



Florida Department of Transportation

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ANANTH PRASAD, P.E.
SECRETARY

September 8, 2014

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: State Specifications and Estimates Office
Section
Proposed Specification: **6760000 Traffic Cabinets.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

This change is proposed by Alan El-Urfali of the State Traffic Engineering and Operations Office to consolidate material requirements from the Minimum Specifications for Traffic Control Signals and Devices (MSTCSD) and the Standard Specifications for Road and Bridge Construction (SSRBC). This activity is a planned part of an ongoing specification consolidation effort. Material requirements for pedestrian signal assemblies were moved from A676 of the Minimum Specifications for Traffic Control Signals and Devices (MSTCSD) to Section 676 of the Standard Specifications for Road and Bridge Construction (SSRBC). Also moved material requirements for ITS cabinets from Section 785 to Section 676, and added material requirements for small enclosures.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to SP965DS or daniel.scheer@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Daniel Scheer, P.E.
State Specifications Engineer

DS/dt



Florida Department of Transportation

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Attachment

cc: Florida Transportation Builders' Assoc.
State Construction Engineer

CONTROLLER-TRAFFIC CABINETS.(REV ~~6-27-16~~228-79-5-14)

SECTION 676 is deleted and the following substituted:

SECTION 676
CONTROLLER-TRAFFIC CABINETS

676-1 Description.

Furnish and install traffic cabinets as shown in the Plans. Meet the requirements of Section 603.

676-2 Materials.

676-2.1 General: Use ~~Controller~~ traffic cabinets and accessories that are listed on the Department's Approved Product List (APL). *Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. Place the label on the inside of the main door using a water resistant method. The label must be visible after installation.*

676-2.2 NEMA Traffic Signal Controller Cabinets: *Provide NEMA traffic signal controller* ~~Ensure that all Controller Cabinets are marked in accordance with Section 603 and the markings are visible after installation.~~ *cabinets with all terminals and facilities necessary for traffic signal control meeting the following requirements:*

NEMA TS1 Controller Cabinet.....NEMA TS-1-1989

NEMA TS2 Controller Cabinet..... NEMA TS 2 2003

676-2.2.1 Documentation: *Provide four copies of the cabinet wiring diagram with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan. ~~A heavy duty, resealable plastic opaque bag must be mounted on the backside of main cabinet door for storing cabinet prints and other documentation.~~*

Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires.

A heavy duty, resealable plastic opaque bag must be mounted on the backside of main cabinet door for storing cabinet prints and other documentation.

~~*A list must be attached to the inside of the main cabinet door using a water resistant method identifying the terminal strip termination connections for the signal cable used for: (1) vehicular and pedestrian signal heads, (2) the detector loop lead-in cable, and (3) the pedestrian pushbutton wire using a water resistant method.*~~

676-2.2.2 Police Switches: *Provide the following police switches with Type 3, ~~4~~, and ~~5~~ larger controller cabinets. The switches must be mounted on the police panel and identified as to their function.*

(a) AUTO-FLASH: When this switch is in the FLASH position, all signal indications must immediately transfer to the flashing mode. AC power shall be removed from the load switches and stop timing applied to the controller unit. When this switch is placed in the AUTO position the controller unit must operate in accordance with the appropriate specification.

(b) **MANUAL ON-OFF:** When this switch is in the on position, a logic ground must be applied to the manual control enable input of the controller unit.

(c) **MANUAL JACK:** Install a manual jack on the police panel. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

Provide a manual pushbutton ~~with cord~~ with Type 3, ~~4 and 5~~ and larger cabinets. The pushbutton cord must have a minimum length of ~~threesix feet. It must have~~ with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton ~~enclosed in a hand held enclosure~~ at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

676-2.2.3 Service Switches: Service switches must be mounted on the service panel or other locations approved by the Department and identified as to their functions. Provide the following service switches with Type 3, ~~4,~~ and ~~5~~ larger cabinets.

(a) **SIGNALS ON-OFF:** When this switch is in the off position, AC power shall be removed from all signal heads. The SIGNALS ON-OFF switch must be connected to the control input of a contactor (displacement relay). Current supplied to the switch must not exceed five amperes (amps) total. Do not directly route the main signal head power buss and cabinet power through the service or police switches.

(b) **AUTO-FLASH:** When this switch is in the FLASH position, all signal indications must transfer to the flashing mode in accordance with the Uniform Code Flash (UCF) requirements. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode. The controller unit must operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the AUTO position, transfer from the flash mode to normal operation shall be made in accordance with UCF requirements.

(c) **CONTROLLER ON-OFF:** When this switch is in the off position, AC power shall be removed from the controller.

(d) **AUX POWER ON-OFF:** When this switch is in the off position, AC power shall be removed from all circuits of the cabinet except for the duplex receptacle, cabinet light and ventilation fan.

(e) **VEHICLE DETECTORS:** A ~~three position~~ detector test switch must be provided for each phase of the controller unit. ~~The functions of the Detector test switches must include a position for normal operation (phase receives calls from detectors), a position that provides a constant call, and a position that provides a momentary call. are as follows:~~

~~Down position (Call): call is placed into the controller unit.~~

~~Up position (Auto): output of vehicle detector is connected to the controller unit vehicle detector input.~~

~~Center position (Off): no call is placed into the controller unit.~~

676-2.2.4 Doors and Locks: Provide Type 3, ~~4,~~ and ~~5~~ larger cabinets with a hinged, rain tight and dust tight police door which allows access to the police switches and manual jack.

Locate the police door in the bottom half of the main door for Type 3 and 4 pole mount cabinets. Locate the police door in the upper half of the main door for Type 4 -and 5larger base mount cabinets. ~~For optional Type 4 pole mount cabinet, locate the police door in the bottom half of the main door.~~

Hinges ~~must be made of 14 gauge stainless steel. The~~ and hinge pins must be constructed of stainless steel ~~material and be designed to prevent the door (main or police) from sagging.~~ Hinges for the main and police doors must be located on the right side (viewed from the front).

Type 3, ~~4,~~ and 5larger cabinets must be furnished with a three point draw roller latching system ~~for the main door~~ consisting of the following latching points:

- (a) Center of the cabinet (lock)
- (b) Top of the cabinet--controlled by the door handle
- (c) Bottom of the cabinet--controlled by the door handle

The ~~latching points (b) and (c)~~ on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. ~~When the lock is unlocked, rotation of the door handle shall allow the main door to swing open~~ The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Type 3, ~~4,~~ and 5larger cabinets must be furnished with a door stop which retains the main door open in a 90 degree and 120 degree position.

676-2.2.5 Police and Service Panels: Provide a police service panel with Type- 3, ~~4~~ and 5larger cabinets. The panels may be constructed of either sheet aluminum or cast aluminum. Locate the police panel behind the police door attached to the main door. The service panel must be mounted on the back side of the police panel. The police panel must have the following minimum dimensions:

- (a) Height – 4- inches
- (b) Width – 8 inches
- (c) Depth – 2-1/2 inches

676-2.2.6 Ventilation: Type 1 and 2 cabinets must be vented to allow dissipation of the heat generated by the equipment housed inside the cabinet.

Type 3, ~~4,~~ and 5larger cabinets must have dual thermostatically controlled fans, rated for continuous duty with a service life of at least three years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70 F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. The intake vent must be rain tight, located on the bottom half of the cabinet, and covered with a removable filter.

676-2.2.7 Shelves: Type 2 cabinets must be furnished with one shelf. Type 3, ~~4,~~ and 5larger cabinets must be furnished with two adjustable shelves. Shelves must be adjustable in a maximum of 2 inch increments from the top of the load panel to 12 inches from the top of the controller cabinet.

676-2.2.8 Mounting Hardware: Type 1, 2, and 3 cabinets must be supplied with hardware for attaching the top and bottom half of the cabinet onto a flat or round surface. Optional wall or pole mount hardware must be provided for mounting Type 4 cabinets in specific installations.

Type 4 cabinets must have rigid tabs attached to the bottom of the cabinet. Type 5 cabinets must have rigid brackets attached to the bottom of the cabinet. Rigid brackets and tabs must be constructed of the same material used for the cabinet.

Type 4 and 5 larger cabinets must be provided with one of the following alternatives for fastening to a concrete base:

(a) Galvanized anchor bolts, nuts, lock washers, and flat washers in accordance with ASTM A153. The anchor bolts must be at least 1/2 inch in diameter, seven inches in vertical length with at least three inch horizontal, or

(b) Heavy duty machine bolt anchors, flat washers, lock washers and machine screws at least 1/2 inch in diameter.

