or automatic configuration of the com ports.

Radar Detection Cabling. All Radar Detection cable shall be paid per the unit cost of the

pay item for Radar Detection Cable, as shown on the plans or details. The manufacturer is responsible for obtaining plan sets and ensuring cable lengths are properly measured and accounted for in the bid price for each sensor unit and as shown on the plans.

The cable shall have a single continuous run with no splices, unless inside a manufacturer supplied junction box. The cable shall be terminated only on the two (2) farthest ends of the cable. The cable shall meet the requirements of the manufacturer.

Electrical Isolation and Surge Protection. All communication and power lines shall be installed using surge protection devices (SPD), as stated in the Surge Suppressors section of this specification.

Configuration--SRVD. The radar sensor can either have an on screen interactive or automatic configuration setup. The auto setup shall automatically define traffic lanes, stop bars, and detection zones without requiring user intervention. The auto- configuration process shall automatically define traffic lanes or detection zones by detecting the relative position of vehicles with the sensor's field of view.

The radar sensor shall also allow the ability of the user to manually adjust the sensor configuration. The graphical interface shall operate on a MS Windows™ based software. The software shall automatically negotiate the baud rate, the correct serial communication port, operate over a TCP/IP connection, support dial-up modem connectivity, give the operator the ability to save/back up the sensor configuration to a file or load/restore the configuration from a file, and provide a virtual connection option so that the software can be used without connecting to an actual sensor.

Stop Bar Radar Vehicle Detection. The stop bar sensor shall support the configuring of lanes, stop bars, and detection zones in 1-foot increments and as stated in these specifications for lane detection.

Advanced Radar Vehicle Detection. The advance radar sensor can either have an on screen interactive or automatic setup. The auto setup shall have a method for automatically configuring the sensitivity of detection between 5-foot and 7.5-foot increments. The advanced radar sensor shall support the configuring of zones in at least 5-foot increments.

The advanced radar sensor shall support user configurable high-speed and low-speed detection filters for each zone. These speed filters shall be configured in 1-mph increments.

Construction Requirements. Radar Detection System shall be constructed to withstand and operate in sustained winds of up to 90 mph and a 30% gust factor. For projects that are in areas with higher wind standard, the higher standard shall be used.

Cabinet Interface Unit. Where required, the Contractor shall install any contact closure modules and cabinet interface modules needed to connect the sensor(s) to the signal controller within the signal cabinet environment shown in the plans. Sensors (up to 4) shall be connected to the cabinet interface module and the cabinet interface unit shall be connected to the signal controller per the manufacturer's requirements for the particular signal cabinet environment shown in the plans at no additional cost, or as approved by the Engineer.

Warranty. The Signal Radar Detection sensors shall be warranted to be free of manufacturer defects in materials and workmanship for a period of one (1) year from the date of Final Acceptance. Equipment covered by the manufacturer's warranties shall have the registration of that component placed in the Department's name prior to Final Inspection. The Contractor

shall be responsible for ensuring that the vendors and/or manufacturers supplying the components and providing the equipment warranties recognize the Department as the original purchaser and owner/end user of the component from new. During the warranty period, the supplier shall repair or replace with new or refurbished material, at no additional cost to the State, any product containing a warranty defect, provided the product is returned postage-paid by the Department to the supplier's factory or authorized warranty site. Products repaired or replaced under warranty by the supplier shall be returned prepaid by the supplier.

During the warranty period, technical support shall be available from the supplier via telephone within four hours of the time a call is made by the Department, and this support shall be available from factory certified personnel. During the warranty period, updates and corrections to control unit software shall be made available to the Department by the supplier at no additional cost.

WIRELESS MAGNETOMETER DETECTION

Description. The system shall detect vehicles on a roadway using only changes in the earth's magnetic field and provide detection outputs to a roadside master device before the data is relayed to a freeway cabinet, a local traffic controller cabinet, a Central Software System, and/or data server as required as required by the application. These specifications cover both intersection presence-based vehicle detection used for traffic controller input, as well as freeway system or advanced system detection data collection of volume, occupancy and speed. This specification sets forth the minimum requirements for the system.

The detection system shall provide accurate roadway data as needed to support the traffic management application. All wireless, battery-powered Magnetometer Vehicle Detection Systems (MDS) shall consist of one or more battery-powered wireless Vehicle Sensor Nodes (VSN) installed in-pavement with reusable enclosure. The MDS may also consist of one (1) or more Repeaters (RPs) mounted on poles on the side of the roadway.

The MDS shall also consist of either:

- One (1) or more Access Points (AP) mounted on the side of the roadway, one (1) or more Access Boxes, and one (1) or more Contact Closure Interface Card(s) (with Expansion Card System (EX) if required); or
- One (1) or more Access Point Contact Closure (APCC) Interface cards (with an Expansion Card System (EX) if required), one (1) or more Isolator Modules (ISO), and one (1) or more Serial Port Protocol Digital Radios (DR) mounted on the side of the roadway; or
- Equivalent system as approved by the Engineer

The MDS may also include Input/Output (I/O) Modules if Access Point Contact Closure cards are used. All MDS shall also include CAT6 Outdoor Ethernet Cable, Epoxy Sealant for installation, and applicable operating and configuration software. Software shall operate on a conventional laptop PC. Communications between the sensors and the DR or RP and between the RP and DR or another RP shall be via radio. Detection data shall be relayed using contact closure signals. Data shall be capable of being relayed to a Central Software System or central server over standard IP networks. The MDS shall also include any incidental items necessary for a complete and operable unit in place and accepted.

Materials.

Functional Capabilities. The VSN shall detect a vehicle by measuring a change in the x, y, and z axis components of the earth's magnetic field near the VSN caused by a stopped or passing vehicle. The VSN shall communicate the detection information to the AP, DR, or RP via wireless radio. The VSN shall transmit detection information within 150-ms of a detected event. The VSN shall communicate time-stamped ON and OFF vehicle detection events. The VSN shall automatically re-transmit a detected event if no acknowledgment is received from the AP or APCC/DR. The VSN shall automatically recalibrate in the event of a detector lock. If radio connection is lost due to stopped vehicles near the VSN, each VSN shall be capable of re-establishing radio link with supporting AP or APCC/DR or RP in less than two (2) seconds. Each MDS system shall consist of one (1) or more VSN's located as identified on the plans. Communications between a VSN and DR or AP can be direct, via a single repeater, or via two (2) repeaters operating in tandem.

The Radio Frequency (RF) link among the AP, DR, RP, and VSN shall conform to the following:

- The RF link shall utilize an IEEE approved wireless communications protocol.
- The center frequencies, bandwidths, and transmit power levels of the radio links shall allow operation in an unlicensed frequency band.
- Frequency channels which are user configurable shall be employed by the sensors, APs or APCCs and RPs to avoid interference with other devices operating in the unlicensed band.
- The AP or DR to VSN (or RP to VSN) RF range shall be at least 150 feet for an DR/AP/RP installed at 20 feet above the roadway and at least 125 feet at 18 feet above the roadway.
- The RP to AP or DR RF range shall be at least 750 feet when both units are installed 18 feet above the roadway with clear line of sight.

For freeway applications and where advanced system detection is provided, per the plans and specifications, detection data shall be relayed to a central software system or central server. In this case each installation of the wireless, battery-powered Magnetometer Vehicle Detection System shall provide the following measurements, as required by the application:

- Vehicle volume (count) per lane over a specified time interval
- Lane occupancy (percent) over a specified time interval
- Vehicle speed (mph or kph) when more than one sensor is deployed in a lane
    - Per-vehicle speed
    - Median speed over a specified time interval
    - Mean speed over a specified time interval
    - Distribution of speeds over a specified time interval
- Vehicle classification when more than one (1) sensor is deployed in a lane
    - Per-vehicle length
    - Report distribution of vehicle lengths over a specified time interval
    - The time interval for measurements shall be selectable from 30 seconds to 24 hours

Each VSN shall transmit a unique identifying code. Each sensor in an installation shall be capable of being individually configured with its own sensitivity level. Sensitivity of the VSN shall be adjustable as may be required to detect bicycles and/or motorcycles. The VSN shall respond within 100 seconds when the AP or APCC/DR is powered on and transmitting.

Two (2) types of sensor applications of sensors shall be available from the manufacturer. Type A shall provide all sensor functions, including data collection functions. Sensors used for this application shall provide for advanced system detection or stop bar detection. In the advanced system detection scenario a single Type A VSN shall be configurable to approximate the detection zones of 6-foot x 6-foot. In the stop bar detection scenario multiple Type A VSNs shall be configurable to emulate 6-foot x 6-foot to longer lengths.

Type B sensors shall support presence detection only. Sensors used for this application shall provide for stop bar detection. In this scenario single or multiple Type B VSNs shall be configurable to emulate 6-foot x 6-foot to longer lengths. The plans shall dictate the sensor type required.

The AP or APCC shall have the capability to transmit detection information to central software or a centralized server through several types of communication media, as required by

the application. The AP shall be capable of communicating over a cellular data connection, or an Ethernet connection. The APCC shall be capable of simultaneously communicating detection data via the contact closure interface, Ethernet interface, and cellular data modem interface, as applicable. The APCC cards shall provide sensor information processing and support the interface between a DR and the traffic controller using contact closure signals, or, for freeway applications, mounted in a stand-alone cabinet with direct IP communications. The AP or APCC shall have the capability to transmit detection information to 170, 2070, and NEMA TS 1 and TS 2 traffic controllers to provide real time detection information via a standard contact-closure based input shelf. The VSN, RP, DR, APCC or AP shall be capable of accepting software and firmware upgrades.

VSN Hardware. The VSN shall consist of a magnetometer, a microprocessor, a wireless transmitter and receiver, battery, an "enclosure case", and epoxy sealant for installation. The VSN components shall be contained within a single housing. The VSN housing shall meet NEMA 6P and IEC IP68 standards. The VSN components shall be fully encapsulated within the housing to prevent moisture from degrading the components. The VSN shall be able to operate at temperatures from -37°F to +176°F. The VSN shall be designed to operate from its battery for an average of 10 years of life under normal traffic conditions.

Repeater Hardware. The RP (if required) shall extend the effective communication range of the sensor to the AP or DR an additional 750 feet. The RP communicating directly to an AP or APCC/DR shall support at least 10 sensors while an RP communicating to an AP or APCC/DR via an intermediate RP (i.e., tandem operation) shall support at least six (6) sensors. If the RP is battery powered, the RP battery shall be field replaceable. The RP shall operate in the -37°F to +176° temperature range. All RP Components shall be contained within a single housing. The RP shall meet NEMA 4X and IEC IP67 standards. If battery powered, the RP shall be designed to operate from its battery for a minimum of seven (7) years of life under normal traffic conditions.

AP Hardware. The AP shall be the master device of the sensor network. The AP shall be able to communicate to up to 48 VSN's and 15 RP's. The AP shall operate in the -37°F to +176°F temperature range. The AP shall meet NEMA 4X and IEC IP67 standards. It shall contain a weatherproof connector on the bottom of the device, which shall be shipped with a cover firmly attached to provide protection from the elements. The AP shall communicate via the following options: The controller via the Contact Closure Interface Card(s), Ethernet to a Central computer/server, or simultaneously to both the controller and the Central computer/server.

Contact Closure Interface Card (CCI) and Expansion Card System (EX) Hardware. The Contact Closure Cards and Expansion Cards, collectively called Contact Closure Interface Card(s) (CCI), shall provide detector outputs to the controller. The CCI shall directly plug in to the standard 170/2070 Input Files and NEMA detector racks and detection file type shall be selectable via dipswitch. Each CCI card shall provide up to four (4) channels of detection. Additional contact closure input channels shall be provided via Expansion Cards (EX) daisy chained to the CCI (user configurable from one (1) to four (4) outputs each). All required EX cards to handle the number of sensors or controller channels as indicated in the plans or project specifications shall make up the Expansion Card System. The CCI shall be able to provide pulse or presence detection outputs.

The front panel of the CCI shall provide:

- Status LED's displaying
    - Detection Channel Status

- Line Quality
- Fault Monitor

The CCI shall be powered by 11 to 26 VDC. The CCI shall be surge protected to GR-1089 standards. The CCI card(s) shall operate -37°F to +176° temperature range. The CCI shall operate in up to 95% humidity (non-condensing).

Access Box. The access box shall provide a communication link between the AP and CCI card(s). The access box shall provide the ability for remote communications.

Access Point Contact Closure (APCC) Interface Card and Expansion Card System (EX) Hardware. The APCC shall also serve as the master device of the MDS, where AP type configurations are not specified. It shall provide all the higher level processing and interface functions of the MDS system and shall only require a single detection rack width slot. All required EX cards to handle the number of sensors or controller channels as indicated in the plans or project specifications shall make up the Expansion Card system.

Each APCC card shall provide detector data as contact closure signals to the traffic controller. The APCC card shall be capable of plugging directly in to standard 170/2070 input files and NEMA detector racks or shall be supplied within a standard enclosure to supply power for use in freeway applications. The APCC and EX cards front panel shall be configurable either via software or via front panel switches to provide presence/pulse mode, delay timing and extension timing. The front panel of the APCC and EX card system shall provide LED's to monitor:

- Detection Channel Status
- Line Quality
- Fault Monitor

APCC and EX card system shall operate at temperatures from -37°F to +176°F, and in humidity up to 95% (non-condensing).

Digital Radio Hardware. The Serial Port Protocol Digital Radio (DR) shall support at least 48 sensors with a 0.125 second latency. It shall contain a weatherproof connector on the bottom of the device, which shall be shipped with a cover firmly attached to provide protection from the elements. The DR shall operate at temperatures from -37°F to +176°F, and DR shall be contained within a single housing that conforms to NEMA Type 4X and IEC IP67 standards.

Isolator (ISO) Module. If required, an Isolator Module may be used in between each DR and APCC to extend communications range and protect the APCC card from transient surges. The Isolator Module shall extend the communication range between the APCC and DR from 30 feet to 2000 feet. The Isolator Module shall provide electrical isolation of 1500V, surge protection of up to 1500V, and shall provide AC power cross protection.

Input/Output (I/O) Module. The MDS may include I/O modules to expand the capabilities of an APCC by providing additional communication options, memory options and a battery backed real time clock. The module shall include a RS232 port for serial communications. As an option, it may also allow for detection data shall be communicated as IP data over either GSM-based cellular data services via a GPRS cellular modem or over CDMA based cellular data services via a 1xRTT cellular modem.

Configuration Software. The MDS shall include the software necessary to configure the

VSN. The MDS shall include the software necessary to configure the RP, AP, APCC, EX, CCI and DR.

Epoxy. The MDS shall also include the necessary epoxy for installation. The epoxy used for installation of the sensor(s) shall be a two part poly-urea based joint sealant having self-leveling characteristics. Surfaces the epoxy will be bonding to shall be free of debris, moisture, and anything else which might interfere with the bonding process. The epoxy used shall be approved by the manufacturer of the detection system.

Warranty. The supplier shall provide a limited 5-year warranty on the detection system from the point of the project final acceptance. During the warranty period, technical support shall be available from the supplier via telephone within 24 hours of the time a call is made by a user, and this support shall be available from factory- authorized personnel or factory-authorized installers. During the warranty period, standard updates to the software shall be available from the supplier without charge.

Accuracy Requirements. The following error levels shall be achievable and shall be demonstrated, at the request of the Engineer, during testing:

Parameter	Error Percentage
Presence	±2%
Lane Occupancy	±5%
Volume	±8%
Average Speed	±10%
Length Classification limits	±10%

VIDEO DETECTION AND EQUIPMENT

TYPE 1 VIDEO DETECTION.

General. The Type 1 Video Vehicle Detection shall consist of power supply, video camera, mounting brackets, and lightning protection as recommended by the manufacturer, video detection processors/extension modules capable of processing the number of camera and phase combination video sources shown on the project plans or in the purchase order. In addition, Type 1B Video Vehicle Detector shall consist of a single integrated camera with video detection processor, a cabinet interface which mounts in a standard detector rack or as a standalone shelf mount unit.

Functional Requirements. The Type 1 Video Vehicle Detection configuration shall utilize video processors with one or more video inputs and one (1) video output, responding to specific site applications, camera locations and detection zones shown on the project plans. Video processors or interface modules shall be provided which plug directly into NEMA TS 1 and TS 2 detector racks without adapters. Extension modules which allow detection zones from one camera to be routed to other card slots shall also be provided if required. The system shall be Ethernet compatible with an RJ45 port. The Type 1 Video Vehicle Detection shall be able to detect vehicles and bicycles in multiple lanes using only the video image.

Interface. The following interfaces shall be provided:

1) Video inputs that accept RS 170 (NTSC) signals from an external video source. A BNC type interface connector shall be provided and located on the front of the video processing unit.
2) A LED indicator to indicate the presence of the video signal. The LED shall illuminate upon valid video synchronization and turn off when the presence of a valid video signal is removed.
3) One (1) video output per processor module. The video output shall be RS 170 compliant and shall pass through the input video signal. The video output shall have the capability to show text and graphical overlays to aid in system setup. The overlays shall display real-time actuation of detection zones upon vehicle detection or presence. Control of the overlays and video switching shall also be provided through the serial communications port. The video output interface connector shall be BNC or RCA type. If RCA connector is used, an RCA to BNC adapter shall be provided.
3) A serial communications port on the front panel. The serial port shall be compliant with RS-232 or RS-422 electrical interfaces and shall use a DB9 or RJ45 type connector. The serial communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information.
5) Interface software. The interface protocol shall support multi-drop or point-to-multipoint communications. Each video detection sensor shall have the capability to be individually IP addressable either built in or with third party video server units.
6) Open collector contact closure outputs meeting NEMA TS-2 requirements. The open collector output will be used for vehicle detection indicators as well as discrete outputs for alarm conditions.
7) LED status indicators on the front panel. The LED's shall illuminate when a contact closure output occurs. Provide one output LED for each contact closure output.
8) A mouse compatible port (PS-2 or USB) on the front panel of the video processing unit. The mouse port shall be used as part of the system setup and configuration.
9) A Cabinet Interface shall be provided that is specifically designed to mount in a standard NEMA TS 1 and TS 2 detector rack without adapters or rewiring, or as a

stand-alone shelf mount unit. The Interface shall operate in a temperature range from -31°F to +165°F and a humidity range from 0% to 95% relative humidity. The Cabinet Interface shall be powered by 100v to 240v AC, 50 or 60Hz. The front of the Interface shall include LED detection indications for each channel of detection, One BNC video output and detector test switches that allow the user to place calls on each channel

Functionality. Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the video detection processor. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. The video detection processor shall detect vehicles, bicycles, and pedestrians in real time as they travel across each detection zone. The video detection processor shall have an RS-232 (DB9 or RJ45) port for communications with an external computer. The video detection processor port shall be multi-drop capable.

It shall be possible to upload and save all configuration data including loop placement and save the file on a computer. It shall be possible to download a configuration file from a computer to the detection device.

The video detection processor shall accept new detection patterns from an external computer through the RS-232 port when the external computer uses the correct communications protocol for downloading detection patterns.

A Windows™ based software designed for local and remote connection shall be provided for video capture, real-time detection indication and detection zone modification capability. The video detection processor shall send its detection patterns to an external computer through the RS-232 port.

The video detection processor shall default to a safe condition, such as minimum recall, fixed recall or a constant call on each active detection channel, in the event of unacceptable interference with the video signal, low visibility conditions, or power failure.

The system shall be capable of automatically detecting a low-visibility condition such as fog and respond by placing all defined detection zones in a constant call mode. The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.

Detection. Type 1A shall have a minimum of 24 detection zones per camera input shall be possible, and each detection zone shall be capable of being sized to suit the site and the desired vehicle detection area. Type 1B shall have a minimum of 8 detection zones per camera input shall be possible, and each detection zone shall be capable of being sized to suit the site and the desired vehicle detection area.

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

Placement of detection zones shall be done by using only a pointing device, and a Graphical Interface built into the video detection processor and displayed on a video monitor, to draw the detection zones on the video image from each video camera. Detection zones created in this manner shall be compatible with the PC-based software provided with the system.

The video detection processor shall support bicycle type zones where the zone can differentiate between motorized vehicles and bicycles, producing a call for one but not the other. Bicycle zones shall only output when a bicycle is detected. The video detection processor shall provide the ability to assign a separate output channel for bicycle zones to allow traffic controllers to implement special bicycle timing for applications where the traffic controller has separate bicycle detection inputs. Bicycle zones shall have the ability to have extensions assigned to individual bicycle zones for applications where the traffic controller does not have bicycle specific detection inputs.

For Type 1A, six (6) additional count zones for bicycles shall be provided to accumulate bicycle counts at user specified intervals.

The video detection processor's memory shall be non-volatile to prevent data loss during power outages.

When a vehicle is detected crossing a detection zone, the corners or entire zone of the detection zone shall flash/change color on the video overlay display to confirm the detection of the vehicle. It shall be possible to record the operation of the unit in real time with the detection zones operating.

Detection shall be at least 98% accurate in all weather conditions, with slight degradation acceptable under adverse weather conditions (e.g. rain, snow, or fog) which reduce visibility.

The video detection processor shall maintain normal operation of existing detection zones when one (1) zone is being added or modified.

The video detection processor shall output a constant call on any detector channel corresponding to a zone being modified and shall resume normal operation upon completion.

Detection zones shall be directional to reduce false detections from objects traveling in directions other than the desired direction of travel in the detection area.

The video detection processor shall process the video input from each camera using a microprocessor at 30 frames per second at one volt, peak to peak, 75 ohms, or EIA 170 NTSC video standard.

The video detection processor shall output minimum recall, fixed recall or constant call for each enabled detector output channel if a loss of video signal occurs. The recall behavior shall be user selectable for each output. The video detection processor shall output a constant call during the background "learning" period.

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

Type 1A shall have up to six (6) detection zones per camera view that have the capability to count the number of vehicles detected, measure classification and speed. The data values shall be internally stored within the processor module for later retrieval through the RS-232 port. The data collection interval shall be user definable in periods of 5, 15, 30, or 60 minutes or by intersection cycle. Real-time data shall be retrieved from the PC-based software provided with the system.

Camera. Type 1A cameras shall be completely compatible with the video detection processor and shall be certified by the manufacturer to ensure proper system operation.

Type 1B shall be a single integrated camera with built in video detection processor.

The Video Vehicle Detection shall produce accurate detector outputs under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.009 to 930 foot-candles.

The camera shall use a color CCD sensing element with resolution of not less than 470 lines horizontal and 400 lines vertical.

The camera shall include mechanisms to compensate for changing of lighting by using an electronic shutter and/or auto-iris lens.

The camera shall include a variable focal length lens with factory preset focus that requires no field adjustment. Zooming of the camera lens to suit the site geometry by means of a portable interface device designed for that purpose. The horizontal field of view shall be adjustable. Camera configuration shall be customized for each approach based on field site conditions and the project plans.

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

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

The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view.

The camera enclosure shall include a thermostatically controlled heater to assure proper operation of the lens shutter at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. The heater shall directly heat the glass lens and require less than five (5) watts over the temperature range.

Power consumption of the camera shall be 15 watts or less under all conditions.

The camera enclosure shall be equipped with separate, weather-tight connections for power and setup video cables at the rear of the enclosure. These connections shall allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module furnished under this bid item.

The video signal output by the camera shall in accordance with NTSC standards.

All necessary mounting brackets shall be mounted to pole shafts, mast arms, or other structures to mount cameras as indicated on the project plans. Mounting brackets shall result in a fixed-position mounting. Mounting Brackets shall be included at no additional cost.

Video Cable. The cable provided shall be as recommended by the manufacturer for optimal video detection performance. The power and video cable may be installed under the same outer jacket. The cable and installation tools shall be approved by the supplier and

manufacturer's instructions must be followed to ensure proper connection.

Power Cable. The cable provided shall be as recommended by the manufacturer for optimal video detection performance.

Camera power cable shall be suitable for installation in conduit and in exposed sunlight environment, and UL listed.

The power and video cable may be installed under the same outer jacket. The cable and installation tools shall be approved by the supplier and manufacturer's instructions must be followed to ensure proper connection.

Surge Protection. Surge protection devices shall be provided for all new or added video detection devices as recommended by the manufacturer.

Video and/or Power cable shall be protected with an inline surge suppressor as recommended by the manufacturer or a panel mounted surge suppressor as recommended by the manufacturer or approved equal, installed and grounded per manufacturer's recommendations.

Physical and Environmental Specifications. Physical and Environmental Specifications shall be as follows.

Video Vehicle Detection Processor: The video vehicle detection processor shall operate reliably in a typical roadside traffic cabinet environment. Internal cabinet equipment and a video vehicle detection processor shall be provided that meets the environmental requirements of NEMA TS-2-2003 Section 2. If the processor is located in the sensor, it shall meet the same requirements.

Video Camera Sensor: The operating ambient temperature range shall be -30°F to 140°F. Additionally, a heater shall be included to prevent the formation of ice and condensation in cold weather. The heater shall not interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.

Vibration: Vibrations shall meet the requirements of NEMA TS 2-2003 Section 2.1.9.

Shock: Shock shall meet the requirements of NEMA TS 2-2003 Section 2.1.10.

Acoustic Noise: A video camera sensor and enclosure shall be provided that can withstand 150 dB for 30 minutes continuously, with no reduction in function or accuracy.

TYPE 2 VIDEO DETECTION.

General. The Type 2 Video Vehicle Detection shall be span wire mounted and consist of power supply, video camera, mounting brackets, and lightning protection as recommended by the manufacturer, video detection processors/extension modules capable of processing the number of camera and phase combination video sources shown on the project plans or in the purchase order

Functional Requirements. The Type 2 Video Vehicle Detection configuration shall utilize video processors with one or more video inputs and one (1) video output, responding to specific site applications, camera locations and detection zones shown on the project plans. Video processors or interface modules shall be provided which plug directly into NEMA TS 1 and TS 2 detector racks without adapters. Extension modules which allow detection zones

from one camera to be routed to other card slots shall also be provided if required. The system shall be Ethernet compatible with an RJ45 port. The Type 2 Video Vehicle Detection shall be able to detect vehicles and bicycles in multiple lanes using only the video image.

Interface. The following interfaces shall be provided:

1) Video inputs that accept RS 170 (NTSC) signals from an external video source. A BNC type interface connector shall be provided and located on the front of the video processing unit.
2) A LED indicator to indicate the presence of the video signal. The LED shall illuminate upon valid video synchronization and turn off when the presence of a valid video signal is removed.
3) One (1) video output per processor module. The video output shall be RS 170 compliant and shall pass through the input video signal. The video output shall have the capability to show text and graphical overlays to aid in system setup. The overlays shall display real-time actuation of detection zones upon vehicle detection or presence. Control of the overlays and video switching shall also be provided through the serial communications port. The video output interface connector shall be BNC or RCA type. If RCA connector is used, an RCA to BNC adapter shall be provided.
4) A serial communications port on the front panel. The serial port shall be compliant with RS-232 or RS-422 electrical interfaces and shall use a DB9 or RJ45 type connector. The serial communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information.
5) Interface software. The interface protocol shall support multi-drop or point-to-multipoint communications. Each video detection sensor shall have the capability to be individually IP addressable either built in or with third party video server units.
6) Open collector contact closure outputs meeting NEMA TS 2 requirements. The open collector output will be used for vehicle detection indicators as well as discrete outputs for alarm conditions.
7) LED status indicators on the front panel. The LED's shall illuminate when a contact closure output occurs. Provide one output LED for each contact closure output.
8) A mouse compatible port (PS-2 or USB) on the front panel of the video processing unit. The mouse port shall be used as part of the system setup and configuration.
9) A Cabinet Interface shall be provided that is specifically designed to mount in a standard NEMA TS 1 and TS 2 detector rack without adapters or rewiring, or as a stand-alone shelf mount unit. The Interface shall operate in a temperature range from -31°F to +165°F and a humidity range from 0% to 95% relative humidity. The Cabinet Interface shall be powered by 100v to 240v AC, 50 or 60Hz. The front of the Interface shall include LED detection indications for each channel of detection, One BNC video output and detector test switches that allow the user to place calls on each channel

Functionality. Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the video detection processor. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. The video detection processor shall detect vehicles, bicycles, and pedestrians in real time as they travel across each detection zone. The video detection processor shall have an RS-232 (DB9 or RJ45) port for communications with an external computer. The video detection processor port shall be multi-drop capable.

It shall be possible to upload and save all configuration data including loop placement and save the file on a computer. It shall be possible to download a configuration file from a

computer to the detection device.

The video detection processor shall accept new detection patterns from an external computer through the RS-232 port when the external computer uses the correct communications protocol for downloading detection patterns.

A Windows™ based software designed for local and remote connection shall be provided for video capture, real-time detection indication and detection zone modification capability. The video detection processor shall send its detection patterns to an external computer through the RS-232 port.

The video detection processor shall default to a safe condition, such as minimum recall, fixed recall or a constant call on each active detection channel, in the event of unacceptable interference with the video signal, low visibility conditions, or power failure.

The system shall be capable of automatically detecting a low-visibility condition such as fog and respond by placing all defined detection zones in a constant call mode. The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.

The Video Detection Processor (VDP) for the Type 2 Video Vehicle Detection shall employ Dynamic Zone Stabilization to provide motion tracking and compensation for swaying camera sensors mounted on dual or single span wires. The VDP shall include software that discriminately detects the presence of vehicles and bicycles in single or multiple lanes using only the video image. The VDP shall compensate for swaying motions by tracking the position of the stop bar for the approaching vehicle or bicycle movement. The VDP shall compensate for low frequency (cable sag) motion due to temperature changes during the day. The VDP shall compensate for moderate frequency motion induced by winds. The VDP shall compensate for up to +/- 5 degrees of tilt from vertical without any adverse detection false calls or dropped calls.

Detection. Type 2 shall have a minimum of 24 detection zones per camera input shall be possible, and each detection zone shall be capable of being sized to suit the site and the desired vehicle detection area. .

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

Placement of detection zones shall be done by using only a pointing device, and a Graphical Interface built into the video detection processor and displayed on a video monitor, to draw the detection zones on the video image from each video camera. Detection zones created in this manner shall be compatible with the PC-based software provided with the system.