676-2.2.9 Electrical: Fabricate ground bussbars of copper alloy material compatible with copper wire and provide at least two positions where No. 2 AWG stranded copper wire can be attached.

Mount a ground bussbar on the side of the cabinet wall adjacent to the power panel for the connection of AC neutral wires and chassis ground wires.

If more than one ground bussbar is used in a cabinet, a minimum of a No. 10 AWG copper wire must be used to interconnect them.

676-2.2.9.1 Wiring: All wiring must be laced. All conductors in the cabinet must be stranded copper.

All inputs and outputs must be terminated on terminal strips. A connector harnesses for the controller, conflict monitor, vehicle detectors, and other controller accessory equipment must be furnished and wired into the cabinet circuitry.

A vehicle detector harness or rack must be furnished with the cabinet. Terminal strip circuits must be provided for connection of the loop lead-in cable.

676-2.2.9.2 Terminal Strips: The voltage and current rating of terminal strips must be greater than the voltage and current rating of the wire which is terminated on the terminal strip.

Conductors must be terminated on terminal strips with insulated terminal lugs. A calibrated ratchet crimping tool must be used to terminate the conductor in the terminal lug.

When two or more conductors are terminated on field wiring terminal strip screws, a terminal ring lug shall be used for termination of those conductors. All terminal strip circuits must be numbered.

676-2.2.9.3 Cabinet Light and Receptacle: Provide a light fixture capable of producing a minimum of 950 lumens with Type- 3, 4, and 5 larger cabinets. The fixture must include a clear shatterproof shield and be mounted on the inside, front top of the cabinet and the light must automatically turn on when the main cabinet door is opened and off when the door is closed.

Mount and wire a three-wire 115 V_{AC} duplex receptacle in all cabinets. The receptacle must be protected by a 15A circuit breaker. Do not mount the receptacle on the main cabinet door or police and service switch panels.

676-2.2.9.4 Main Circuit Breaker: Provide a 15A circuit breaker with Type 1 and 2 cabinets, and a 30A circuit breaker with Type 3, 4, and 5 larger cabinets.

The main circuit breaker must turn off all power to the cabinet and shall not be used for the power switch located in the service panel.

676-2.2.9.5 Radio Interference Suppression: A radio interference suppressor must be provided in series with the AC power before it is distributed to any equipment inside the cabinet. The suppressor must provide a minimum attenuation of 50

decibels over a frequency range of 200 kHz to 75 MHz when used with normal installations and shall be hermetically sealed in a metal case.

The radio interference suppressor must have the same minimum current rating as the main circuit breaker.

The ground connection of the radio interference suppressor must be connected only to AC neutral and shall not be connected to earth ground directly.

676-2.2.9.6 Opto Isolation: *The Opto Common input is the common reference pin for four optically isolated inputs.*

The Opto inputs are intended to provide optical isolation for pedestrian detector and remote interconnect inputs. The Opto inputs are intended to connect through external 27 k Ω , 1 W resistors for 120 V_{AC} operation and are intended for direct connection to 12 V_{AC} from the cabinet power supply for pedestrian detector applications. These inputs may alternatively be used for low-true DC applications when the Opto Common pin is connected to the 24 V supply.

The Opto inputs shall provide electrical isolation of 10 M Ω minimum resistance and 1000 V_{AC} RMS minimum breakdown to all connector pins except the Opto Common pin. These inputs shall exhibit nominal impedance to the Opto Common pin of 5 k Ω , plus or minus 10 percent, and shall require 2.4 mA, plus or minus 10 percent, from a nominal 12 V_{AC} supply. The Opto inputs shall not recognize 3 V_{AC} RMS or less relative to the common input and recognize 6 V_{AC} RMS or more relative to the common input. Any steady state voltage applied between an Opto input and the Opto Common shall not exceed 35 V_{AC} RMS. Opto inputs shall not be acknowledged when active for 25 ms or less, and shall be acknowledged when active for 50 ms or more.

676-2.2.9.7 Load Resistors: *A load resistor or capacitor must be installed between the AC (common) and each signal field wiring terminal for the yellow, green and walk indication. All load resistors and capacitors must be on the front side of any panel used in the cabinet.*

676-2.2.9.8 Surge Protection: *Furnish surge protective devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet.*

The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker.

SPDs for signal and interconnect cable field wiring terminals must meet the following:

(a) Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.

(b) Withstand a surge current of 1000A with an 8 by 20 μ s waveform six times (at 1 second intervals between surges) without damage to the suppressor.

SPDs for loop lead-in cables must be designed in accordance with the following requirements:

(a) Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges.

(b) Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges.

(c) Withstand repetitive 400A surges with an 8 by 20 μ s waveform without damage.

SPDs must be installed according to the SPD manufacturer's instructions and not affect the operation of detectors. SPD leads must be kept as short as possible.

676-2.3 Type 170 Traffic Signal Controller Cabinets: Provide Type 170 traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control and meeting the following requirements:

Model 332, 334 and 336S Cabinets.....

..... CALTRANS TEES 2009

Model 336S cabinet must incorporate input surge protection mounted on a fold-down termination panel at the input file.

Model 332 cabinets must incorporate a lower input termination panel. Model 332 and 334 cabinets must be base mounted. The Model 332 cabinet must have an auxiliary MODEL 420 output file, and be configured for 8 vehicle, 4 pedestrian, and 4 overlaps.

Model 552A designation is given to Model 332 cabinet assemblies that include a swing-out EIA 19 inch rack cage.

Cabinets must comply with figures for traffic control signals and devices available on the Department's website at the following URL:

http://www.dot.state.fl.us/trafficoperations/Traf_Sys/Product-Specifications.shtm

All terminals and facilities on panels must be clearly identified using permanent silk-screened text.

676-2.3.1 Base Plate and Mounting Plates and Lifting Brackets: Provide cabinets with a removable base plate and provisions for a standard base mounting bolt pattern. Cabinets must have two aluminum plates welded inside for anchoring to a concrete or composite base.

~~Lifting brackets must be attached with Grade 18-8 stainless steel 5/16 inch by 1 1/4 inch carriage bolts and hex nuts. Cabinets must be delivered with the brackets attached in the upright position. Fabricate brackets from 1/4 inch 6061 T6 extruded aluminum rectangular bar capable of supporting a weight load of 500 pounds. [MRG1]~~

676-2.3.2 Police Switches: Police switches panels must include a manual jack. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of 6 feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals. ~~must include a manual police push button on a coiled rubber cord, in conjunction with a manual/auto switch. When placed in the manual position, "stop time" shall be applied to the controller, and "recall" shall be applied to all phases. Activation of the push button shall "advance" the controller. Manual advancement must be prohibited during yellow and red timing intervals.~~

676-2.3.3 Output File: Fabricate the output file using a "hard wired" harness. Printed board circuit boards are not acceptable.

676-2.3.4 Shelf: Provide an aluminum shelf with storage compartment in the rack below the controller (for remote secondary monitor/lap top computer use). The storage compartment must have telescoping drawer guides for full extension. The compartment top must have a non-slip plastic laminate attached. Provide an RS-232 connector for communications to the C2S port.

676-2.3.5 Loads: Provide dummy loads consisting of 4.7k resistors rated at five watts minimum for Greens, Peds, and Yellows. The dummy loads must be mounted on a terminal block in the rear of the output file or other approved location. Wire one side of each dummy load to AC return in a manner that allows a technician to easily attach the load to outputs from selected load switches.

676-2.3.6 Cabinet Light: Provide a light fixture capable of producing a minimum of 950 lumens. The fixture must include a clear shatterproof shield and be mounted on the inside, front top of the cabinet. The light must automatically turn on when the cabinet door is opened and off when the doors are closed.

676-2.3.7 Surge Protection: Provide each cabinet with devices to protect equipment from surges. Surge protection must be provided for the full capacity of the cabinet Input File and shall be in accordance with the assignment of the slots of a standard 336S cabinet assembly. Surge protector termination panels must be attached to the cabinet rack assembly and allow sufficient space for connections, access, and surge protector replacement. AC isolation terminals must be on the same side of the cabinet as the AC service inputs. DC terminals and loop detector terminals must be installed on the opposite side of the cabinet from the AC power lines.