The video detection processor shall support bicycle type zones where the zone can differentiate between motorized vehicles and bicycles, producing a call for one but not the other. Bicycle zones shall only output when a bicycle is detected. The video detection processor shall provide the ability to assign a separate output channel for bicycle zones to allow traffic controllers to implement special bicycle timing for applications where the traffic controller has separate bicycle detection inputs. Bicycle zones shall have the ability to have extensions assigned to individual bicycle ones for applications where the traffic controller does not have bicycle specific detection inputs.

Six (6) additional count zones for bicycles shall be provided to accumulate bicycle counts at user specified intervals.

The video detection processor's memory shall be non-volatile to prevent data loss during power outages.

When a vehicle is detected crossing a detection zone, the corners or entire zone of the detection zone shall flash/change color on the video overlay display to confirm the detection of the vehicle. It shall be possible to record the operation of the unit in real time with the detection zones operating.

Detection shall be at least 98% accurate in all weather conditions, with slight degradation acceptable under adverse weather conditions (e.g. rain, snow, or fog) which reduce visibility.

The video detection processor shall maintain normal operation of existing detection zones when one (1) zone is being added or modified.

The video detection processor shall output a constant call on any detector channel corresponding to a zone being modified and shall resume normal operation upon completion.

Detection zones shall be directional to reduce false detections from objects traveling in directions other than the desired direction of travel in the detection area.

The video detection processor shall process the video input from each camera using a microprocessor at 30 frames per second at one volt, peak to peak, 75 ohms, or EIA 170 NTSC video standard.

The video detection processor shall output minimum recall, fixed recall or constant call for each enabled detector output channel if a loss of video signal occurs. The recall behavior shall be user selectable for each output. The video detection processor shall output a constant call during the background "learning" period.

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

The processor shall have up to six (6) detection zones per camera view shall have the capability to count the number of vehicles detected, measure classification and speed. The data values shall be internally stored within the processor module for later retrieval through the RS-232 port. The data collection interval shall be user definable in periods of 5, 15, 30, or 60 minutes or by intersection cycle. Real-time data shall be retrieved from the PC-based software provided with the system.

Camera. Type 2 cameras shall be completely compatible with the video detection processor and shall be certified by the manufacturer to ensure proper system operation.

The Video Vehicle Detection shall produce accurate detector outputs under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.009 to 930 foot-candles.

The camera shall use a color CCD sensing element with resolution of not less than 470 lines

horizontal and 400 lines vertical.

The camera shall include mechanisms to compensate for changing of lighting by using an electronic shutter and/or auto-iris lens.

The camera shall include a variable focal length lens with factory preset focus that requires no field adjustment. Zooming of the camera lens to suit the site geometry by means of a portable interface device designed for that purpose. The horizontal field of view shall be adjustable. Camera configuration shall be customized for each approach based on field site conditions and the project plans.

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

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

The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view.

The camera enclosure shall include a thermostatically controlled heater to assure proper operation of the lens shutter at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. The heater shall directly heat the glass lens and require less than five (5) watts over the temperature range.

Power consumption of the camera shall be 15 watts or less under all conditions.

The camera enclosure shall be equipped with separate, weather-tight connections for power and setup video cables at the rear of the enclosure. These connections shall allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module furnished under this bid item.

The video signal output by the camera shall in accordance with NTSC standards.

All necessary mounting brackets shall be mounted to pole shafts, mast arms, or other structures to mount cameras as indicated on the project plans. Mounting brackets shall result in a fixed-position mounting. Mounting Brackets shall be included at no additional cost.

Video Cable. The cable provided shall be as recommended by the manufacturer for optimal video detection performance. The power and video cable may be installed under the same outer jacket. The cable and installation tools shall be approved by the supplier and manufacturer’s instructions must be followed to ensure proper connection.

Power Cable. The cable provided shall be as recommended by the manufacturer for optimal video detection performance.

Camera power cable shall be suitable for installation in conduit and in exposed sunlight environment, and UL listed.

The power and video cable may be installed under the same outer jacket. The cable and installation tools shall be approved by the supplier and manufacturer’s instructions must be

followed to ensure proper connection.

Surge Protection. Surge protection devices shall be provided for all new or added video detection devices as recommended by the manufacturer.

Video and/or Power cable shall be protected with an inline surge suppressor as recommended by the manufacturer or a panel mounted surge suppressor as recommended by the manufacturer or approved equal, installed and grounded per manufacturer's recommendations.

Physical and Environmental Specifications. Physical and Environmental Specifications shall be as follows.

Video Vehicle Detection Processor: The video vehicle detection processor shall operate reliably in a typical roadside traffic cabinet environment. Internal cabinet equipment and a video vehicle detection processor shall be provided that meets the environmental requirements of NEMA TS 2-2003 Section 2. If the processor is located in the sensor, it shall meet the same requirements.

Video Camera Sensor: The operating ambient temperature range shall be -30°F to 140°F. Additionally, a heater shall be included to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.

Vibration: Vibrations shall meet the requirements of NEMA TS 2-2003 section 2.1.9.

Shock: Shock shall meet the requirements of NEMA TS 2-2003 section 2.1 .10.

Acoustic Noise: A video camera sensor and enclosure shall be provided that can withstand 150 dB for 30 minutes continuously, with no reduction in function or accuracy.

MULTI SENSOR VEHICLE DETECTION.

General. The Multi-Sensor Vehicle Detector shall utilize two (2) different sensors of different technologies, video imaging and radar, to detect and track licensed and unlicensed vehicles at distances up to 600 feet. The detector shall fuse vehicle information from the two sensors to provide highly accurate and precise detection for special or advanced applications.

The Multi-Sensor Vehicle Detector shall use a primary detector rack mounted processor to interface with the traffic control cabinet. The module shall process information from both video imaging and radar sensors simultaneously in real-time.

Detector Configuration.

The proposed MSVD shall be available in various configurations to allow maximum deployment flexibility. Each configuration shall have an identical user interface for system setup and configuration. The communications protocol to each configuration shall be identical and shall be hardware platform independent.

The detector shall include software that detects vehicles in multiple lanes. Video imaging detection zones shall be defined using only an on-board video menu and a pointing device to place the zones on a video image. Up to 24 video detection zones per camera view shall be available. Two (2) additional trigger zones for the radar sensor shall be available and be

configurable by using the same system setup menu on the DP. A separate computer shall not be required to program the detection zones. A pre-programmed setup tool is required to align and input radar information and set the camera field of view (zoom and focus).

Hardware. The MSVD hardware shall consist of the following four (4) elements:

1) Video Imaging Camera Sensor
2) Radar Sensor
3) Sensor Data Combiner
4) Detection Processor

Video Imaging Camera Sensor. The video imaging camera sensor shall meet the following minimum requirements:

- To accommodate deployment flexibility, the MSVD camera sensor shall be compatible with the Data Processor platforms. The MSVD camera sensor shall be supplied by the MSVD manufacturer.
- The advanced camera enclosure shall utilize technology for the heating element of the front glass. The transparent coating shall not impact the visual acuity and shall be close to optically clear.
- Cable terminations at the data combiner for video and power shall not require crimping or special tools.
- The camera sensor shall allow the user to set the focus and field of view via Wi-Fi connectivity.
- The camera shall produce a useable video image of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 1.0 lux to 10,000 lux.
- The camera electronics shall include automatic gain control (AGC) to produce a satisfactory image at night.
- The imager luminance signal to noise ratio (S/N) shall be more than 50 dB with the automatic gain control (AGC) disabled.
- The imager shall employ three (3) dimensional dynamic noise reduction (3D-DNR) to remove unwanted image noise.
- The camera imager shall employ wide dynamic range (WDR) technology to compensate for wide dynamic outdoor lighting conditions. The dynamic range shall be greater than 100 dB.
- The camera shall be digital signal processor (DSP) based and shall use a CCD sensing element and shall output color video with resolution of not less than 550 TV lines.
- The camera sensor shall include an electronic shutter control based upon average scene luminance and shall be equipped with an auto-iris lens that operates in tandem with the electronic shutter. The electronic shutter shall operate between the range of 1/1 to 1/10,000th second.
- The camera sensor shall utilize automatic white balance.
- The camera sensor shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier.
- The horizontal field of view shall be adjustable. This camera configuration may be used for the majority of detection approaches in order to minimize the setup time and

spares required by the user. The lens shall be a minimum 10x zoom lens with a variable focal length.

- The lens shall also have an auto-focus feature with a manual override to facilitate ease of setup.
- The camera shall incorporate the use of preset positioning that store zoom and focus positioning information. The camera shall have the capability to recall the previously stored preset upon application of power.
- The camera shall be housed in a weather-tight sealed enclosure conforming to IP-67 specifications. The housing shall allow the camera to be rotated to allow proper alignment between the camera and the traveled road surface.
- The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view.
- The camera enclosure shall be designed so that the pan, tilt and rotation of the camera assembly can be accomplished independently without affecting the other settings.
- The camera enclosure shall include a proportionally controlled heater design that maximizes heat transfer to the lens. The output power of the heater shall vary with temperature, to assure proper operation of the lens functions at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure.
- The glass face on the front of the enclosure shall have an anti-reflective coating to minimize light and image reflections.
- When mounted outdoors in the enclosure, the camera shall operate in a temperature range from -29°F to +165°F and a humidity range from 0% RH to 100% RH. Measurement of satisfactory video shall be based upon DP system operation.
- The camera sensor shall acquire its power from the sensor data combiner.
- Recommended camera placement height shall be 18 to 33 feet above the roadway, and over the traveled way on which vehicles are to be detected. For optimum detection the camera should be centered above the traveled roadway. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier.
- The video signal shall be fully isolated from the camera enclosure and power cabling
- A weather-proof protective cover shall be provided to protect all terminations at the camera.

Radar Sensor. The radar sensor shall meet the following minimum requirements:

- The radar sensor shall operate in the 24 GHz frequency band.
- The radar detection range shall be 600 feet minimum, ±5%.
- The radar sensor shall be able to track up to 20 independent objects simultaneously.
- Object speed detection shall be within a range of zero (0) to 150 mph ±1.0 mph.
- The radar sensor shall be able to detect vehicles in one (1) to four (4) traffic lanes.
- The radar sensor shall be housed in a weather-tight sealed enclosure conforming to IP-67 specifications. The housing shall allow the radar to be adjusted to allow proper alignment between the sensor and the traveled road surface.
- When mounted outdoors in the enclosure, the radar shall operate in a temperature range from -29°F to +165°F and a humidity range from 0% RH to 100% RH.
- The radar sensor shall communicate with the sensor data combiner.
- The radar sensor shall acquire its power from the sensor data combiner.

- Data and power cables between the radar sensor and sensor data combiner shall be fully isolated from the sensor enclosure.

Assembly. Multi-Sensor Vehicle Detection Assembly shall meet the following requirements:

- Both camera and radar sensors shall be housed in an overall, single enclosure assembly.
- The maximum power consumption for the Multi-Sensor Vehicle Detection Assembly shall be less than ten (10) watts typical, 20 watts peak.

Sensor Data Combiner. The sensor data combiner (if required) shall meet the following minimum requirements:

- A sensor data combiner that combines sensor information from both video and radar sensors shall be employed.
- The sensor data combiner shall supply primary power to each sensor unit.
- The sensor data combiner shall facilitate digital communications between the sensor data combiner and each of the sensor units.
- The sensor data combiner shall get its primary power from an AC power source using industry standard 3-Conductor cabling.
- The sensor data combiner shall communicate with the detection processor using a single coax cable. Both video imaging and radar data shall use the single coax cable.
- The sensor data combiner shall also employ industry standard Wi-Fi connectivity for remote sensor system setup using a mobile programming device such as a netbook or tablet computer. Video camera and radar sensor shall be able to be configured independently.
- The sensor data signal shall be fully isolated from the mechanical enclosure and power cabling
- Cable terminations at the sensor data combiner shall not require crimping tools.
- The Sensor Data Combiner shall be housed in a weather-tight sealed enclosure conforming to IP-67 specifications.

Detection Processor. The detection processor shall meet the following minimum requirements:

- Each sensor input shall accept RS170 (NTSC) or CCIR (PAL) signals from an external video source. The interface connector shall be BNC type and shall be located on the front of the processing unit. The sensor input shall have the capability to be terminated into 75-ohms or high impedance (Hi-Z) using dip switches or software control from the user menu. The sensor input shall also facilitate the data from the radar sensor.
- A LED indicator shall be provided to indicate the presence of the sensor signal. The LED shall illuminate upon valid sensor synchronization and turn off when the presence of a valid sensor signal is removed.
- One (1) video output shall be provided. The video output shall be RS170 or CCIR compliant and shall pass through the input video signal. For multi-channel video input configurations, a momentary push-button shall be provided on the front panel to cycle through each input video channel. In the absence of a valid sensor signal, the channel shall be skipped and the next valid sensor signal shall be switched. The real time video output shall have the capability to show text and graphical overlays to aid in system setup. The video output interface connector shall be positive

locking BNC type. Friction type (e.g. RCA type) connectors shall not be allowed.

- A communications port shall be provided on the front panel. The communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information. The interface protocol shall be documented or interface software shall be provided. Each MSVD shall have the capability to be addressable. The DP shall support data rates of 1200 bps to 230,400 bps, inclusive.
- Open collector (contact closure) outputs shall be provided. Four (4) open collector outputs shall be provided for the single or dual channel rack-mount configuration. Additionally, the DP shall allow the use of extension modules to provide up to 24 open collector contact closures per camera input. Each open collector output shall be capable of sinking 30 mA at 24 VDC. Open collector outputs will be used for vehicle detection indicators as well as discrete outputs for alarm conditions. The DP outputs shall be compatible with industry standard detector racks assignments.
- Logic inputs such as delay/extend or delay inhibit shall be supported through the appropriate detector rack connector pin or front panel connector in the case of the I/O module. For DPs and extension modules, 4 inputs shall be supported via detector rack interface. The I/O module shall accommodate eight (8) inputs through a 15-pin "D" connector.
- Detection status LEDs shall be provided on the front panel. The LEDs shall illuminate when a contact closure output occurs. The front panel of the DP shall have detector test switches to allow the user to manually place calls on each DP output channel. The test switch shall be able to place either a constant call or a momentary call depending on the position of the switch.
- A USB mouse port shall be provided on the front panel of the rack mount detection processing unit. The mouse port shall not require special mouse software drivers. The mouse port shall be used as part of system setup and configuration.
- Extension modules (if required) shall be connected to the DP by an 8-wire twisted-pair cable with modular RJ45 connectors. DP and EM communications shall be accommodated by methods using differential signals to reject electrically coupled noise.
- Extension modules (EM) shall be available to eliminate the need of rewiring the detector rack, by enabling the user to plug an extension module into the appropriate slot in the detector rack to provide additional open collector outputs. The extension module shall be available in both two (2) and four (4)-channel configurations. The DP and EM shall be specifically designed to mount in a standard detector rack, using the edge connector to obtain power, provide contact closure outputs and accept logic inputs (e.g. delay/extend). No adapters shall be required to mount the DP or EM in a standard detector rack. Detector rack rewiring shall not be required.
- The DP shall utilize non-volatile memory technology to store on-board firmware and operational data.
- The DP shall enable the loading of modified or enhanced software through the EIA232 or USB port (using a USB thumb drive) and without modifying the DP hardware.
- The DP and EM shall be powered by 12 or 24 volts DC. DP and EM modules shall automatically compensate for either 12 or 24 VDC operation. DP power consumption shall not exceed 7.5 watts. The EM power consumption shall not exceed three (3) watts.
- The DP shall operate satisfactorily in a temperature range from -40°F to +165°F and a humidity range from zero (0) %RH to 95 %RH, non-condensing as set forth in NEMA specifications.

- A video surge suppresser shall be provided for each sensor input. The surge suppresser shall be appropriately grounded to the cabinet ground rod using AWG 14 minimum.

Detection Software. The detection software shall meet the following general system functions:

- Detection zones shall be programmed via an on board menu displayed on a video monitor and a pointing device connected to the DP. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. A separate computer shall not be required for programming detection zones or to view system operation.
- The DP shall store up to three (3) different detection zone patterns in non-volatile memory. The DP can switch to any one of the three (3) different detection patterns within one (1) second of user request via menu selection with the pointing device. Each configuration shall be uniquely labeled and able to be edited by the user for identification. The currently active configuration indicator shall be displayed on the monitor.
- The DP shall detect vehicles in real time as they travel across each detection zone.
- The DP shall accept new detection patterns from an external computer through a communications port when the external computer uses the correct communications protocol for downloading detection patterns.A Windows™ based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability shall be provided with the system.
- The DP system shall have the capability to automatically switch to any one of the stored configurations based on the time of day which shall be programmable by the user.
- The DP shall send its detection patterns to an external computer through the communications port when requested when the external computer uses the appropriate communications protocol for uploading detection patterns.
- The DP shall default to a safe condition, such as a constant call on each active detection channel, in the event of unacceptable interference or loss of the sensor signal.
- The system shall be capable of automatically detecting a low-visibility condition such as fog and respond by placing all effected detection zones in a constant call mode. A user-selected alarm output shall be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.
- Up to 24 detection zones per camera input shall be supported and each detection zone can be sized to suit the site and the desired vehicle detection region.
- The DP shall support two (2) independent trigger points for radar outputs for dilemma zone applications.
- The DP shall provide up to 24 open collector output channels per sensor input using one or more extension modules.
- A single detection zone shall be able to replace multiple inductive loops and the detection zones shall be OR'ed as the default or may be AND'ed together to indicate vehicle presence on a single approach of traffic movement.
- Placement of detection zones shall be done by using only a pointing device, and a graphical interface built into the DP and displayed on a video monitor or laptop computer to draw the detection zones on the video image from each video camera.

- When a vehicle is detected within a detection zone, a visual indication of the detection shall activate on the video overlay display to confirm the detection of the vehicle for the zone.
- Detection shall be at least 98% accurate in good weather conditions, with slight degradation possible under adverse weather conditions (e.g. rain, snow, or fog) which reduce visibility. Detection accuracy is dependent upon site geometry, camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.
- The DP shall provide dynamic zone reconfiguration (DZR). DZR enables normal operation of existing detection zones when one zone is being added or modified during the setup process. The new zone configuration shall not go into effect until the configuration is saved by the operator.
- Detection zone setup shall not require site specific information such as latitude and longitude to be entered into the system.
- The DP shall process the video input from each camera at 30 frames per second. Multiple camera processors shall process all video inputs simultaneously.
- The DP shall output a constant call during the background learning period of no more than three (3) minutes.
- Detection zone outputs shall be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse, extend, and delay outputs shall be user definable between 0.1 to 25.0 seconds.
- Up to six (6) video detection zones per sensor input shall have the capability to count the number of vehicles detected. The count value shall be internally stored for later retrieval through the communications port.
- In addition to the count type zone, the DP shall be able to calculate and/or acquire average speed and lane occupancy using both video and radar sensors. These values shall be stored in non-volatile memory for later retrieval.
- The DP shall have an “advance” zone type where detection outputs to the traffic controller are compensated for angular occlusion and distance.
- The user shall have the ability to enable or disable the display of the phase information on the video output.
- The DP shall have the capability to change the characteristics of a detection zone based on external inputs such as signal phase. Each detection zone shall be able to switch from one zone type (i.e. presence, extension, pulse, etc.) to another zone type based on the signal state. For example, a zone may be a “count” zone when the phase is green but change to a “presence” zone type when the phase is not green. Another application would be zone type of “extension” when the signal phase is green and then “delay” when red.
- The DP shall aid the user in drawing additional detection zones by automatically drawing and placing zones at appropriate locations with only a single click of the mouse. When the user wishes to modify the location of a zone, the DP shall allow the user move a single zone, multiple zones or all zones simultaneously.
- On screen zone identifiers shall be modifiable by the user. The user shall be allowed to select channel output assignments, zone type, input status, zone labels or zone numbers to be the identifier.
- For multiple camera input DPs, the user shall have the ability to enable automatic video output switching. The dwell time for each sensor input shall be user programmable.
- For the radar sensor zones the output can be triggered by presence of a vehicle only or by presence of a vehicle above a speed defined by the user.

Cable. The cable to be used between the Multi-Sensor Vehicle Detection Assembly and the DP in the traffic cabinet shall be per manufacturer's specifications. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. BNC plug connectors shall be used where applicable. The cable, BNC connector, and crimping tool shall be approved by the supplier of the MSVD, and the manufacturer's instructions must be followed to ensure proper connection.

Power Cable. The power cabling shall be per manufacturer's specifications. The cabling shall comply with the National Electric Code, as well as local electrical codes.

Warranty. The Video Vehicle Detection shall be warranted to be free of manufacturer defects in materials and workmanship for a period of three (3) years from the date of final acceptance. Equipment covered by the manufacturer's warranties shall have the registration of that component placed in the Department's name prior to final inspection. The Contractor is responsible for ensuring that the vendors and/or manufacturers supplying the components and providing the equipment warranties recognize the Department as the original purchaser and owner/end user of the components from new. During the warranty period, the supplier shall repair or replace with new or refurbished material, at no additional cost to the State, any product containing a warranty defect, provided the product is returned postage-paid by the Department to the supplier's factory or authorized warranty site. Products repaired or replaced under warranty by the supplier shall be returned prepaid by the supplier.

The Multi-Sensor Vehicle Detector shall be warranted to be free of manufacturer defects in materials and workmanship for a period of three years (3) from the date of final acceptance.

During the warranty period, technical support shall be available from the supplier via telephone within four (4) hours of the time a call is made by the Department, and this support shall be available from factory certified personnel. During the warranty period, updates and corrections to Control Unit Software shall be made available to the Department by the supplier at no additional cost.

THERMAL VEHICLE DETECTION SYSTEMS

Materials.

Video Image Processor. The VIP shall accept video images received for Thermal Imaging Based Vehicle Detection System (TIBVDS) camera, dynamically process the video image and provide real time vehicle detection outputs for use by a traffic signal controller in allocating green time per approach. Each VIP shall be designed to provide failsafe error detection. The output state shall produce a constant call in the event that the VIP is not functioning properly or the video input signal from the camera is unusable for vehicle detection for any reason. A user definable quality level shall be programmable into the unit which would trigger a constant call. Normal detection shall automatically resume when faults with the unit or video input image is corrected. Data zones shall collect and store vehicle counts, volume, speed, gap time, headway, occupancy and classification information. All data stored shall be time-stamped and retained in the unit in a non-volatile memory, binned at user selectable intervals from 1 to 60 minutes. Presence hold time shall be user selectable from 10 to 600 seconds. Data and event alarms shall be generated for queues, wrong direction, speed drop, lack of video, and other events. The VIP shall support up to 24 presence detection zones and up to 8 data collection zones. The VIP shall be supplied with a "Thermal On/Off" setting; optimizing the unit for use with a thermal based camera. The system shall be supplied with one unit interface device (such as a mouse) to allow field programming of the unit and one swivel mounted 7" color LCD monitor in each

cabinet for future viewing of the video image. The Thermal Imaging Based Vehicle Detection system shall be supplied with all necessary software and hardware to allow the end user to program, setup, and/or modify detection zones within each video camera image.

Camera. A Thermal Image Based Vehicle Detection System Camera to be used to provide a video image to the Video Image Processor. The camera shall not be dependent on any visible or infrared illumination to produce images. The unit shall be totally passive and not produce any energy or emit light in any bandwidth. It shall be capable of allowing the user to clearly identify images in the total absence of light. Images shall be clearly visible through smoke and light fog allowing for the display of thermal patterns and contrast to the scene. The camera shall utilize a Vanadium Oxide (VOx) uncooled microbolometer responding in the LWIR (Long Wave Infrared) spectral range of 7.5 – 13.5 µm. It shall not be susceptible to damage after imaging the sun. The camera shall not utilize shutters or dynamic apertures to prevent sun damage. The camera shall be supplied with thermal optics that automatically adjusts to background thermal changes. The camera shall not be susceptible to "image blooming" caused by bright lights. The camera shall include an Auto digital detail Enhancement (Auto DDE) advanced non-linear image processing algorithm. This will serve to enhance the image detail to match the total dynamic range of the original image. In addition, the unit shall provide Non-Uniformity Correction (NUC) which serves to apply a set of compensation factors for each pixel. The camera shall be supplied with Automatic Gain Control (AGC) circuitry to compensate for scene variations, improved image quality by eliminating saturation and distortion and balance signal levels prior to display to maximize image quality. The camera shall be supplied with both white-Hot and Black Hot operating modes. This provides the option of defining display representations of cooler versus warmer objects.

Coaxial and Power Cables. The cables must be rated to meet outdoor temperature, water blocking, ultraviolet and insulation characteristics. Coaxial cable shall be suitable for exterior use and exposure to direct sunlight and the power cable shall be a minimum of six conductors. A junction box on the camera bracket arm shall provide access to video and power cable terminations. Coaxial cable shall terminate with a barrel style BNC connector and power conductors shall be terminated via a small terminal strip. The cable shall be comprised of two elements; one supporting camera power and the other supporting the image signal. The power element shall be 6 conductor, 18 AWG, 7.26 BC. Insulation shall be polyethylene with a thickness of .016". The coaxial element shall be 20 AWG solid BC, with an insulation thickness of .056", a jacket thickness of .035 and a nominal outside diameter of .242. The overall assembly of the cable shall have a jacket thickness of .030", black color, insulation shall be PVC with an outside diameter of .512 and a voltage rating of 300 volts.

Mounting Bracket. The mounting bracket and mounting hardware shall be in accordance with manufacturer's recommendations. The camera shall be mounted to the top of the tube with the camera manufacturers recommended bracket. Camera bracket shall provide adjustments for both vertical and horizontal positioning for the camera. Camera attachments shall be designed to securely fasten the camera to prevent the camera and extension tube from falling into the path of vehicles and/or becoming loose. Miscellaneous hardware shall be stainless steel or galvanized steel. The design wind speed for the cameras and associated

attachment unit shall be as shown in the design specifications with a minimum of 90 mph. For projects that are in areas with higher wind standards, the higher standard shall be used.

SINGLE CAMERA VEHICLE DETECTION SYSTEM

General. The Single Camera System shall employ a single camera to count and detect vehicles for a signalized intersection.

Features. The Camera shall be rugged, environmentally sealed and shall require no aim or focus. The view shall be horizon to horizon, including the center of the intersection.

Camera. The Camera shall have a 180 degree fisheye lens. The camera shall have a minimum resolution of 2560 x 1920 pixels. The output shall be MJPEG. The Camera shall be internally pressurized and leak tested by water submersion and tested in freezing conditions. The housing shall be made of milled aluminum meeting IP68 requirements. Power consumption shall be 5w nominal and 50w with heaters on.

Video/Power Cable. Connectivity to the camera for power and data shall be with a single shielded Cat5e cable.

Physical and Environmental Specifications. The single camera vehicle detection system shall operate satisfactorily in a temperature range from -29°F to +165°F and a humidity range from zero (0) %RH to 95 %RH, non-condensing as set forth in NEMA specifications.

Mounting Hardware. The mount shall be able to withstand vibration (to ANSI C136.31-2010 Section 5 for luminaires), wind tunnel drag force, have a hot/cold force to move greater than 60lbs (greater than 180mph winds), and salt spray, ASTM G85, Annex A3.

Junction Box. The Junction Box shall meet IP67 standards, be tested for Hot/cold submersion, UV exposure (greater than 7 years), and meet vibration standards to ANSI C136.31-2010 section 5 for luminaires).

Regulatory. The Camera shall meet FCC Class A regulations.

Processor.

General. The processor shall be able to support up to 2 fisheye cameras. The processor shall be able to track and count vehicles at a signalized intersection and be able to actuate a traffic signal controller.

Detector I/O. The processor shall be able to work with TS1, TS2, 170/2070. The processor shall have 24 optically isolated I/O and an SDLC interface conforming to TS2 specifications and be programmable for up to 64 detectors.

Connectivity. The communications shall be TCP/IP compliant and shall feature Wide Area Network (WAN) for remote connectivity.

Dimensions. Approximately 8.5” x 11.5” x 1.75", weighing less than 6 lbs. The unit shall have multiple position options including horizontally on an shelf, vertically with an foot stand, and in a 19” rack.

Environmental. Tested to -29°F to 165°F (-34°C to 74°C) NEMA TS2 0-95% non-condensing

Power. 120/240 VAC 50/60 Hz

Consumption. 35W nominal 85W with active camera heaters

Regulatory. FCC Class A

Video Output. MJPEG Color

Testing. Tested to NEMA TS2-2016 standards for Transient, Temperature, Voltage, Vibration and Shock.

Warranty. The camera and processor shall have a 3 year hardware warranty.

RADIO INTERCONNECT SYSTEMS AND EQUIPMENT

Materials. The wireless link shall support the minimum bandwidth requirements with a 99.99% reliability factor. All components must be 100% compatible with the existing Wireless Network (where applicable) and provide the same features, specifications, bandwidth, and capabilities unless specifically stated otherwise.

The wireless system shall include wireless communications devices that are inclusive of the following types: Signal Control, Broadband Type Short Range, Broadband Type Long Range, Television Broadcast Radio (TVBR) Type Short Range, TVBR Type Long Range. Each Type shall be capable of meeting all requirements as identified in this specification except broadband Type Long Range shall be capable of meeting all performance requirements for line-of-sight (LOS) wireless link distances of 10 miles or greater. Broadband Type Short Range shall be capable of meeting all performance requirements for LOS wireless link distances of up to 10 miles. TVBR Type Long Range shall be capable of meeting all performance requirements for non-line-of-sight (NLOS) wireless link distances of two (2) miles or greater. TVBR Type Short Range shall be capable of meeting all performance requirements for wireless link distances of up to two (2) miles. The Contractor shall provide all elements necessary to provide a functional system including radios, antennas, coaxial cable and connectors, lightning suppressors, mounting and grounding hardware, and any other equipment, hardware, enclosures and cabling required to make a complete and fully functional system.