Surge protection for 332A cabinets must be mounted on the lower input termination panel.

-Surge protection for 336S cabinets must be mounted on a custom fold down termination panel at the input file.

Under no circumstance (normal operation or short-circuit condition) shall the amperage capacity of the internal wiring and printed circuit board traces be less than the protecting threshold of circuit breakers and surge protectors provided.

676-2.3.7.1 Power Distribution Assembly Protection: The power distribution assembly (PDA) SPD must be a two stage series/parallel device that meets or exceeds the following:

- (a) Maximum AC line voltage: 140 V_{AC}
- (b) 20 pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20kA.
- (c) The protector must include the following terminals:
 - Main line (AC Line first stage terminal)
 - Main Neutral (AC Neutral input terminals)
 - Equipment Line Out (AC Line second stage output terminal, 10-A)
 - Equipment Neutral Out (Neutral terminal to protected equipment)
 - Ground (Earth connection)

(d) The main AC line in and the equipment line outer terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10A AC service

(e) The first stage clamp shall be between Main Line and ground terminals

(f) The second stage clamp shall be between Equipment Line Out and Equipment Neutral

(g) The protector for the first and second stage clamp must have a metal oxide varistor (MOV) or similar solid state device, rated 20- kA.

The main neutral and equipment neutral output shall be connected together internally, and shall have an MOV (or similar solid state device, or gas discharge tubes) rated at 20- kA between main neutral and ground terminals.

The PDA SPD must have a peak clamp voltage of 250V at 20 kA (voltage measured between equipment line out and equipment neutral out terminals, current applied between main line and ground terminals with ground and main neutral terminals externally tied together).

The PDA SPD must have a maximum let through voltage not exceeding 500 Vpk using an 8 by 20 μ s/1.2 by 50 μ s; 6 kV, 3 kA surge. The SPD must either be epoxy-encapsulated in a flame retardant material or utilize thermally protected varistors and be designed for continuous service current of 10A at 120 V_{AC} RMS. Power to the Type 170E controller and to the 24-V power supply must be provided from the equipment line out terminal of the PDA SPD.

676-2.3.7.2 Inductive Loop Detector Protection: Protect each inductive loop detector input channel with an external SPD that meets or exceeds the following:

(a) The SPD must be a three-terminal device, two of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.

(b) The SPD must instantly clamp differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array shall be designed to appear as a very low capacitance to the detector.

(c) The SPD must clamp common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.

(d) Peak Surge Current

Differential Mode: 400A (8 by 20 μ s)

Common Mode: 1000A (8 by 20 μ s)

Estimated Occurrences: 500 @ 200A

(e) Response Time: 40 ns

(f) Input Capacitance 35 pF typical

(g) Clamp Voltage

30V max @ 400A (Differential Mode)

30V max @ 1000A (Common Mode)

676-2.3.7.3 Signal Load Switch Protection: The outputs of each load switch in the output file shall be provided with a MOV connected from the AC positive field terminal to the chassis ground. The MOV must be rated 150 V_{AC} and shall be a V150LA20A (or approved equal).

676-2.3.7.4 Communication Input Protection: Each low voltage communication input must be protected as it enters the cabinet with a hybrid two-stage SPD that meets or exceeds the following:

- (a) The SPD must be a dual pair (four-wire) module with a double-sided, gold-plated printed circuit board connector.
 - (b) The SPD must be installed in a ten-circuit card edge terminal block (PCB1B10A).
 - (c) The SPD must be utilized as two independent signal pairs. The data circuits must pass through the SPD in a serial fashion.
 - (d) Peak Surge Current
10kA (8 by 20 μ s)
Occurrences at 2000A: greater than 100
 - (f) Response Time: less than 1 ns
 - (g) Clamp Voltage: 30V maximum
 - (h) Series Resistance: greater than 15 ohms per line
 - (i) Primary Protector: 3 element gas tube
 - (j) Secondary Protector: Solid state clamp (1.5 kW minimum)
- The line side of the SPD must be connected to the communication field wires, the load side connected to the communication connector of the controller, and the ground terminal connected to chassis ground.

676-2.3.7.5 Low Voltage DC input protection: Each DC input must be protected by an SPD that meets or exceeds the following:

- (a) The SPD must be a 5 terminal device. Two terminals must be connected to the line side of the low voltage pair, two terminals must be connected to the input file side, and the fifth terminal connected to chassis ground.
- (b) Peak Surge Current
2 kA (8 by 20 μ s)
Occurrences at peak current: 100 (typical)
- (c) Response Time: 5-30 ns
- (d) Shock: Must withstand 10 foot drop on concrete
- (e) Clamp Voltage: 30V
- (f) Series Resistance: greater than 15 ohms each conductor

676-2.3.7.6 Preemption and 115V AC signal input protection: Each preemption or AC signaling input channel must be protected by an external SPD that meets or exceeds the following requirements:

- (a) The SPD must be a 3 terminal device
- (b) Peak Surge Current
2000A (8 by 20 μ s)
Occurrences at peak current: 25 (minimum)
- (c) Response Time: less than 200 ns
- (d) Peak Surge Trip Point: less than 890V nominal

676-2.3.8 Model 210 Conflict Monitor with Absence of Red Monitoring: The conflict monitor must be a Model 210 "PLUS" conflict monitor capable of detecting fault sequencing of signals on a per channel basis (i.e. short or absence of yellow interval and/or simultaneous dual indications). All integrated circuits having 14 pins or more must be socket-mounted.

676-2.3.8.1 Absence of Red Monitoring: The conflict monitor must be capable of monitoring for the absence of voltage on all of the inputs of a channel (defined here as red, yellow, and green). If an output is not present on at least one input of a channel at all times, the unit shall begin timing the duration of this condition. If this condition exists for less than 700-milliseconds, the unit shall not trigger. If this condition exists for more than 1000 milliseconds, the unit shall trigger as if a conflict had occurred, causing the intersection to transfer immediately into a flashing mode, and "stop-time" to be applied to the controller. A red signal shall require the presence of a minimum of 60 V_{AC}, plus or minus 10 V_{AC}, to satisfy the requirements of a red indication. The red input signals shall be brought into the conflict monitor through an auxiliary connector on the monitor's front panel. Provide a similar connector on the output file, with a removable harness connecting the two. Provide an indicator on the front panel of the monitor to identify the triggering of the monitor in response to the absence of red condition.

676-2.3.8.2 Red Monitor Harness: A connector and terminal assembly designated as P20 for monitoring the absence of red, shall be an integral part of the output file. The connector must terminate, and be compatible with, the cable and connector of a Type 170 conflict monitor unit (CMU), capable of monitoring the absence of red. Provide the pin assignments of the P20 connector and terminal assembly with the cabinet plans. The P20 connector shall be physically like the cable and connector of a Type 170 CMU to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

676-2.3.8.3 Programming of Unused Red Channels: Provide all cabinet assemblies with a means of programming unused red channels by installing jumpers from red monitor inputs to 115 V_{AC}. The connecting terminals for the jumpers must be accessible and located in the same terminal block for all 16 channels to assure full compatibility of all cabinet assemblies with "210 Plus" conflict monitor units.

676-2.3.9 Police Door and Panel: Provide cabinets with police doors and panels. The police panel must include text informing officers that yellow and all-red clearance intervals are timed internally.

676-2.3.9.1 Manual Control: Police switch panels must include a manual jack. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of six feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals. ~~The cabinet must include and be wired for a hand control to permit manual operation of the controller. This hand control must be wired through a jack and accessible via the police door. The manual push-button assembly shall consist of a manual push button with a neoprene retractable power cord. The retracted length shall be 1 foot with a practical extended length of 6 feet. The manual push button must be waterproof, encased in a neoprene rubber housing with a diameter of 1 inch, and a minimum length of 4 inches long. The push-button jack must be wired behind the police/technician panels.~~

676-2.3.10 Technician Service Panel: Provide cabinets with a technician service panel which is mounted on the back side of the police panel (inside the main cabinet front door).

676-2.3.10.1 Service Panel Switches: There must be two switches located on the technician service panel, clearly labeled according to the following functions:

(a) UCF – This toggle switch shall:

Place the intersection into Flashing Operation.

After meeting requirements for Flashing

Operations, all power shall be removed immediately from signal load switches.

(b) Signal On/Off – This toggle switch shall disconnect all power to the signal lights through the use of a 60A contact switch placed in series with the load switch packs.

Labels must be silk screened directly on the panel.

676-2.3.11 Swing-out Rack Assembly: Provide 552-A cabinets with a pullout and rotatable rack assembly as well as an interface panel mounted on the top of the rack assembly and attached to the top shelf. The rack assembly must be constructed to house components designed to be installed in a standard EIA 19 inch rack and shall house the Controller, Input File, Output File No. 1, PDA No. 2, and a storage compartment.

Construct the rack and slide/hinged mounting brackets so that when the rack assembly (fully loaded) can be pulled out with one hand with complete ease of operation including rotation of the assembly.

The rack assembly must have a spring-loaded latch mechanism to secure the rack assembly inside the cabinet while in the "rest" position. When pulled out of the cabinet at any point from its resting position (inside cabinet) to its full extension and rotation, the fully loaded rack assembly shall not cause any member of the assembly to bend, warp or bind. The rack must be made of one inch square aluminum tubing with welded joints and extend and retract smoothly without noticeable friction or stress on roller guides, extension brackets, or other mechanical components. Clearance between the mounting rails shall be 17-3/4 inches. Maximum deflection of the entire rack assembly (with all equipment installed) shall not exceed 1/8- inch.

The rack assembly must have 12 technician test switches mounted to the interface frame assembly. Technician test switches must be of the momentary type and shall have eight vehicle and four pedestrian inputs.

The front of the rack assembly must be tapped with 10-30 threads with EIA universal spacing for 19 inch electrical equipment racks.

The rack assembly must be attached to the left cabinet wall through combination slide/hinged mounting brackets.

The slide/hinged mounting brackets must be fabricated from aluminum and/or stainless steel only.

Mounting bracket guides must utilize 7/8 inch stainless steel ball bearing rollers and allow extension and retraction of a loaded rack with minimal effort.

The rack assembly must be capable of rotating 210 degrees from its rest position after full extension from the cabinet.

The rack assembly must have an minimum 7/16 inch diameter aluminum rack stop rod attached to the inside left cabinet wall from the left side of the rack assembly to lock the rack into final position.

All cabinet harnesses must be long enough to maintain cabinet connections and functionality when the rack assembly is fully extended and rotated to its maximum limit. Harnesses must not bind or crimp when the rack is fully retracted, extended, or in motion.

676-2.3.12 Service Panels for 552A: *The 552A cabinet must include a field service panel, auxiliary field service panel, and interface panel, all constructed of aluminum with a 1/8 inch minimum thickness. All components must be accessible from the front of the panels. Do not mount components or attach wires behind panels.*

676-2.3.12.1 Field Service Panel: *The field service panel must consist of terminal strips, circuit breakers, transient protection devices, load resistors, capacitors, cable tie mounts and associated wiring for making all field wiring connections. Mount the field service panel in the cabinet on the lower right exterior cabinet wall.*

The field service panel must provide the necessary interconnecting junction points between the rack assembly and cabinet for the field service wires. The panel must be grouped for internal connections (jumpers) between terminals boards, wiring from the panel to the rack assembly, and wiring from the panel to the cabinet.

The field service panel wiring harness must have flexible wire covered by a flexible non-metallic conduit from the field service panel to the PDA, output file, and interface panel. The harness must have a metal clamp with a rubber grommet center attached to the field service panel to secure the harness to the panel for proper orientation of the harness with the rack assembly. Terminal strips for the panel shall be as listed below:

a) TBS1 - Terminal Block, Deadfront type, 3 position, No. 4 to No. 14 AWG wire range, 70A, 600V.

b) TBS2 - Terminal Block, Barrier, 16 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V.

c) TBS3 - Terminal Block, Barrier, 20 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No 16 AWG (max), 15A, 250V.

d) TBS4 & TBS5 - Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

The panel must have a main cabinet circuit breaker rated at 30A and a cabinet accessory circuit breaker rated at 15A for cabinet fans and light. Mount the circuit breakers near the back cabinet door on the panel.

The panel must include load resistors for all Walk, Green, Green Arrow, Yellow and Yellow Arrow Switch Pack outputs to prevent the conflict-voltage monitor from going into "Flash" due to a failed signal lamp. Load resistors must be 2K, 10 watt.

MOVs must be physically tied to one side of each terminal on TBS4 and TBS5 and be physically secured to the field service panel with a 6-32 screw.

676-2.3.12.2 Auxiliary Field Service Panel: *The auxiliary field service panel must be mounted on the lower left interior cabinet wall and consist of a minimum of four terminal strips, 18 detector surge protectors and one pedestrian button isolation board assembly. The 18 surge protectors must be a three-terminal device, two of which are connected across the signal inputs of the detector for differential mode protection and the third terminal is grounded to protect against common mode damage. Mount the pedestrian button isolation board on the auxiliary field service panel. Terminal strips for the panel shall be Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.*

Install a four-button pedestrian isolation board on the auxiliary field service panel to provide for the connection of the pedestrian buttons on phases- 2, 4, 6 and 8. The board must provide electrical isolation of the field wiring to the internal cabinet wiring. The inputs to this isolation board shall be wired to terminal block TBA5 for connection to field wiring. The outputs of this board shall be carried through the harness to the input file to the proper wires that go to the interface extension panel of the controller.

The pedestrian button isolation board must include a PC board mounted on an aluminum panel with the following minimum dimensions:

Height: 2 inches

Width: 8 inches

Thickness: 1/8 to 3/16 inches

676-2.3.12.3 Interface Panel: *The interface panel must consist of eight terminal strips, one telephone line suppressor and mounting fixture, two 24 V_{DC} relays and mounting fixtures, and all associated wiring for connecting the required interface equipment modules.*

The front of the panel must be covered by a 1/4 inch clear plexiglass sheet, supported from the panel by four 1-1/2 inch separators. Secure the panels to the separators using wing nuts that are removable without the use of tools. The plexiglass cover shall have 1/2 inch slot, centered over each of the terminal strips. All covers and panels must be interchangeable.

The panel wiring must provide the necessary interconnecting junction points between interface equipment cable harnesses and controller cabinet input and output signal. The panel wiring provides the functional wiring information for connecting the interface equipment in the cabinet.

The panel wiring must be grouped for internal connections (jumpers between terminal boards) as well as wiring from the controller and related cabinet functions to the terminal boards on the interface panel.

Ground wires must be No. 14 AWG wire, minimum. The internal harnesses must be located between TB1, TB2 and TB3. The external and internal wiring must be located outside of TB1 and TB4, between TB2 and TB3.

Terminal strips shall be Barrier type, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V. Terminals must use nickel/cadmium plated brass screws. All terminals and facilities on panels must be clearly identified using permanent silk-screened

The K1P and K2F relays shall be 15A miniature relays with polycarbonate cover, 2 form C (CO) contact arrangement, DC coil input, socket mount, .187 inch quick connect/solder terminals, AgCdO (15A) contacts, and 24V_{AC} coil voltage with matching socket and hold down spring. All screws on the relay socket must be brass with nickel/cadmium plating.

676-2.3.13 Storage Compartment: *Mount an aluminum storage compartment in the rack assembly. The storage compartment must have telescoping drawer guides for full extension of drawer from rack assembly and have a continuous front lip for opening the compartment top for storage. The top of the compartment must be non-slip plastic laminate.*

Install a communication port on the right hand side of the drawer at the front for connecting to the communications port of the controller unit via the cabinet harness.

676-2.3.14 Cabinet Rails: Provide the cabinet with four cabinet rails for mounting wiring panels and various brackets. Rails must be keyhole design with slots 2 inches on center with a top opening diameter of 5/8 inches to allow the insertion of a 5/8 inch by 1 inch carriage bolt. The rails must be approximately 1-1/2 inch to 2 inches wide by 1/2 inches deep. Do not use unistruts or other rails.

676-2.3.15 Electrical: Do not use printed circuit boards in any controller cabinet subsystem file or panel, including but not limited to the output file (except for the red monitor program board), service panel, interface panel, and input file.

676-2.3.15.1 Wiring: Cut all wires to the proper length and neatly laced into cables with nylon lacing. No wire shall be doubled back to take up slack. Cables in the cabinet must not interfere with the routing and connection of field wiring. Cables must be secured with nylon cable clamps, unless specified otherwise. The position of cables 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 controller cabinet.