General Requirements. Unless specified otherwise in preceding sections, the radio interconnect systems discussed herein shall adhere to the following minimum technical requirements for Radio Interconnect System devices.

All furnished equipment shall be new, environmentally hardened, and capable of optimal operation in all weather conditions as applicable to Mississippi.

The Contractor shall test all radio hardware and required equipment necessary to provide a complete and fully operational system at no additional cost to the Department.

The Contractor shall obtain and reserve necessary frequencies, and apply for all required licenses by the FCC. The Contractor shall also meet the requirements for filing with the Federal Aviation Administration for proposed structures, which are based on a number of factors: mounting height, proximity to an airport, location, and frequencies emitted from the structures, etc. as described in CFR Title 14 Part 77.9. The charges and fees incurred while applying for and obtaining licenses are included in the pay items outlined in this specification and will not be paid for separately.

The wireless communication equipment shall be fully interchangeable by radio frequency, radio type and compatible with the existing network to transmit all data from field devices across the Department wireless network to communications towers (where applicable), hubs, and/or nodes to be transmitted to the MDOT ITS Network by way of existing network equipment.

The wireless radio equipment shall be configured for minimal noise and interference as determined by project location and the manufacturer's equipment specifications and include the required channel(s) to communicate with radios of the same type and operating as designed.

The Mean Time Between Failures (MTBF) shall be at least 87,658. If the radio system has not been manufactured long enough to validate the corresponding MTBF then Contractor may present the MTBF from a radio system of similar type for approval by the Department. The Contractor must first request approval by the Department to permit the submittal of MTBF specifications of an approved radio system.

The minimum bandwidth provided per each individual link shall be the cumulative minimum bandwidth of each device type and number of each per device utilizing that link according to the following table of min bandwidth requirements.

Device Type	Min Bandwidth per Device
CCTV PTZ	512 kbps
CCTV Fixed	256 kbps
DMS	128 kbps
Detection	256 kbps

Radio Interconnect System General Equipment requirements are as follows:

1) Network Features
    a. 802.3i 10 Mbps Ethernet.
    b. 802.3u 100 Mbps Ethernet with auto-negotiation.
    c. Network topology: Point-to-Point (PTP) and Point-to-Multipoint.
    d. The RF network latency shall not exceed 15ms between each transmitting and receiving device.
    e. The wireless radio shall be analogous to a Layer 2 device by operating similar to a switch or bridge device. The wireless radio shall be capable of connecting to the MDOT Network via an RJ-45 port.
    f. The wireless radios shall be fully interchangeable and compatible with the existing wireless devices operating on the same frequency and of the same type.

2) Management
    a. Local management interface via RS-232, RS-422/485, or RJ45.
    b. Remote Management, i.e., HTTP, SSH, Telnet, SNMP, TFTP, or CLI.
    c. Web-based Management (HTML) shall have Web GUI.
        i. The web-based management shall be password protected management software allowing remote configuration.
3) Power Requirements
    a. The wireless radios may transmit/receive data and receive power via Ethernet cable by PoE. PoE devices adhering to the alternative A/B standards for PoE are recommended. For proprietary PoE devices, the Contractor shall be responsible for ensuring that these devices are not connected to IEEE standard PoE switches or vice versa as this may result in damage to the device and/or switch.
    b. Output Voltage: voltage and power ratings shall adhere to 802.3af or 802.3at for devices conforming to the IEEE standards.

4) Environmental Requirements
    a. Radio interconnect field equipment shall be fully operational in all-weather conditions occurring in Mississippi.
    b. Relative humidity 95% non-condensing.
    c. Weather, Water, & Dust Proof, e.g., IP-66/IP-67.
    d. Operating temperature shall exceed the range from -35°F to 135°F

Radio Interconnect System, Signal Control. The radio interconnect system, signal control shall provide communications between the master and the local intersections by RF data link. The radio shall operate in the 900 MHz data frequency bands. Each local intersection shall have a transceiver, power supply and an antenna. A transceiver shall be provided at the master location.

Specific Requirements.

Antennas. Two (2) antennas will be required at repeater stations, one for each radio. Measures shall be taken to minimize the chance of interference between these antennas. One effective technique for limiting interference shall employ vertical separation. In this arrangement, one antenna is mounted directly over the other, separated by at least four feet (4'). This takes advantage of the minimal radiation exhibited by most antennas directly above and below their driven elements.

Another interference reduction technique is to cross-polarize the repeater antennas. If one antenna is mounted in the vertical plane and the other in the horizontal plane, an additional 20 dB attenuation can be achieved. The corresponding stations shall use the same antenna orientation when cross-polarization is used.

Interface Wiring. A null modem cable shall be required between the Data Interface connectors of the two radios forming a repeater station, allowing radios to exchange data even though they are both configured as DCE (data circuit-terminating equipment) devices.

Radio Interconnect System, Broadband. The radio interconnect system, broadband, shall be a licensed or unlicensed wireless communication device as called out in the plans or directed by the project engineer, capable of transmitting and receiving broadband wireless communication at distances as called out on the plans. The Contractor shall be responsible for determining the most optimal frequency range to furnish radios that will provide wireless links with sufficient bandwidth for all devices to communicate properly across the network. When expanding the wireless link of an existing system, the Contractor shall ensure the frequency of the new equipment is compatible with the existing system. The radio system shall be used to connect ITS device sites and Traffic signal systems to the existing MDOT ITS Network as described in project plans. The broadband wireless communication system shall be furnished with all necessary hardware and software to include radios, repeaters, antennas, cable, surge protection and connectors in accordance with the plans and specifications to establish stable wireless communication channel(s) between two (2) or more LOS/partial LOS devices setup in point-to-point or point-to-multipoint configurations. The broadband radio interconnect requirements shall be as follows:

1) The broadband radios furnished and installed shall meet all regulations set forth by the FCC part 15 of the FCC rules.
2) Short range broadband radios shall be capable transmitting up to 10 miles.
3) Long range broadband radios shall be capable of transmitting at distances exceeding 10 miles.
4) The short range and long range broadband radios shall provide reliable communication and sufficient bandwidth (i.e., greater than the cumulative minimum bandwidth of each device that will utilize the link) for all devices utilizing the wireless link(s).
5) The Contractor may propose the use of multiband (dual band, tri band, etc.) radios using licensed 4.9 GHz and unlicensed 5.8 GHz and 2.4 GHz bands if bandwidth requirements and path interference warrants the use of such radios, and approved by

the Project Engineer.

Radio Interconnect System, Television Broadcast Radio (TVBR). TVBRs are unlicensed radios designed to produce, transmit, and/or receive radio communication signals at select geographical locations. These radios transmit on available channels in the broadcast television frequency band. The TVBRs shall be proposed on project plans and drawings in geographical locations lacking visual line-of-sight transmission between the proposed transmitting and receiving devices. These devices shall provide partial line-of- sight (LOS) and/or non-line-of-sight (NLOS) radio transmission to establish network communication in areas with obstacles obstructing LOS wireless communication.

The TVBRs operate under the Federal Communications Commission (FCC) approved white space TV band database. Each TVBR shall determine the available TV channels it can operate on before it will be functional for typical usage. The TVBRs retrieve a list of available channels via an Internet connection from the white space TV band database dependent on the TVBRs specific geographic coordinates, which are acquired and saved on the device during configuration. Typically, TVBRs can transmit and receive radio communication on six (6) MHz channels. TV Channels 14-36 and 38-51 are available for TVBRs operating on TV channels in the UHF frequency range (470-698 MHz). Once a TVBR is registered with the white space TV band database and associated with a specified operating channel, the channel is removed from the list of available channels. The Contractor shall be responsible for determining the availability of TV bands in the geographical areas for all TVBRs proposed. The Contractor shall provide a list of available TV channels in the UHF frequency range to the Project Engineer, or approved designee. The Contractor shall not procure, purchase, furnish, or install TVBRs or any related equipment without the consent of the Project Engineer or the approved designee without first receiving confirmation from the Project Engineer or their designee that verification has been made that the specified channels are available in all geographic location(s) for each proposed TVBR site.

Specific Requirements. The TVBR, type long range and short range, shall be a capable of LOS, partial LOS, and NLOS wireless radio transmission. Each TVBR and antenna shall be pole mounted or mounted to an approved structure. The antenna shall be mounted in the immediate location of the TVBR to minimize attenuation due to cable length. The TVBR radio interconnect requirements shall be as follows.

1) The TVBR's procurement and installation shall meet all regulations set forth by the FCC 47 CFR 15 subpart H – Television Band Devices.
2) The TVBR's shall be capable of LOS and NLOS wireless transmission operating on the UHF TV band frequency range (470-698 MHz).
3) The Type Long Range TVBR shall be capable of communicating over wireless link distances exceeding two (2) miles. The bandwidth capacity shall exceed 25 Mbps provided LOS transmission and 5 Mbps provided NLOS transmission.
4) The Type Short Range TVBR shall be capable of communicating over wireless link distances up to two (2) miles. The bandwidth capacity shall exceed 3 Mbps provided LOS transmission and 1 Mbps for NLOS transmission.
5) The TVBR's transmit power shall not exceed 30 dBm for stable RF communication given the minimum distance and bandwidth requirements.
6) The RF network latency for Long Range TVBR shall not exceed 5ms between each transmitting and receiving device.
7) The MTBF shall be at least 43,829 hours for Type Short Range TVBR and 87,658 for Type Long Range TVBR. If the TVBR system has not been manufactured long enough to validate the corresponding MTBF, the Contractor may present the MTBF from a radio system of similar type for approval by the Department. The Contractor

shall first request approval by the Department to permit the submittal of MTBF specifications of an approved radio system.

Warranty. The radio interconnect system shall be warranted to be free of manufacturer defects in materials and workmanship for a period of one (1) year from the date of final acceptance. Equipment covered by the manufacturer's warranties shall have the registration of that component placed in the Department's name prior to Final Inspection. The Contractor is responsible for ensuring that the vendors and/or manufacturers supplying the components and providing the equipment warranties recognize the Department as the original purchaser and owner/end user of the components from new. During the warranty period, the supplier shall repair or replace with new or refurbished material, at no additional cost to the State, any product containing a warranty defect, provided the product is returned postage-paid by the Department to the supplier's factory or authorized warranty site. Products repaired or replaced under warranty by the supplier shall be returned prepaid by the supplier.

During the warranty period, technical support shall be available via telephone within four (4) hours of the time a call is made by the Department, and this support shall be available from factory certified personnel. During the warranty period, updates and corrections to control unit software shall be made available to the Department by the supplier at no additional cost.

POWER SERVICE PEDESTAL

The pedestal shall be of NEMA Type 3R rainproof construction and shall be UL Listed as "Enclosed Industrial Control Equipment" (UL 508A). External construction shall comply with UL50 requirements and shall be unpainted aluminum.

Nominal size of the pedestal shall be 48"H x 16"W x 16"D.

Pedestal shall have a voltage rating or 120v/240v single phase with an Amperage rating that is adequate to run all traffic signal equipment as specified in the plans (max 800A).

Hinges shall be stainless steel and of the continuous piano hinge type.

The pedestal mounting bolts shall not be externally accessible. The pedestal shall be able to be embedded in concrete or use anchor bolts for mounting on concrete base. Either pedestal mounting base or anchor bolt kit shall be required for installation.

The service pedestal shall have three separate isolated sections for metering equipment, utility termination and customer equipment.

The metering section shall be pad-lockable and sealable and have a hinged swing hood with an integral hinged polycarbonate sealable window for access to demand meters. Meter socket type shall meet the requirements of the serving utility.

The utility termination section shall be pad-lockable and sealable and shall have a stainless steel handle provided on a lift-off cover. Sufficient clearance shall be provided for a 4- inch diameter conduit for utility cables entrance. Utility landing lugs shall be UL listed and shall accommodate #6 – 350 kcmil conductors.

The customer compartment door shall be hinged on the left hand side. A stainless pad-lockable hasp shall be provided to secure customer compartment. An outdoor rated heavy duty combination lock shall be provided to lock the customer compartment door. A door keeper shall be provided to keep the door in an open position. A print pocket shall be provided on the inside of the door in a weatherproof sleeve. Required UL labeling shall be located on the inside of the customer door. Distribution and control equipment shall be behind an internal dead-front door with a quarter-turn securing latch and shall be hinged to open more than
90 degrees. The dead-front door shall be hinged on the same side as the customer section door. All distribution and control equipment shall be factory wired using 600 volt wire sized to NEC and UL requirements.

The service pedestal shall be rated for operation at 10K minimum (AIC) amps interrupting capacity. The provided documentation shall list circuit breaker combinations and those to be used for de-rated operation for series ratings. Circuit breakers shall be permanently labeled with engraved name plates.

ELECTRICAL CABLE

Electric Cable. Electric cables shall be high-grade insulated conductors of premium quality material and workmanship manufactured in accordance with the accepted industry standards, suitable for use in trays, ducts, conduit, aerial installs, and direct burial applications. It shall be accessible to the Engineer for inspection at all reasonable times. In lieu of such inspection, the Engineer may require that three (3) certified copies of factory tests be furnished.

The materials used for electrical conductors, insulation, jacket armoring and covering shall meet the requirements herein and as indicated on the plans.

Material for backfilling cable trenches shall be as shown on the plans.

Cable shall be of the following types with number of conductors and conductor size as indicated on the plans.

Signal Cable. Signal cable shall be polyethylene insulated, polyethylene jacketed cable, rated at 600 volts meeting the requirements of IMSA Specification No. 20-1, and with integral messenger cable meeting the requirements of IMSA Specification No. 20-3.

Power Cable. Power cables shall be three (3)-Conductor cables or as noted in the plans, rated at 600 volts meeting the requirements of IMSA Specification No. 20-1. Engineer may approve alternate cable at their discretion.

Luminaire Power Cable. Luminaire power cables shall be two (2) or three (3)-Conductor cables, as indicated on the plans, rated at 600 volts meeting the requirements of IMSA Specification No. 20-1. Engineer may approve alternate cable at their discretion.

Tracer Cable and Warning Tape. Tracer cable shall be Type THWN, annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with abrasion, moisture, gasoline, and oil resistant Nylon, or UL-listed equivalent. The cable shall be AWG #10 with 19 strands and a 20-mil insulation thickness. It shall be suitable for operations at 600 volts as specified in the National Electric Code (NEC).

The warning tape shall be a non-detectable commercial warning tape approved by the Engineer.

Category 6 Cable. Category 6 (Cat6) cable shall be outdoor and industrial rated, shielded, and shall be suitable for underground use. Cable shall have an AWG 24 integrated electrostatic discharge drain wire. Cable shall conform to the global cabling, ISO/IEC 11801 standards. The cable standard provides performance of up to 250 MHz and is suitable for 10BASE-T, 100BASE-TX (Fast Ethernet), 1000BASE-T/1000BASE-TX (Gigabit Ethernet), and 10GBASE-T (10-Gigabit Ethernet). Cable shall be UL Copper pairs and shall be AWG 24 solid copper and have solid polyolefin insulation. Cable shall have an inner jacket of linear low density. Cable shielding shall be aluminum foil bonded to polyester film to provide 100% shield coverage. The cable shall have a linear low density polyethylene outer jacket rated for sunlight resistance, oil resistance, and a maximum operating voltage of 300 V RMS.