Fabricate ground buss bars of a copper alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached. Mount a 6 inch ground buss bar with screw terminals on the bottom flange on each side of the cabinet for connection of AC neutral wires and chassis ground. Attach a flexible ground strap between the left side ground buss bar and the left side bottom rear of the rack assembly. Wiring harnesses must be covered by a flexible non-metallic conduit. Panel wire size must be a minimum of No. 18 AWG unless otherwise specified.

676-2.3.15.2 Terminals: Terminal connections must be soldered or constructed using a calibrated ratchet type crimping tool. Wiring must be traceable and without entanglement.

676-2.4 Controller Cabinet Flashing Operation: When a non-emergency flashing operation is required, the selected operation shall be performed by the UCF format. The following shall utilize UCF format:

- a) Flash Switch located on the cabinet service panel
- b) Time Base Coordination Flash
- c) Time Switch

When flashing operation is initiated, the controller assembly shall transfer from normal operation to flashing operation only at the end of the common major street red interval, the common minor street yellow interval, or the all red interval.

UCF shall be an internal function of the controller unit and must not be inhibited by the hold command. External logic will not be allowed to provide this function.

In the event of an emergency when flashing operation is required, the controller assembly shall immediately place the intersection on flash. Emergency flash may be initiated by the following:

- a) Auto/Flash Switch - A switch located on the cabinet police panel
- b) Conflict-Voltage Monitor senses a conflicting indication or system

error

When emergency flash is initiated, the controller assembly shall immediately transfer to flashing operation.

The transfer of the controller assembly from flashing operation to normal operation shall cause the controller unit to revert to its start-up sequence unless the conflict-voltage monitor has transferred the controller assembly to flashing operation. If transferred to

flashing operation by the conflict-voltage monitor, the controller assembly shall remain in flashing operation until the monitor unit is reset and automatic operation can be implemented through the normal start-up sequence.

676-2.5 Intelligent Transportation System Cabinets: The cabinet shell must conform to NEMA 3R requirements, be constructed of unpainted sheet aluminum alloy 5052-H32 with a minimum thickness of 0.125 inches and have a smooth, uniform natural aluminum finish without rivet holes, visible scratches or gouges on the outer surface. Other finishes are acceptable if approved.

The minimum dimensions for cabinets are listed below.

Table 1 Minimum Cabinet Dimensions in Inches			
Cabinet Type	Height	Width	Depth
336	36" - 39"	24" - 26"	20" - 22"
336S	46" - 48"	24" - 26"	22" - 24"
334	66" - 68"	24" - 26"	30" - 32"

The ~~field~~ cabinet must be weather resistant and constructed with a crowned top to prevent standing water. All exterior cabinet welds must be gas tungsten arc (TIG) welds and all interior cabinet welds must be gas metal arc (MIG) or TIG welds. All exterior cabinet and door seams must be continuously welded and smooth and all inside and outside edges of the cabinet must be free of burrs, rounded and smoothed for safety. All welds must be neatly formed and free of cracks, blow holes and other irregularities. Use ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements for welding on aluminum. Procedures, welders and welding operators must conform to AWS requirements as contained in AWS B3.0 and C5.6 for aluminum.

The cabinet must have a lifting eye plates on either side of the top for lifting the cabinet and positioning it. Each lifting eye opening must be a minimum diameter of 0.75 inches and capable of supporting a weight load of 1,000 pounds. All external bolt heads must be tamperproof.

Ground-mount cabinets must include a removable base plate and two aluminum plates, welded inside, for anchoring the cabinet to a concrete or composite type base as shown in the Plans. Fabricate the plates from aluminum alloy 5052-H32 a minimum of 4 inches wide by 0.125 inches thick. Provide the cabinet with four 1 inch diameter holes for anchoring.

676-2.5.1 Doors: Provide cabinets with front and rear doors, each equipped with a lock and handle. Doors must be full size, matching the height and width dimensions of the cabinet enclosure, with no fewer than three stainless steel hinges or; alternately, one full-length "piano" hinge. Hinges must be constructed of 14 gauge stainless steel with stainless steel hinge pins that are spot-welded at the top. Mount the hinges so that they cannot be removed from the door or cabinet without first opening the door. Brace the door and hinges to withstand 100 pounds per vertical foot of door height load applied vertically to the outer edge of the door when standing open. Ensure there is no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.

Door opening must provide a flange that allows the door gasket to mate with a flat surface. Include a gasket made of closed-cell material resistant to UV, weathering,

elevated temperatures, and permanent deformation that is permanently bonded to the inside of each door forming a weather-tight seal when the door is closed.

676-2.5.2 Latches: *Provide all cabinets with a three-point draw roller latching system for the doors. The latching system must have the following latching points.*

- 1. Center of the cabinet (lock).*
- 2. Top of the cabinet – controlled by the door handle.*
- 3. Bottom of the cabinet – controlled by the door handle.*

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Provide the cabinet with a door stop that retains the main door open in a 90 degree and 120 degree position.

Outfit the doors with an industrial standard pin tumbler lock with No. 2 key, or an approved alternate, and hardware that allows the door to be secured using a padlock. Provide two keys for each cabinet lock.

676-2.5.3 Rails: *Provide the cabinet with four cabinet rails that form a cage for mounting miscellaneous wiring panels and various mounting brackets. Use rails constructed of either 0.1345 inch thick plated steel or 0.105 inch thick stainless steel that extend the length of the cabinet's sides, starting from the bottom of the enclosure. Rails must be keyhole designed with slots 2 inches on center with a top opening of 5/8 inch in diameter to allow the insertion of a 5/8 inch by 1 inch carriage bolt. Rails must be 1-1/2 to 2 inches wide by 1/2 inches deep, drilled and tapped for 10-32 screws or rack screws with EIA universal spacing. Do not use unistruts or other rail types.*

676-2.5.4 Racks: *The cabinet must include a standard 19 inch EIA/TIA equipment rack centered in the cabinet for mounting devices to be installed inside. Clearance in the rack between the rails must be 17-3/4 inches.*

676-2.5.5 Shelf: *Provide a level, rollout internal shelf with a minimum work area measuring 10 inches by 10 inches. The shelf must be capable of sustaining a constant 20 pound load and the shelf position must be adjustable.*

676-2.5.6 Sunshield: *Sunshields must be mounted on standoffs that provide an air gap of at least of one inch between the exterior cabinet walls and the sunshields. Construct sunshields of 0.125 inch thick 5052-H32 aluminum sheet with corners that are rounded and smoothed for safety.*

676-2.5.7 Ventilation: *Provide ventilation through the use of a louvered vent at the bottom of the door. Vent depth must not exceed 0.25 inch. Provide an air filter a minimum of 192 square inches and 1 inch thick behind the vent. The filter must be removable and held firmly in place so that all intake air is filtered.*

Provide a bottom trough and a spring-loaded upper clamp to hold the filter in place. The bottom trough must drain any accumulated moisture to the outside of the field cabinet.

ITS field cabinets must have dual thermostatically controlled fans, rated for continuous duty with a service life of at least three years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70°F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. Use UL-listed exhaust fans having a minimum air flow rating of

100 cubic feet per minute. Electric fan motors must have ball or roller bearings. Vent the exhaust air from openings in the roof of the field cabinet.

676-2.5.8 Electrical Requirements: All equipment must conform to applicable UL, NEC, EIA, ASTM, ANSI, and IEEE requirements. SPD's must be accessible from the front of any panel used in the cabinet. Connect the SPD for the cabinet's main AC power input on the load side of the cabinet circuit breaker. All wiring must be laced. All conductors must be stranded copper.

676-2.5.8.1 Service Panel Assembly: Provide a service panel assembly to function as the entry point for AC power to the cabinet and the location for power filtering, transient suppression and equipment grounding. Provide branch circuits, SPDs, and grounding as required for the load served by the cabinet, including ventilation fans, internal lights, electrical receptacles, etc.

676-2.5.8.2 Terminal Blocks: Terminate electrical inputs and outputs on terminal blocks where the voltage and current rating of the terminal block is greater than the voltage and current rating of the wire fastened to it.

Terminate conductors on terminal blocks using insulated terminal lugs large enough to accommodate the conductor to be terminated. When two or more conductors are terminated on field wiring terminal block screws, use a terminal ring lug for termination of those conductors. Number all terminal block circuits and cover the blocks with a clear insulating material to prevent inadvertent contact.

676-2.5.8.3 Ground Buss Bar: Fabricate ground buss bars of copper alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached.