Communication Cable. Communication cables shall be as per manufacturer's recommendations. Communication cables installed underground in conduit shall meet the requirements of IMSA Specification No. 40-2. Communication cables that are aerial cables with messenger support strands shall meet the requirements of IMSA Specification No. 40-4.

TRAFFIC SIGNAL PULL BOXES

Materials.

Pull Box Enclosures, Grade-Level. Pull box enclosures and covers shall be made of either precast Class "B" concrete or composite material using matched surface tooling and shall conform to all test provisions of the latest version of ANSI/SCTE 77 - *Specification for Enclosure Integrity.*

Surface Mounted Pull Box. Surface mounted junction boxes shall be cast iron, inside flanged and gasket for a NEMA 4 rating. Boxes shall be of size and characteristics as indicated on the plans.

For grade level pull boxes and enclosures only, Tier 22 (22,500-pound design load, 33,750-pound test load) enclosures with minimum size dimensions as shown in the detail drawings on the plans shall be installed for use in traffic signal construction. Enclosure boxes shall be open bottom. The cover supplied shall have a design load equal to that of the enclosure box. In no assembly can the cover design load exceed the design load of the enclosure box. Stainless steel hex bolts and nuts shall be provided to secure the cover. Bolts and nuts shall withstand a minimum torque of 35 foot-pounds and a minimum of 750 pounds straight pull-out as a means to secure the cover to the box. The inside of the cover and the box shall be permanently marked (by impress or ink) with manufacturer's name or logo, ANSI/SCTE Tier level and model number.

If required by the Engineer, independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met will be submitted with each submittal. All covers shall be provided with legend "Traffic Signal", or as specified in plans, and the appropriate ANSI/SCTE Tier level embossed on their surface.

Boxes shall be of size and characteristics as indicated on the plans.

All pull boxes provided shall be of the following minimum dimensions for each respective pull box type.

Pull Box Type	**Nominal Minimum Dimensions** Width (inches) x Length (inches) x Depth (inches)
Type 1	11" x 18" x 12"
Type 2	13" x 24" x 18"
Type 3	17" x 30" x 24"
Type 4	24" x 36" x 24"
Type 5	30" x 48" x 24"

PEDESTRIAN DETECTION ASSEMBLIES

Materials.

Standard Pedestrian Pushbutton Detector. The Standard Pedestrian Pushbutton Detector shall meet the latest ADA Compliant Specifications. Pushbuttons shall be raised from or flush with their housings and be a minimum of two (2) inches in the smallest dimension. The Pushbutton shall require no more than five pounds (5 lbs.) of force to activate. The detector shall be weather-tight and tamper resistant. The pushbutton shall be provided complete with suitable mounting hardware for banding, or attaching by other suitable methods, to poles.

Housing. The housing shall be a two (2) piece unit consisting of a base housing and a removable cover. The housing shall be cast metal with a brushed aluminum finish and shall be primed and painted black in color. The housing shall be rain-tight, weatherproof, and shall protect users from electrical shock. The housing or adapter shall conform to the shape of a pole and provide a flush, secure fit. Unused openings shall be closed with a weatherproof closure and painted to match the housing. The housing shall be permanently marked with the Manufacturer name or trademark, part number, date of manufacture, and serial number.

Pushbutton. The Pushbutton shall include a normally-open, mechanical phenolic enclosed, positive-acting, snap-action switch with signal pole, single throw contacts or Piezo driven solid state switch rated for a minimum of 50 V. The switch, when activated, shall give an audible (i.e., click) and visual indication of actuation. The visual indication shall remain illuminated until the pedestrian's WALK indication is displayed. Switch connections inside the housing shall allow wiring and installation without binding. The switch shall have a minimum design life of one (1) million operations at rated load.

Electrical Requirements. The cabling, at a minimum, shall be AWG 14, 5- Conductor stranded with 600 V outdoor insulation rating.

Control Electronics. Control electronics shall not require more than four (4) wires for each Pushbutton connection, and no more than two (2) wires for each controller pedestrian input. Voltage at the Pushbutton shall not exceed 24 VAC.

Accessible Pedestrian Pushbutton Detector. The Accessible Pedestrian Pushbutton Detector shall be MUTCD, latest edition, compliant and consist of all electronic control equipment, wiring, mounting hardware, pushbuttons, and Pedestrian Actuation Signs designed to provide both a pushbutton with a raised, vibrating tactile arrow on the button as well as a variety of audible indications for differing pedestrian signal functions.

Electronic Control Equipment. The Accessible Pedestrian Pushbutton Detector shall include electronic control equipment that is programmable and adjustable using a laptop computer or vendor supplied programmer. Electronic control equipment shall be able to be installed within a traffic controller cabinet or within Pedestrian Signal housing. Electronic control equipment installed within a traffic controller cabinet shall allow the use of up to 16 pushbuttons (four (4) maximum per channel) with a single traffic controller cabinet. The Accessible Pedestrian Pushbutton Detector shall receive timing from WALK and DON'T WALK signals.

Audible Messages. Audible messages shall be programmable. All audible messages and tones shall emanate from the Accessible Pedestrian Pushbutton housing. The Accessible Pedestrian Pushbutton Detector shall utilize digital audio technology. The system shall have, at a minimum, three (3) programmable locator tones. The Accessible Pedestrian Pushbutton

Detector shall have independent minimum and maximum volume limits for the Locator Tone, "Walk," and Audible Beaconing features. The "Wait" message shall only annunciate once per actuation.

Pushbutton Locator Tone. The Accessible Pedestrian Pushbutton Detector shall provide independent ambient sound adjustment for the locator tone feature. The Accessible Pedestrian Pushbutton Detector shall allow the locator tone to be deactivated.

Vibrating Pushbutton (VPB). The Accessible Pedestrian Pushbutton Detector shall include a Vibrating Pushbutton (VPB). The VPB shall be a single assembly containing an ADA compliant, vibro-tactile, directional arrow button, weatherproof audible speaker and pedestrian actuation sign with optional placard Braille messages. The VPB tactile arrow shall be two (2) inches in length, be field adjustable to two (2) directions, and require no more than five pounds (5 lbs.) of applied force to activate.

Conflict Monitoring. The Accessible Pedestrian Pushbutton Detector shall monitor the WALK condition for conflict operation. The Accessible Pedestrian Detector system shall disable the WALK functionality if a conflict is detected.

Cabinet Control Unit (CCU). The Accessible Pedestrian Pushbutton Detector may include a CCU for interfacing and connecting the system. The CCU shall have labeled LED indicators for each channel operation. The CCU shall reset upon loss of internal communication.

Inputs and Outputs. All inputs and outputs shall use Mil-Spec Multi-pin connectors.

Inputs. WALK and DONT WALK inputs shall be optically isolated 80-150 volts AC/DC, five (5) mA max. General purpose inputs shall be optically isolated 10-36 volts AC/DC, ten (10) mA max.

Outputs. Outputs shall be optically isolated 36 volts AC/DC peak, 300mA solid state fused contact closures. CCUs shall include a normally open relay contact fault output.

Communication. The CCU shall include an Ethernet interface. The CCU shall have an integral web server that provides information on audible/tactile pedestrian- pushbutton detector status, access to event logs, and provides for remote configuration of Accessible Pedestrian Pushbutton Detector System options. VPBs shall include an Ethernet, serial, or USB programming interface.

Electrical. All wiring shall meet applicable NEC requirements. The Accessible Pedestrian Pushbutton Detector shall operate using a nominal input voltage of 120 volts alternating current (VAC). If any device requires nominal input voltage of less than 120
VAC, furnish the appropriate voltage converter.

Accessible Pedestrian Pushbutton Detector control electronics that are mounted in a pedestrian signal head shall be able to receive power from the WALK and DONT WALK circuits of the signal head. Control electronics shall not require more than four (4) wires for each pushbutton connection, and no more than two (2) wires for each controller pedestrian input. Voltage at the Pushbutton shall not exceed 24 VAC.

Mechanical. Equipment shall be permanently marked with manufacturer name or trademark, part number, date of manufacture, and serial number. Self-tapping screws shall not be used on the exterior of the assembly.

All parts shall be made of corrosion-resistant materials. All assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, shall be Type 304 or 316 passivated stainless steel. Stainless steel bolts, screws and studs shall meet ASTM F593. Nuts shall meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter shall be galvanized. Bolts, studs, and threaded rod shall meet ASTM A307. Structural bolts shall meet ASTM A325.

Enclosures shall have a NEMA 4X rating. Pushbutton housings shall be black in color.

Environmental. Ensure equipment performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2, Sections 2.2.7, 2.2.8, and 2.2.9.

LED INTERNALLY ILLUMINATED SIGNS

Materials.

Illuminated Traffic Signs. Illuminated traffic signs shall be LED internally illuminated warning or regulatory signs with a single sided rigid mount.

Mechanical Specifications. The outer dimensions of the sign assembly shall be as shown on the plans, or as specified in the MUTCD, with standard nominal heights of 18" to 36".

Housing. The long edges of the sign shall be made from corrosive resistant aluminum. The ends caps shall be made from aluminum and shall be affixed to the frame with stainless steel screws. The power supply shall be mounted internally and one (1) end cap shall be removable to enable replacing panels and components.

Both the back panel and the sign face panel shall be securely held inside of the sign's extruded rails.

The sign shall have a front panel that is UV, weather, abrasion and impact resistant. The front panel shall be replaceable so that maintaining agencies have the option to supply sheeting and electrocut film for the sign faces.

All exterior surfaces of the sign assembly shall be powder-coat painted in accordance with Military Standard MIL-C-24712. Finish will meet the requirements of ASTM D3359, ASTM D3363, and ASTM D552

No silicone will be used in the weather resistant seal of the sign. The sign enclosure shall have a weatherproof design that ensures water does not reach internal components, and shall be able to do so in its design, without the use of silicone.

Rigid Mount. The sign shall rigid mount directly to the signal mast arm or to a sign mast arm with no moving parts. Sign brackets shall be able to be leveled to accommodate mast arms that are slightly off level. Sign bracket hardware shall mount as per manufacturer's specifications.

The sign will have no holes drilled though the enclosure's back plate for use in a rigid mount mast arm configuration. Adjustable rigid mount hardware shall securely grasp the top and bottom rails of the sign to provide maximum retention of the sign when installed on the mast arm.

The sign shall be supplied with rigid back brace mounting brackets on two (2) positions on the back of the sign. The rigid back brace mounting brackets will be powder-coat painted to an exact match of the sign extrusions and shall be in accordance with Military Standard

MIL-C-24712. The finish shall meet the requirements of ASTM D3359, ASTM D3363, and ASTM D552. Approved brackets as per manufacturer's specifications, shall be used for this installation.

Environmental. The sign and power supply shall be field hardened and be able to withstand extreme operating temperatures.

Signs shall be tested and certified for the following environmental conditions:

- Exclusion of Water Test
- Thermal Shock Test
- Salt Spray Test
- Strain Relief Test
- Temperature Test
- Dielectric Voltage - Withstand Test.

Signs shall be UL (Underwriters Laboratories) listed and approved.

Structural. The sign shall meet the specifications set forth in the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The sign shall meet the wind requirements set forth in the latest edition of the AASHTO Wind Map.

Luminance. The entire surface of the sign panel shall be evenly illuminated with a minimum average brightness reading at the letters of a minimum of 500 lux.

Light Source. The light source for the sign shall be LEDs. The LEDs shall evenly illuminate a light panel that is the same dimensions of the sign face. The LEDs shall have a minimum projected lifespan of 50,000 hours. The Failure of one (1) LED shall not reduce the light output or cause other LEDs to fail. All LED's shall meet ITE Standards for color and viewing angle and be high in optical power.

Energy Requirement. The sign shall be an Energy Star Qualified Product.

Quality Assurance. Manufacturer shall be ISO 9001:2000 compliant certified.

Electrical Standards. The sign shall be listed and approved to UL Standards by a Nationally Recognized Testing Laboratory.

LED Single Output Switching Power Supply shall be a fully-encapsulated, constant- current design built to withstand 300VAC surge input for five (5) seconds, with inherent short circuit/over current/over voltage protection. The Power Supply shall be a UL 1310 Class 2 power unit, and will be housed in a fully isolated plastic case to prevent water intrusion.

Safety Standards shall meet the following criteria: UL1310 Class 2, CAN/CSA C22.2 No. 223-M91 (for LPC-60-1750 only), IP67 approved; design refer to TUV EN60950-1, EN61347-2-13.

Warranty / Guarantee. Sign shall be guaranteed for a minimum of five (5) years.

Illuminated Street Name Signs. Illuminated Street Name Signs shall be LED Internally illuminated signs allowing for single or double sided signs for span wire or rigid mounts.

Mechanical Specifications. The outer dimensions of the sign assembly shall be as shown on the plans with standard nominal heights of 18" to 36", and standard nominal lengths of 48" to 144".

Mounting. For a single-sided underhang sign, the sign shall be supplied with underhang mounting brackets on two (2) positions on the back of the sign. The mounting bracket shall have a bolt hole pattern to accept manufacturer specified sign hardware. For a double-sided

sign, the sign shall be supplied with underhang mounting brackets on two (2) positions on the top of the sign that allows the sign to swing freely. The mounting bracket shall have a bolt hole pattern to accept the manufacturer's hardware.

Energy Requirements. The average power consumption of the sign shall not exceed 3 – 5 Watts per square foot of viewing area. The sign shall be capable of operating at 120 VAC to 277 VAC. The sign shall be an Energy Star Qualified Product.

LED Blank-Out Signs. Blank-Out Signs are an alternative to static warning and regulatory signs to increase visibility, and for creating a safer driving environment. The signs shall conform to Manual on Uniform Traffic Control Devices (MUTCD), latest edition, font and symbol sign standards. In addition enclosures shall meet NEMA 3R standards. The sign shall be capable of displaying one (1) or multiple messages. The messages may be red, amber or bluish/green and be displayed on one (1) side or two (2). The messages shall be formed by single or double rows of LED's.

Housing and Mounting. The housing shall be weatherproof and made of 5052-H32 marine-grade aluminum that is 0.125 inch thick.

The finish shall be black powder coat unless otherwise specified in the plans. The finish on the sign housing shall be two (2) coats of exterior enamel applied after surface material is acid-etched and primed with zinc-chromate primer.

All corners and seams of one 1- or 2-way housings shall be heli-arc 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.

Window dimension shall be between 24" to 60" wide with a maximum weight of 100 pounds.

Door gaskets shall be $^{3}/_{16}$-inch x 1-inch neoprene to provide a weatherproof seal. Each door shall be fitted with a sun hood of 0.063-inch aluminum. The standard length shall be six inches (6"). Drainage shall be provided by four (4) drain holes at the corners of the housing.

The sign shall rigid mount directly to the signal mast arm or to a sign mast arm with no moving parts. Sign bracket shall be able to be leveled to accommodate mast arms that are slightly off level. The sign shall also be able to mount on span wire.

Light Source. 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.

All LED's shall have an expected lifetime of a minimum of 50,000 hours. LED Modules shall continue to shall continue to operate if one LED goes out.

All LED's shall meet ITE Standards for color and viewing angle and be high in optical power.