Mount the ground buss bar on the side of the cabinet wall adjacent to the service panel assembly for the connection of AC neutral wires and chassis ground wires. If more than one ground buss bar is used in a cabinet, use a minimum of a No. 10 AWG copper wire to interconnect them. Connect the equipment rack to the ground buss bar in the cabinet to maintain electrical continuity throughout the cabinet.

Follow the PANI recommendations of USDA-RUS-1751 for connections to the ground buss bar. Producer (P) or electrical power and sources of stroke current connections shall be on the left end of the buss bar. Absorbing (A) or grounding wires shall be connected immediately right of the P connections. Non-isolated (N) connections such as doors and vents shall be connected to the right of the A connections. Isolated (I) equipment grounds from equipment in the cabinet shall be connected on the right end of the buss bar.

676-2.5.8.4 Power Distribution Assembly: Furnish a power distribution assembly that fits in the EIA 19 inch rack and provides for protection and distribution of 120 V_{AC} power unless otherwise shown in the Plans.

676-2.5.8.5 Interior Lighting: Provide the ~~field~~ITS cabinet with two light fixtures, each capable of producing a minimum of 950 lumens, with clear shatter-proof shields. Mount a fixture on the inside front and rear top of the cabinet and include door switches so that the lights automatically turn on when a cabinet door is opened and turn off when the door is closed. Light fixtures must be unobstructed and able to cast light on the equipment in the cabinet.

676-2.6 Generator and Auxiliary Power Connection: Traffic signal controller cabinets must include a generator and auxiliary power connection. ITS cabinets must include a generator and auxiliary power connection unless otherwise shown in the Plans.

Cabinets with generator and auxiliary power connection must include provisions for the connection of an external power source, such as a portable generator, through a weatherproof, secure interface. This feature must allow authorized personnel to access, connect, and secure an external power source to the cabinet in order to restore power within five minutes of arrival time at the cabinet.

Provide the cabinet with either a manual or automatic transfer switch as shown in the Plans. The transfer switch must meet UL 1008 and be rated equal to or higher than the design load of the cabinet's main breaker and the generator input twist-lock connector rating. The transfer switch must provide a means of switching between normal utility power and auxiliary backup generator power. Switching time cannot exceed 250 milliseconds. Ensure that the transfer switch does not allow simultaneous active power from more than one source and does not allow generator backflow into normal utility AC circuits.

676-2.6.1 Manual Transfer Switch: *Provide a two-position manual transfer switch with the switch positions labeled "Generator Power" and "Utility Power".*

Equip the transfer switch with a "Utility-on" indicator, which will illuminate when normal utility power service is available and the switch is in the "Generator Power" position. The indicator must turn off when the transfer switch is moved to the "Utility Power" position. The Utility-on indicator must be clearly visible outside the cabinet and the indicator's on/off state must be obvious from a distance of 30 feet.

676-2.6.2 Automatic Transfer Switch: *An automatic transfer switch may be used instead of a manual transfer switch to provide for automatic transition from generator power back to normal utility service after utility power is restored. Provide the automatic transfer switch with indicators that display the status of connected power sources and indicate which power source is actively energizing the cabinet.*

If a relay circuit is used to provide switching, the normally closed circuits must be connected to normal utility power. The relay must be energized solely by the generator. When energized, the relay must break the connection to normal utility power and make connection to the generator power input. Any automatic transfer switch or relay operated switch must include a bypass switch that disables automatic switching and permits manual selection of the power sources connected to the cabinet.

676-2.6.3 Generator Access Panel: *Include a generator connection panel consisting of, at a minimum, the manual transfer switch and a three-prong, 30 amp twist-lock connector with recessed male contacts for generator hookup. Locate the access panel as close as possible to the main AC circuit breaker with the bottom of the access panel no less than 24 inches above the bottom of the cabinet. Do not place the generator access panel on the main cabinet door or back door. Locate and label the transfer switch and twist lock connector on a panel easily accessible behind a weatherproof lockable exterior access door equipped with a tamper-resistant hinge. Label this access door "Generator Access Door" Provide the access door with a No. 2 lock unless otherwise specified in the Plans.*

The access door must include a weatherproof opening for the generator cable. The generator hookup compartment must be recessed no more than six inches into the cabinet but be deep enough to allow closing and locking of the access door when the generator cable is connected. Avoid blocking access to any other equipment in the cabinet.

676-2.7 Small Equipment Enclosures: *Small equipment enclosures, such as equipment cabinets less than 13 inches high by 10 inches wide by 11 inches deep, may be constructed of aluminum or non-metallic materials. Enclosures must include a safe means of removing power*

from the installed equipment for servicing and replacement, such as a switch, fuse, or breaker. Discrete markings, such as manufacturer name and model, are permitted on the outside of small enclosures.

All fasteners less than 5/8 inch exposed to the elements must be Type 304 or 316 stainless steel.

Construct aluminum enclosures of 5052 sheet aluminum alloy with a minimum thickness of 0.090 inches. Aluminum enclosures must have a uniform natural finish or be powder coat painted in accordance with AAMA-2603-02 specifications. All welds, bends, and seams must be neatly formed and free of cracks, blow holes and other irregularities. All inside and outside edges of the enclosure must be free of burrs, rivet holes, visible scratches, and gouges and have a smooth, uniform finish.

Non-metallic enclosures must be UL 508A listed, be rated for outdoor use, and resist chemicals, corrosion, and ultraviolet rays. Enclosures must be NEMA 3R (IP 66) rated, minimum.

Enclosure doors must include a vandal resistant hinge and be secured with a locking latch or a minimum of two quick-release Type 304 or 316 stainless steel latches with padlock hasps. Removal of the hinge or hinge pin must not be possible while the enclosure is closed. Provide two sets of keys with each lock.

Enclosures may be vented. Holes larger than 1/8 inches must be covered by heavy duty screen.

Post mounted enclosures must be supplied with mounting hardware for attaching the enclosure to a 4-1/2 inch (OD) aluminum post.

676-3 Installation Requirements.

376-3.1 General: *Ground all cabinets in accordance with the requirements of Section 620. Keep the ground wire from the cabinet ground bussbar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet. Controller cabinets shall be wired in accordance with the signal operating plan specified in the Contract Documents. If phases are omitted for future use, the cabinet must be wired for these future phases. However, the load switches for the future phases do not have to be furnished. All field drilled conduit entrance holes or other holes must be reamed and free of burrs. All conduit connections to the cabinet must be weatherproof.*

676-3.1.2 General Traffic Signal Signal Controller Cabinet Installation: *Install traffic signal controller cabinets in accordance with the Design Standards, Index No. 17841. ~~Ensure that all conduit entrance holes or other holes which are field drilled are reamed and free of burrs. Make all conduit connections to the cabinet watertight by the use of clear silicone rubber sealant.~~*

676-3.2.1 Pole Mounted Cabinets (Types 1, 2, 3, and 4) [MRG2]:

(a) Fasten the pole mounted hardware which is furnished with the cabinet to the cabinet, making all connections watertight.

(b) Use stainless steel bands for mounting cabinets onto steel strain poles.

(c) Use stainless steel bands or lead anchors (or equivalent) for mounting cabinets onto concrete strain poles.

(d) Use stainless steel bands or lag bolts for mounting cabinets onto wood poles.

676-3.2.2 Base Mounted Cabinets (Types 4, 5, and types used for Model 170 Controller Assemblies):

(a) Use anchor bolts to fasten base mounted cabinets to the concrete base.

(b) Seal the joint between the bottom of the cabinet and the concrete base (inside and outside of cabinet) with a clear silicone rubber sealant.

(c) Construct the base for the cabinets with concrete in accordance with Section 347. Make the concrete base for the cabinet level, free of honeycombs and as smooth as possible. Temporarily seal the end of conduit risers located in the base before placing the concrete. Position the end of the conduit risers a minimum of 2 inches above the finished surface of the concrete base.

676-3.42.3 Field Wiring:

(a) Terminate signal cable, interconnect cable, and loop lead-in wires on the appropriate terminal strips in the controller cabinet with insulated terminal lugs. Use a calibrated ratchet type crimping tool to install the insulated terminal lugs onto the field wires.

(b) Label spare circuits of the signal and interconnect cables and connect them to the cabinet ground bussbar.

(c) Neatly bundle and identify all field wiring cables in the controller cabinet.

676-3.3 Intelligent Transportation System Cabinet Installation: *Mount the cabinet as shown in the Plans, and provide the cabinet with the necessary base or pole mount hardware. Ensure that pole and structure-mounted field cabinets have mounting brackets on the side so that both cabinet doors are fully functional.*

Make provisions for all telephone, data, control, and confirmation connections between the ITS device and field cabinet and for any required wiring harnesses and connectors.

Place a heavy-duty resealable plastic bag on the backside of the main cabinet door for containing cabinet prints, a list of terminal block connections, and other documentation.

Place all equipment in the cabinet according to the recommendations of the manufacturer. Maintain a minimum clearance of 6 inches between the top of the cabinet and the top of any equipment placed on the top shelf of the cabinet and a minimum clearance of 2 inches between each side of the cabinet and any equipment placed on the cabinet shelves.

676-3.4 Small Enclosure Installation: *Mount the enclosure on a pole or support structure, as shown in the Plans, and provide any hardware necessary for a complete and accepted installation.*

~~676-3.5 Grounding: Ground all controller cabinets in accordance with the requirements of Section 620. Keep the ground wire from the controller cabinet ground bussbar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet.~~

676-4 Warranty.

Ensure traffic cabinets have a manufacturer's warranty covering defects for a minimum of two years from the date of final acceptance in accordance with 5-11 and Section 608. The warranty must include providing replacements, within 10 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or maintaining agency.

676-4.5 Method of Measurement.

~~676-4.1 General: Measurement for payment will be in accordance with the following work tasks.~~

~~676-4.2 Furnish and Install:~~ The Contract unit price each for ~~controller~~ traffic cabinet, furnished and installed, will include all materials specified in the Contract Documents, and all

labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

No separate payment will be made for a traffic cabinet when included with the controller assembly as per Section 670.

~~676 4.3 Furnish: The Contract unit price each for controller cabinet, furnished, will include all materials and all shipping and handling costs involved in delivery as specified in the Contract Documents.~~

~~676 4.4 Install: The Contract unit price each for controller cabinet, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply all materials as specified in the Contract Documents.~~

~~676 4.5 Modify: The Contract unit price each for controller cabinet, modified as specified in the Contract Documents, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.~~

676-56 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 676- 1- ~~Controller~~ *Traffic Signal Controller* Cabinet - each.

Item No. 676- 2- ITS Cabinet - each.

Item No. 676- 3- Small Equipment Enclosure - each.

TRAFFIC CABINETS.**(REV 9-5-14)**

SECTION 676 is deleted and the following substituted:

**SECTION 676
TRAFFIC CABINETS**

676-1 Description.

Furnish and install traffic cabinets as shown in the Plans. Meet the requirements of Section 603.

676-2 Materials.

676-2.1 General: Use traffic cabinets and accessories that are listed on the Department's Approved Product List (APL). Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. Place the label on the inside of the main door using a water resistant method. The label must be visible after installation.

676-2.2 NEMA Traffic Signal Controller Cabinets: Provide NEMA traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control meeting the following requirements:

NEMA TS1 Controller Cabinet NEMA TS-1-1989

NEMA TS2 Controller Cabinet NEMA TS 2 2003

676-2.2.1 Documentation: Provide four copies of the cabinet wiring diagram with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan.

Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires.

A heavy duty, resealable plastic opaque bag must be mounted on the backside of main cabinet door for storing cabinet prints and other documentation.

676-2.2.2 Police Switches: Provide the following police switches with Type 3 and larger controller cabinets. The switches must be mounted on the police panel and identified as to their function.

(a) **AUTO-FLASH:** When this switch is in the FLASH position, all signal indications must immediately transfer to the flashing mode. AC power shall be removed from the load switches and stop timing applied to the controller unit. When this switch is placed in the AUTO position the controller unit must operate in accordance with the appropriate specification.

(b) **MANUAL ON-OFF:** When this switch is in the on position, a logic ground must be applied to the manual control enable input of the controller unit.

(c) **MANUAL JACK:** Install a manual jack on the police panel. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

Provide a manual pushbutton with Type 3 and larger cabinets. The pushbutton cord must have a minimum length of six feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the pushbutton during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

676-2.2.3 Service Switches: Service switches must be mounted on the service panel or other locations approved by the Department and identified as to their functions. Provide the following service switches with Type 3 and larger cabinets.

(a) **SIGNALS ON-OFF:** When this switch is in the off position, AC power shall be removed from all signal heads. The SIGNALS ON-OFF switch must be connected to the control input of a contactor (displacement relay). Current supplied to the switch must not exceed five amperes (amps) total. Do not directly route the main signal head power buss and cabinet power through the service or police switches.

(b) **AUTO-FLASH:** When this switch is in the FLASH position, all signal indications must transfer to the flashing mode in accordance with the Uniform Code Flash (UCF) requirements. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode. The controller unit must operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the AUTO position, transfer from the flash mode to normal operation shall be made in accordance with UCF requirements.

(c) **CONTROLLER ON-OFF:** When this switch is in the off position, AC power shall be removed from the controller.

(d) **AUX POWER ON-OFF:** When this switch is in the off position, AC power shall be removed from all circuits of the cabinet except for the duplex receptacle, cabinet light and ventilation fan.

(e) **VEHICLE DETECTORS:** A detector test switch must be provided for each phase of the controller unit. Detector test switches must include a position for normal operation (phase receives calls from detectors), a position that provides a constant call, and a position that provides a momentary call.

676-2.2.4 Doors and Locks: Provide Type 3 and larger cabinets with a hinged, rain tight and dust tight police door which allows access to the police switches and manual jack.

Locate the police door in the bottom half of the main door for Type 3 and 4 pole mount cabinets. Locate the police door in the upper half of the main door for Type 4 and larger base mount cabinets.

Hinges and hinge pins must be constructed of stainless steel and prevent the door (main or police) from sagging. Hinges for the main and police doors must be located on the right side (viewed from the front).

Type 3 and larger cabinets must be furnished with a three point draw roller latching system consisting of the following latching points:

- (a) Center of the cabinet (lock)
- (b) Top of the cabinet--controlled by the door handle
- (c) Bottom of the cabinet--controlled by the door handle

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Type 3 and larger cabinets must be furnished with a door stop which retains the main door open in a 90 degree and 120 degree position.

676-2.2.5 Police and Service Panels: Provide a police service panel with Type 3 and larger cabinets. The panels may be constructed of either sheet aluminum or cast aluminum. Locate the police panel behind the police door attached to the main door. The service panel must be mounted on the back side of the police panel. The police panel must have the following minimum dimensions:

- (a) Height – 4 inches
- (b) Width – 8 inches
- (c) Depth – 2-1/2 inches

676-2.2.6 Ventilation: Type 1 and 2 cabinets must be vented to allow dissipation of the heat generated by the equipment housed inside the cabinet.

Type 3 and larger cabinets must have dual thermostatically controlled fans, rated for continuous duty with a service life of at least three years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70 F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. The intake vent must be rain tight, located on the bottom half of the cabinet, and covered with a removable filter.

676-2.2.7 Shelves: Type 2 cabinets must be furnished with one shelf. Type 3 and larger cabinets must be furnished with two adjustable shelves. Shelves must be adjustable in a maximum of 2 inch increments from the top of the load panel to 12 inches from the top of the controller cabinet.

676-2.2.8 Mounting Hardware: Type 1, 2, and 3 cabinets must be supplied with hardware for attaching the top and bottom half of the cabinet onto a flat or round surface. Optional wall or pole mount hardware must be provided for mounting Type 4 cabinets in specific installations.

Type 4 cabinets must have rigid tabs attached to the bottom of the cabinet. Type 5 cabinets must have rigid brackets attached to the bottom of the cabinet. Rigid brackets and tabs must be constructed of the same material used for the cabinet.

Type 4 and larger cabinets must be provided with one of the following alternatives for fastening to a concrete base:

(a) Galvanized anchor bolts, nuts, lock washers, and flat washers in accordance with ASTM A153. The anchor bolts must be at least 1/2 inch in diameter, seven inches in vertical length with at least three inch horizontal, or

(b) Heavy duty machine bolt anchors, flat washers, lock washers and machine screws at least 1/2 inch in diameter.

676-2.2.9 Electrical: Fabricate ground bussbars of copper alloy material compatible with copper wire and provide at least two positions where No. 2 AWG stranded copper wire can be attached.

Mount a ground bussbar on the side of the cabinet wall adjacent to the power panel for the connection of AC neutral wires and chassis ground wires.