Electrical. The sign shall be solid state, with a 95 to 125 VAC input, 12 to 15 VDC output, and >95% power factor. The average power consumption of the sign shall be 35 to 105 Watts, varies per message. Transformers shall be used to reduce the incoming 120 volts AC to the design DC voltage. The transformers shall contain Class A insulation and weatherproofing.

The sign shall be capable of continuous operation over a range in temperatures from -35°F

to +165°F.

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

REMOTE CABINET MONITORING DEVICE

Description. Emergency Vehicle Preemption with Remote Cabinet Monitoring for the traffic signal controller shall utilize Radio/GPS to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from phases normally available. The system also allows remote monitoring capabilities of Traffic Signals using either Ethernet communications via fiber or Cellular communications.

Materials. All connections and equipment shall be new and constructed using the highest quality, commercially available components and techniques to assure high reliability and minimum maintenance of the emergency vehicle and railroad signal preemption systems.

Vehicle Equipment. The Vehicle Device shall conform to the following requirements:

- The device shall function correctly between -34°C and +74°C.
- The device shall be capable of being mounted inside a vehicle either under a seat or strapped under the dashboard. The unit will come with all wiring needed to connect the system to the vehicle.
- The device shall interface to a non-invasive road sensor for environmental measurements via either RS485 or Bluetooth connection.
- The device shall be provided with appropriately rated and keyed connectors that allows the device to be exchanged by unplugging connectors, without tools.
- The device shall incorporate an integrated GPS and/or cell modem.
- The configuration of the device shall be accomplished by accessing the internal web server with a browser. It shall be possible to configure the device without any special software.
- The device shall incorporate an integrated GPS which will allow the device to geo-locate itself on the map, without configuration.
- The device shall operate without requiring static IP address. The only configuration required at the device is to enter the URL of where the TSPRMS central software is hosted.
- In the event that the cell service is interrupted or is not available, the device shall store any events that occur in internal memory, and forward these events automatically to the cabinet monitoring system when the cell service is restored. In this way, a complete record of events at the device can be maintained even if cell service is interrupted for a period.
- The device shall utilize HTTP and HTTPS protocols, and XML data structures, for communications with the cabinet monitoring system. In this way the data will be open for future expansion and competition. The use of secret proprietary protocols is not permitted.
- The device shall support Ethernet, cellular and license free radio communication.
- The device shall have the option of being supplied with an enhanced GPS, which provides GPS coordinates based on dead-reckoning even when the GPS signal is shielded from the vehicle such as under an overpass; in a tunnel or in between tall buildings in a city. The dead reckoning system shall include accelerometers, gyroscopes and a distance measure that will provide accuracy of better than 20 feet in 1000 feet, when there is no information from the GPS satellites. The enhanced GPS shall optionally be connected to the vehicle OBD-II port; the J1939 ECU port (for heavy vehicles) or a wheel tick sensor as the project requires. The enhanced GPS shall self-calibrate the wheel tick input.

Intersection Equipment. It is a requirement that the Emergency Vehicle Preemption with Remote Cabinet Monitoring system operate independent of the brand/type of intersection controller deployed at the intersection. The system shall connect to the terminal strip in the cabinet (via a provided wiring harness) and make the system function independent of controller operation. A 19" Rack Mounted option shall be available if required in the plans.

The system Field Device shall conform to the following requirements:

- The Device shall function correctly between -34°C and +74°C.
- The nominal size of the Device shall be 19" x 7.455" by 1.719", and shall be suitable for placing in Traffic Signal Cabinets specified in this specification.
- The Device shall be provided with appropriately rated connectors that allow the Device to be exchanged by unplugging connectors, without tools.
- The Device shall incorporate an integrated GPS and cell modem (when required).
- The configuration of the Device shall be accomplished by accessing the internal web server with a browser. It shall be possible to configure the Device without any special software.
- The Device shall be powered via a standard 120V input power.
- The Device shall allow for the routing of the controller configuration packets to and from the controller (either by Ethernet or serial communications) for the three types of controller that are utilized by the Department. In this way it shall be possible to configure the controller, and utilize the controller specific software to interrogate the controller, and the system shall provide the communications pipe which allows this to be accomplished.
- The Device shall utilize field initiated communications. This allows for a low cost cellular data plans to be used, with infrequent polling. However, when an abnormal event occurs and is detected by the Device, then the Device will immediately initiate the transfer of a data packet to the system to enable real-time alerting of response personnel to take place.
- The Device shall, within the size limitations above, include a battery and battery charging/monitoring circuit, to allow the system to function correctly even when all power to the intersection has failed. The battery shall continue to power the Device for a minimum of five (5) hours after all power has failed to the intersection.
- The Device shall incorporate an integrated GPS which will allow the Device to geo-locate itself on the map, without configuration.
- The Device shall operate without requiring a static IP address. The only configuration required at the Device is to enter the URL of where the system central software is hosted.
- In the event that the cell service is interrupted or is not available, the Device shall store any events that occur in internal memory, and forward these events automatically to the system when the cell service is restored. In this way, a complete record of events at the device can be maintained even if cell service is interrupted for a period.
- The Device shall utilize HTTP and HTTPS protocols, and XML data structures, for communications with the system. In this way the data will be open for future expansion and competition. The use of secret proprietary protocols is not permitted.

Client User Interface. The user interface software shall provide, at a minimum, features to

meet the following requirements:

General. The user interface shall be web based and able to be viewed using a browser. Internet Explorer, Chrome and Firefox browsers shall be supported, as well as Safari on an iPad. Systems that use remote desktop or similar to view a thick-client user interface will not be acceptable. The user interface shall require a user name and password to log on.

Map Display. The system shall include a scrollable, zoomable map display, with the intersections and emergency vehicles shown as representative icons on the map.

The alarm status of the intersection shall be clearly indicated on the icon on the map, so that the user can see at a glance which intersections are in alarm.

The map display shall also include a list of intersections, with the number and priority of alarms indicated on the list. Intersections in high priority alarm shall be moved to the top of the list, followed by medium priority, low priority and then finally by intersections not in alarm.

The icons shall change to be able to clearly indicate if an intersection is offline.

Clicking on the icon on the map shall expose a box with the current parameters of the intersection shown.

The default map display position and zoom shall be configurable by user, so that the user's view will default to show the intersections that the user is responsible for managing.

The map view shall have the ability to show traffic overlays on the map.

The map view shall be able to show vehicle trails when the vehicles have been in an emergency or not active.

Regional Intersection and Vehicle Grouping. The System shall provide for intersections and vehicles to be logically grouped into regional groupings (for example, north; south; Fire 1; Fire 2)

The System user logon shall be configurable so that if a maintenance or operational person is responsible for, say, the north intersections and emergency vehicles then when that user logs on, the user has visible only the intersections that belong to the group that the user is authorized to view.

Intersection Detail Display. Intersection detail display shall be possible to drill down, either from the map icon or from the list, to a device level detail for the intersection, which as a minimum shall display the following parameters:

- The alarm status, with priority indicated, and a text description of the alarm (if an alarm is present for this device).
- The time since the last communication with the device
- The following parameters (real time now values, minimum for the day values, maximum for the day values, and average for the day values)
    - The AC mains voltage (value)
    - The battery back-up voltage (value)
    - The cabinet temperature (value)
    - The cabinet humidity (value)

    - The presence of AC power (OK or Fail)
    - The flashing status of the intersection (OK or Flashing)
    - Stop Time status (OK or Stop Time Active)
    - The cabinet door status (Open or Closed)
    - The intersection fan status (Fan On or Fan off)
- It shall be possible to view graphs of each of the value parameters in graphical form, over the recent two week period. This includes at a minimum real time graphs of:
    - The AC mains voltage
    - The battery back-up voltage
    - The cabinet temperature
    - The cabinet humidity

Diagnostics and Log Display. From the device level detail, it shall be possible to further drill down to get the raw data; the error logs; and the communications logs to allow a technician to fault-find problems on the System.

It shall also be possible to:

- filter the logs by Device; by Device Type and/or by Group as well as between dates.
- print these selected logs to a local printer or a PDF file.
- export these logs to Excel on the local computer for further analysis.

Alarms. The System shall have a comprehensive alarm generation capability.

It shall be possible to configure alarms to be generated on any parameter becoming out of tolerance, including analog values, digital values and enumerated values.

Alarms shall be configurable to be of Low, High or Critical Priority.

The alarm priority shall be displayed throughout the System, on all displays, using color codes such as red-critical; yellow – high; and amber-low to indicate the priority of the alarm.

The current active alarms shall be accessible for view via an expandable window, to see which alarms are active and when the alarm occurred. The highest priority alarms shall rise to the top of the list.

Alerts. The System shall have comprehensive alerting capability, to enable the response personnel to be notified when an abnormal situation has occurred.

It shall be possible to configure alerts to one or more personnel for each alarm. This will cause, as selected, an SMS and/or an email to be sent to the person when an alarm occurs.

The alert shall be configurable to optionally send via email and/or via SMS a message when an alarm clears.

The intention is that the System provides the alerts to the user in near real time. The SMS and email shall be issued within 30 seconds of the occurrence of event which results in an alert being issued.

Reports. It shall be possible to view reports on the screen, in the browser of the System, and if desired print the report to a printer or a PDF file.

Alarm Activity Report. The System shall include a report which shows the alarms activity for a period. The Alarm Report shall indicate the time the alarm occurred; by color the priority of the alarm; whether it is still active; and if not active then the time that the alarm cleared. It shall be possible to filter the alarms by Device Type; by Device and/or by Device Group as well as by date time to be able drill down into a large alarm list to be able to view, for example, the alarm activity for a particular intersection or controller type over a three month period.

User Activity Report. The System shall include a report which shows user activity for a given period, to enable an audit of a user's response to an alarm to be made. The report shall show which screens the user viewed; when the screen was viewed, and the IP address of the computer from which the screen was viewed.

Preempt System Operational Availability Report. The System shall include a report which shows the overall operational availability of the Department intersections. The intersection is available when not in an alarm condition such as flashing or power fail. The availability report shall be detailed for each intersection for the period (say 1 month) and summarized by group (region) and for each controller type. Using this report it shall be possible to determine if system availability is trending up or down for the overall intersection system; by region and/or by controller type. It shall also be possible to compare the system availability by region; and also to compare system availability by controller type.

Fault Occurrence By Controller Type Report. The System shall include a report which shows the number and type of faults that have occurred in each intersection, which can be summarized by region and/or by controller type. This report will allow the user to compare the frequency of faults by region and by controller type.

Response Time for Fault Repair Report. The System shall include a report which shows the response time to clear faults, for a given time frame (say 1 month). This report will allow the user to determine the number of faults, and the total and average time to clear the fault. This report will allow the response times by region to be compared.

Vehicle Trip Report. The System shall include a report which shows all the emergency vehicle trips and include information on start time, end time, total travel time, average speed and destination point. The report shall provide the user the ability to select a start date and end date. This report will show response times to emergency call outs and how quickly the vehicle arrived.

Vehicle Trails. The maps display shall show live information of the preempt status of the emergency vehicles on the system.

The user shall have the option to select which class of emergency vehicles to display on the map via the information overlay menu.

The information overlay will provide the option to select the number of hours of live data the operator would like to see. This ranges from 1 hour to 24 hours. The user shall have the ability to select that the trails will fade away as the data becomes older.

The information overlay shall provide the ability for user to display the device names on the map, for easy identification of both intersections and emergency vehicles.

Operators will have the ability to display legends that explain the emergency vehicle trails

color codes, including idle, preempt service requested, left turn indicator, and right turn indicator so that it is easy to see the behavior of the emergency vehicle.

Vehicle Playback. The System shall include the ability to playback the activity of the emergency vehicles, so that retrospective fault finding of the preempt system can be carried out.

Playback shall support the same controls for panning and zooming the map, as well as using the information overlay to select the type of data being displayed on the playback menu.

Users shall have the additional functionality of controlling which devices are displayed by selecting the checkboxes on a selection panel on the left of the map.

The playback screen should provide the user with the option to select a date range via a drop down date selector menu. The menu will provide a full calendar and the option to select the exact start time and end time for the playback.

The bottom section of the map screen shall display the timestamp based on the location within playback.

The user shall have controls that allow one click access to start from the beginning, rewind, play, fast-forward, and scroll to end.

The user shall have the option to use a slider that is operated by click and drag to the time of interest in the playback.

Remote Power Cycle. The System shall include the ability to remotely cycle power to the outlets on the back of the field device. In this way it shall be possible to cycle power to ancillary connected equipment such as network switches, cameras and similar equipment.

The user interface shall display the status of the outlets, and provide confirmation via an associated input whether the sockets are energized or not.

Electrical and Environmental Requirements. All equipment supplied as part of the priority control system intended for use in the controller cabinet shall meet the following electrical and environmental specifications spelled out in the NEMA Standards Publication TS 2-2003, Part 2: v02.06:

- Line voltage variations per NEMA TS 2-2003, Paragraph 2.1.2.
- Power source frequency per NEMA TS 2-2003, Paragraph 2.1.3.
- Power source noise transients per NEMA TS 2-2003, Paragraph 2.1.6
- Temperature range per NEMA TS 2-2003, Paragraph 2.1.5
- Humidity per NEMA TS 2-2003, Paragraph 2.1.5
- Shock test per NEMA TS 2-2003, Paragraph 2.2.9.
- Vibration per NEMA TS 2-2003, Paragraph 2.2.8
- Non-Destructive Transient immunity NEMA TS 2-2003, Paragraph 2.1.8.
- Input-output terminals NEMA TS 2-2003, Paragraph 2.1.7.
- FCC Part 15 Subpart B Class A EMC Standard
- Canada ICES-003, Issue 4:2004 Class A EMC Standard
- EN50293: 2000 Electromagnetic Compatibility–Road Traffic Signal Systems – Product Standard.
- EN 61326-1:2006 EMC Standard.

- EN 55011:2007 +A2:2007 EMC Standard.

ITS EQUIPMENT CABINETS

Materials.

Equipment and Materials. Equipment cabinets and integral materials shall be as recommended by the manufacturers for outside plant use and the intended application. This requirement shall include wiring and electrical materials and configurations (including connector pin-outs) that are wholly or partially related to the field device applications (CCTV, RDS, VDS, etc.).

Equipment cabinets shall be furnished, installed, and configured at locations shown in the plans. All equipment and materials shall be furnished and configured for each specific location as shown in the plans.

Electrical systems and components shall be UL-listings.

Unless otherwise specified, wire and cable shall be stranded copper conductors, 75°/90° Celsius wet/dry rated insulation, and sized for the maximum voltage and current in the circuit.

Components Specified As Rail-Mounted. Components specified as rail- mounted shall be compliant as follows.

1) DIN EN 50022 (NS35) component rails.
2) Component rails shall be the perforated type and of sufficient length as to protrude beyond the mounted components for fastening to cabinet panels as specified herein.
3) UL 1059.
4) UL 486E.
5) NEMA ISC-4.
6) Alternate Rail configurations may be submitted to the Engineer for consideration and approval.

Terminal Blocks and Component Terminals. Terminal Blocks and Component Terminals shall be nickel-plated copper, copper alloy or brass.

Terminal blocks shall have voltage and current ratings greater than the ratings of the wires that are terminated, be able to terminate wires from #8 AWG to #1/0 AWG wiring and shall be assembled into housing enclosures such that all exposed surfaces are touch-safe. Conductor fastening screws shall be captive. Terminal block housings shall be colored as follows:

1) 120 VAC line/hot: black
2) 120 VAC neutral: white
3) 24 VDC positive: red
4) 24 VDC negative: gray
5) RS485 communications: orange
6) Ground: green or green/yellow

Door Locks. Door Locks shall be provided for all cabinet doors, keyed to the Department standard #2 key type lock keyed to be operated with a traffic industry conventional # 2 key made from heavy-duty blanks. Two keys shall be provided with each cabinet.

Labels.

Cabinet Labels. Labels shall be provided with agency name, device name and ID labels on all cabinets.

Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of one inch (1") in height.

Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

The agency name labels shall be "MDOT ITS" in one continuous adhesive sheet. The device ID labels shall include the device name as an acronym and a hyphen, and shall be one continuous adhesive sheet. Device name acronyms are "CCTV, RDS, VDS or DMS."

The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Multiple device IDs of the same type shall be on the same line separated with a space. Examples: "CCTV-73", "RDS-219 220", "VDS-303 304".

Labels shall be installed along the top of the cabinet door (front cabinet door on Type B cabinets), with MDOT ITS label at the top and the device ID labels immediately underneath.

Voltage Labels. A voltage label shall be provided on all cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements.

Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.

Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are "120VAC" or "24VDC".

Labels shall be installed on all cabinet doors.

Type A Cabinet. All Type A cabinets shall be identical in manufacture and assembly, capable of supporting Radar Detection System units.

A Type A cabinet intended for outdoor use shall be provided with a minimum NEMA 3R rating.

The cabinet enclosure shall be manufactured from 0.125-inch aluminum.

The cabinet shall provide a minimum of one ventilation louver on at least two sides. Any louver opening greater than 3/16 inch in any dimension shall be screened to prevent insect entry.

The cabinet shall be intended for strapped pole-mounting; provide all mounting hardware necessary including ½-inch stainless steel mounting straps.

A Type A cabinet enclosure shall be provided with dimensions of 18 inches (H) x 14 inches (W) x 8 inches (D) with a tolerance of ±0.25 inches.

Cabinet door shall reveal the entire front opening of the cabinet for accessibility. The hinge shall be designed to prevent the door from sagging.

A single-piece 0.125-inch aluminum back panel shall be provided that covers no less than 90% of the cabinet back wall. Back panel shall be affixed to the enclosure with threaded fasteners and shall be removable from the enclosure with hand tools only and without requirement to remove the cabinet door, mounting straps, or any other components other than communications or device wiring.

The cabinet shall be furnished with doorstops, which retain the doors open in a 90 degree and 120 degree positions.

A grounding lug shall be provided on the back panel that is directly bonded to the back panel capable of terminating #6 AWG wire.

RDS Communications Wiring. RDS communication wiring shall meet the following.

1) Component rail physically and electrically fastened to the cabinet back panel.
2) Strain relief brackets for the comm. cable(s) and the RDS unit harness cables.
3) Parallel-connection single-stage surge suppressors for the four wire RS-485 data signal for the RDS units with integral or separate terminals for a minimum of three RDS comm. Cables.
4) Parallel-connection zero-power dissipation surge suppressor for the 12-24VDC power supply for the RDS units with integral or separate terminals for a minimum of three RDS comm. cables and two RDS unit harness cables.
5) Connection/jumper wiring between the surge suppressors and the local/remote communications disconnect module(s) same as conductor size, type, and insulation color in the RDS comm. cable.

Type B Cabinet. All Type B cabinets, except those at solar power locations, shall be uniform in manufacture and assembly, capable of supporting the field equipment as shown on the plans. As a minimum support is required for two RDS units, one Type A, B, D or E network switch, one video encoder, one Type A radio/antenna, RDS comm. cable and fiber drop panel terminations, regardless of the devices shown in the plans at a specific location.

A complete Type B cabinet shall be an assembly consisting of a cabinet housing and electrical subsystems.

A Type B cabinet housing shall be provided that conforms to the standards for a Type 170 336S with approximate exterior dimensions of 46 inches (H) x 24 inches (W) x 23 inches (D), including standard EIA 19-inch rack cabinet cage, as defined in the latest version of the Caltrans Transportation Electrical Equipment Specifications (TEES). The minimum clear vertical inside dimension of the 19-inch rack for equipment mounting shall be 39.5 inches. Standard cabinet accessories for traffic signal operations, such as controller, power distribution assembly, input/output file and termination panels, and the police panel, are not required as part of this cabinet assembly.

Hardware. All mounting hardware necessary for base or pole mounting as shown on the plans shall be provided. As a minimum, three (3) 3/4-inch stainless steel mounting straps shall be provided for pole mounted cabinets.

Hooks welded to the inside of each cabinet door shall be proved for hanging a side-opening, opaque, resealable, heavy-duty plastic documentation pouch with metal or hard-plastic reinforced holes for the door hooks. One pouch shall be proved with each cabinet.

A rack-mounted cabinet sliding storage drawer shall be proved in accordance with the following:

1) Approximate exterior dimensions 1.75 inches (H) x 16 inches (W) x 14 inches (D).
2) Telescoping drawer guides to allow full extension from the rack cage.
3) Opening storage compartment lid to access storage space for cabinet documentation and other items.
4) Supports a weight of 25 pounds when extended.
5) Non-slip plastic laminate surface attached to the compartment lid which covers a minimum of 90% of the surface area of the lid.
6) Mounted in the rack cage with the bottom surface approximately 9 inches above the bottom of the rack cage.

Side panels shall be proved within the two sides of the rack cabinet cage, inserted and fastened from the inside of the cage. Side panels shall be fabricated from 0.125-inch 5052 sheet aluminum alloy and sized to the full inside dimensions of the rack cabinet cage. Side panel surfaces for equipment mounting are denoted by cabinet side with the "right" side being the support pole side and by upper or lower as related to the sliding storage drawer. Upper right side panel (support pole side of cabinet, above the drawer) and lower left side panel (opposite side from the support pole, below the drawer) are example side panel surface names.

A 12-inch long DIN rail shall be include for future components mounted in the horizontal and vertical center of the lower left side panel.

Electrical Subsystems. Type B cabinet electrical subsystems shall meet the following requirements.

1) An electrical distribution module comprised of the following DIN rail-mounted components:
   a. Service entrance terminal block with positions for 120VAC line, neutral, and ground and capable of terminating minimally #6 through #8 AWG wire, located at one end of the mounting rail with an approximately 0.75-inch blank spacer module adjacent to the main cabinet breaker.
2) Main cabinet automatic overcurrent 15A circuit breaker that is UL-listed and of the mechanical-magnetic type rated for use from 0°F to 122°F minimum.
3) Main cabinet surge suppressor for single-phase 120VAC service entrance, parallel wired with a clamp voltage of approximately 280V and capable of a surge current of at least 20,000 amps.
4) Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge suppressor.
5) Electrical distribution terminal block for line and neutral conductors parallel wired to the main cabinet surge suppressor but non-filtered, with a minimum terminating capability of six conductors of #10 to #18 AWG. The terminal block shall be labeled as "ACCY POWER".
6) Electrical distribution terminal block for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of six conductors of #10 to #18 AWG. Label the block as "EQUIP POWER".
7) Electrical distribution terminal block for grounding and bonding conductors located

on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of two #6 AWG conductors and ten #10 to #18 AWG conductors.

8) Ground fault interrupt duplex receptacle (NEMA 5-15R) with 2.5A circuit breaker connected to the ACCY POWER distribution block. Permanently affixed to the receptacle, provide two red, orange or green/yellow labels with minimum 0.25 inch lettering with the legend "300 WATTS MAX." This receptacle is for technician use only and shall not be used to power equipment.
9) Include two duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right side panel. Permanently affixed to the receptacle, two red, orange or green/yellow labels with minimum 0.25-inch lettering with the legend "75 WATTS MAX" permanently affixed to the receptacle.
10) Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type B cabinet.

Lighting Subsystem. A cabinet lighting subsystem shall be provided comprised of the following components:

1) One fluorescent lighting fixture, minimum 15-watt, mounted on the inside top front portion of the cabinet, with a cool white lamp with shatter-proof cover and operated by a normal power factor UL listed ballast.
2) A resistor-capacitor network noise suppressor installed across the light fixture power terminals.
3) Two door-actuated switches installed to turn on the cabinet light when either door is opened.
4) Powered from the ACCY POWER distribution block.

RDS Communications Subsystem. Where RDS are shown in the plans, DIN rail-mounted components shall be have a nominal 24VDC output power supply, capable of user setting between 23 and 28VDC minimum, with minimum 1A output rating and minimum operating temperature range of -13°F to +158°F. Power supply shall provide terminal facilities for a minimum of three sets of #14 AWG conductors (in the RDS comm cable). Maximum size of the power supply shall be 1 inch (W) x 7 inches (H) x 7 inches (D). The power supply shall be connected to the EQUIP POWER distribution block for 120VAC input.

Interconnection wiring shall be provided between the RDS communications subsystem and the Terminal Server.

Surge suppressor for the RS485 data signal, wired between the terminal server and the RDS units shall be provided. The surge suppressor shall protect the 4-wire RS485 data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge suppressor shall have a response time no greater than 1 nanosecond. The surge suppressor shall provide terminal facilities for a minimum of four two-pair cables of #22 AWG conductors.

Type C Cabinet. A complete Type C cabinet shall be an assembly consisting of a cabinet housing, base and electrical subsystems.

The Type C cabinet shall be an AASHTO/ITE/NEMA ITS Cabinet Standard specification Cabinet Housing #3 with two Cages #1. It shall be equipped with four (4) side mounting

panels in the rack cabinet cages. The side mounting panels shall mount from inside the rack cabinet cage only. The side panels shall be fabricated from 5052 sheet aluminum alloy with a minimum thickness of 0.125 inch with minimum dimensions of 50 inches (H) x 21 inches (W). Standard cabinet accessories for traffic signal operations, such as controller, power distribution assembly, input/output file and termination panels, and the police panel, are not required as part of this cabinet assembly.

A minimum of four (4) wiring pass-through holes shall be provided on the inside mounting panels to permit patch cords to pass between the two cabinet sides. Each pass-through hole shall be five (5) inches in diameter and shall be fully grommetted for patch cord protection, with the holes positioned with two (2) in the cabinet front and two (2) in the cabinet rear and aligning horizontally between the two side panels.

Hardware. The hardware shall consist of a minimum of 16 plastic-coated or rubber-coated J-hooks or D-rings, minimum 1-inch depth and height, on the inside rails of the rack cabinet cages, to organize patch cords passing between the two cabinet sides. The J-hooks shall be installed in horizontally-aligned pairs on the inside rails, with four (4) pairs in the cabinet front and four (4) pairs in the cabinet rear.

Hooks shall be welded to the inside of the two front cabinet doors for hanging the plastic documentation pouch. Two plastic documentation pouches shall be provided to store the cabinet and equipment documentation. Pouches shall be side-opening, re-sealable, opaque, and of a heavy-duty plastic material. Pouches shall have metal or hard-plastic reinforced holes for hanging from hooks included on the cabinet door. The pouches shall be of the size and strength to easily hold all wiring diagrams, equipment documentation, maintenance logbooks, etc.

Two sliding drawers shall be installed that are aluminum storage compartments mounted in the rack assembly with the approximate following dimensions: 1.75 inches (H) x 16 inches (W) x 14 inches (D). The compartments shall have telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartments shall open to provide storage space for cabinet documentation and other miscellaneous items. Storage compartment shall be of adequate construction to support a weight of 25 pounds when extended. The tops of the storage compartments shall have a non-slip plastic laminate attached which covers a minimum of 90% of the surface area of the top.

Electrical Systems. Type C cabinet electrical subsystems shall include an electrical distribution module comprised of the following components:

1) Service entrance terminal block with positions for 120VAC line, neutral, and ground and capable of terminating minimally #6 through #8 AWG wire, located at one end of the mounting rail with an approximately 0.75-inch blank spacer module adjacent to the main cabinet breaker.
2) Main cabinet automatic overcurrent minimum 30A circuit breaker that is UL-489 and CSA 22.2 approved and plainly marked with trip, frame sizes and ampere rating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy and enclosed in an arc-quenching chamber. Overload tripping shall not be influenced by an ambient air temperature range from 0°F to 122°F. Minimum interrupting capacity shall be 5,000 amperes RMS.
3) Main cabinet surge suppressor for single-phase 120VAC service entrance, parallel wired with a clamp voltage of approximately 280V and capable of a surge current of at least 20,000 amps.
4) Main cabinet filter for power line noise and switching transient suppression, integral

to, or separate from and wired to, the main cabinet surge suppressor.

5) Electrical distribution terminal block for line and neutral conductors parallel wired to the main cabinet surge suppressor but non-filtered, with a minimum terminating capability of six conductors of #10 to #18 AWG. The terminal block shall be label as "ACCY POWER".
6) Electrical distribution terminal block for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of six conductors of #10 to #18 AWG. The block shall be as "EQUIP POWER".
7) Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of two #6 AWG conductors and ten #10 to #18 AWG conductors.
8) Ground fault interrupt duplex receptacle (NEMA 5-15R) with 2.5A circuit breaker connected to the ACCY POWER distribution block. Two red, orange or green/yellow labels with minimum 0.25-inch lettering with the legend "300 WATTS MAX" permanently affixed to the receptacle. This receptacle is for technician use only and shall not be used to power equipment.
9) Two duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right side panel.

Interconnection wiring shall be installed between all electrical distribution module components and the other systems included in or housed in the Type C cabinet.

Rack mounted power strip outlets shall be connected to the EQUIP POWER distribution block, mounted near the top of the cabinet. The power strip shall incorporate eight (8) NEMA 5-15R receptacles. The power strip receptacle shall face the back of the cabinet and shall be recessed within the cabinet rack to provide a minimum spacing of three (3) inches between the outlet's face and the cabinet door when the door is closed.

Door open switches shall be provided on four doors and configure the switches so that any single door opening will provide a circuit closure. The assembly of switches shall be wired to a single two-position terminal block, with normally open circuit that closes upon a door opening.

Two cabinet ventilation fans shall be connected to the ACCY POWER distribution block, with a minimum capacity of 200 cubic feet of free air delivery per minute. The fan thermostat shall be set at its lowest limit or 70°F, whichever is greater.

Each of the four cabinet doors shall have an intake and filter as specified in Subsection 6.2.7.1 of the AASHTO/ITE/NEMA ITS Cabinet Standard specification.

Lighting Subsystem. The lighting subsystem shall be four (4) fluorescent lighting fixtures mounted inside the top portions of each cabinet side. A cool white lamp, covered and operated by a normal power factor UL listed ballast shall be included with the fixture. A RC network noise suppression filter shall be installed in the light circuit. Door actuated switches shall be installed in the front and rear of each cabinet side, configured to turn on all cabinet lights when any door is opened. The lighting fixtures shall be powered from the ACCY POWER distribution block.