If more than one ground bussbar is used in a cabinet, a minimum of a No. 10 AWG copper wire must be used to interconnect them.

676-2.2.9.1 Wiring: All wiring must be laced. All conductors in the cabinet must be stranded copper.

All inputs and outputs must be terminated on terminal strips. A connector harnesses for the controller, conflict monitor, vehicle detectors, and other controller accessory equipment must be furnished and wired into the cabinet circuitry.

A vehicle detector harness or rack must be furnished with the cabinet. Terminal strip circuits must be provided for connection of the loop lead-in cable.

676-2.2.9.2 Terminal Strips: The voltage and current rating of terminal strips must be greater than the voltage and current rating of the wire which is terminated on the terminal strip.

Conductors must be terminated on terminal strips with insulated terminal lugs. A calibrated ratchet crimping tool must be used to terminate the conductor in the terminal lug.

When two or more conductors are terminated on field wiring terminal strip screws, a terminal ring lug shall be used for termination of those conductors. All terminal strip circuits must be numbered.

676-2.2.9.3 Cabinet Light and Receptacle: Provide a light fixture capable of producing a minimum of 950 lumens with Type 3 and larger cabinets. The fixture must include a clear shatterproof shield and be mounted on the inside, front top of the cabinet and the light must automatically turn on when the main cabinet door is opened and off when the door is closed.

Mount and wire a three-wire 115 V_{AC} duplex receptacle in all cabinets. The receptacle must be protected by a 15A circuit breaker. Do not mount the receptacle on the main cabinet door or police and service switch panels.

676-2.2.9.4 Main Circuit Breaker: Provide a 15A circuit breaker with Type 1 and 2 cabinets, and a 30A circuit breaker with Type 3 and larger cabinets.

The main circuit breaker must turn off all power to the cabinet and shall not be used for the power switch located in the service panel.

676-2.2.9.5 Radio Interference Suppression: A radio interference suppressor must be provided in series with the AC power before it is distributed to any equipment inside the cabinet. The suppressor must provide a minimum attenuation of 50 decibels over a frequency range of 200 kHz to 75 MHz when used with normal installations and shall be hermetically sealed in a metal case.

The radio interference suppressor must have the same minimum current rating as the main circuit breaker.

The ground connection of the radio interference suppressor must be connected only to AC neutral and shall not be connected to earth ground directly.

676-2.2.9.6 Opto Isolation: The Opto Common input is the common reference pin for four optically isolated inputs.

The Opto inputs are intended to provide optical isolation for pedestrian detector and remote interconnect inputs. The Opto inputs are intended to connect through external 27 kS, 1 W resistors for 120 V_{AC} operation and are intended for direct connection to 12 V_{AC} from the cabinet power supply for pedestrian detector applications. These inputs may alternatively be used for low-true DC applications when the Opto Common pin is connected to the 24 V supply.

The Opto inputs shall provide electrical isolation of 10 MS minimum resistance and 1000 V_{AC} RMS minimum breakdown to all connector pins except the Opto Common pin. These inputs shall exhibit nominal impedance to the Opto Common pin of 5 kS', plus or minus 10 percent, and shall require 2.4 mA, plus or minus 10 percent, from a nominal 12 V_{AC} supply. The Opto inputs shall not recognize 3 V_{AC} RMS or less relative to the common input and recognize 6 V_{AC} RMS or more relative to the common input. Any steady state voltage applied between an Opto input and the Opto Common shall not exceed 35 V_{AC} RMS. Opto inputs shall not be acknowledged when active for 25 ms or less, and shall be acknowledged when active for 50 ms or more.

676-2.2.9.7 Load Resistors: A load resistor or capacitor must be installed between the AC (common) and each signal field wiring terminal for the yellow, green and walk indication. All load resistors and capacitors must be on the front side of any panel used in the cabinet.

676-2.2.9.8 Surge Protection: Furnish surge protective devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet.

The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker.

SPDs for signal and interconnect cable field wiring terminals must meet the following:

(a) Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.

(b) Withstand a surge current of 1000A with an 8 by 20 μs waveform six times (at 1 second intervals between surges) without damage to the suppressor.

SPDs for loop lead-in cables must be designed in accordance with the following requirements:

(a) Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges.

(b) Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges.

(c) Withstand repetitive 400A surges with an 8 by 20 μs waveform without damage.

SPDs must be installed according to the SPD manufacturer's instructions and not affect the operation of detectors. SPD leads must be kept as short as possible.

676-2.3 Type 170 Traffic Signal Controller Cabinets: Provide Type 170 traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control and meeting the following requirements:

Model 332, 334 and 336S Cabinets.....

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Model 336S cabinet must incorporate input surge protection mounted on a fold-down termination panel at the input file.

Model 332 cabinets must incorporate a lower input termination panel. Model 332 and 334 cabinets must be base mounted. The Model 332 cabinet must have an auxiliary MODEL 420 output file, and be configured for 8 vehicle, 4 pedestrian, and 4 overlaps.

Model 552A designation is given to Model 332 cabinet assemblies that include a swing-out EIA 19 inch rack cage.

Cabinets must comply with figures for traffic control signals and devices available on the Department's website at the following URL:

http://www.dot.state.fl.us/trafficoperations/Traf_Sys/Product-Specifications.shtm

All terminals and facilities on panels must be clearly identified using permanent silk-screened text.

676-2.3.1 Base Plate and Mounting Brackets: Provide cabinets with a removable base plate and provisions for a standard base mounting bolt pattern. Cabinets must have two aluminum plates welded inside for anchoring to a concrete or composite base.

676-2.3.2 Police Switches: Police switch panels must include a manual jack. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of 6 feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

676-2.3.3 Output File: Fabricate the output file using a "hard wired" harness. Printed board circuit boards are not acceptable.

676-2.3.4 Shelf: Provide an aluminum shelf with storage compartment in the rack below the controller (for remote secondary monitor/lap top computer use). The storage compartment must have telescoping drawer guides for full extension. The compartment top must have a non-slip plastic laminate attached. Provide an RS-232 connector for communications to the C2S port.

676-2.3.5 Loads: Provide dummy loads consisting of 4.7k resistors rated at five watts minimum for Greens, Peds, and Yellows. The dummy loads must be mounted on a terminal block in the rear of the output file or other approved location. Wire one side of each dummy load to AC return in a manner that allows a technician to easily attach the load to outputs from selected load switches.

676-2.3.6 Cabinet Light: Provide a light fixture capable of producing a minimum of 950 lumens. The fixture must include a clear shatterproof shield and be mounted on the inside, front top of the cabinet. The light must automatically turn on when the cabinet door is opened and off when the doors are closed.

676-2.3.7 Surge Protection: Provide each cabinet with devices to protect equipment from surges. Surge protection must be provided for the full capacity of the cabinet Input File and shall be in accordance with the assignment of the slots of a standard 336S cabinet assembly. Surge protector termination panels must be attached to the cabinet rack assembly and allow sufficient space for connections, access, and surge protector replacement. AC isolation

terminals must be on the same side of the cabinet as the AC service inputs. DC terminals and loop detector terminals must be installed on the opposite side of the cabinet from the AC power lines.

Surge protection for 332A cabinets must be mounted on the lower input termination panel.

Surge protection for 336S cabinets must be mounted on a custom fold down termination panel at the input file.

Under no circumstance (normal operation or short-circuit condition) shall the amperage capacity of the internal wiring and printed circuit board traces be less than the protecting threshold of circuit breakers and surge protectors provided.

676-2.3.7.1 Power Distribution Assembly Protection: The power distribution assembly (PDA) SPD must be a two stage series/parallel device that meets or exceeds the following:

- (a) Maximum AC line voltage: $140 V_{AC}$
- (b) 20 pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20kA.
- (c) The protector must include the following terminals:
 - Main line (AC Line first stage terminal)
 - Main Neutral (AC Neutral input terminals)
 - Equipment Line Out (AC Line second stage output terminal, 10A)
 - Equipment Neutral Out (Neutral terminal to protected equipment)
 - Ground (Earth connection)
- (d) The main AC line in and the equipment line outer terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10A AC service
- (e) The first stage clamp shall be between Main Line and ground terminals
- (f) The second stage clamp shall be between Equipment Line Out and Equipment Neutral
- (g) The protector for the first and second stage clamp must have a metal oxide varistor (MOV) or similar solid state device, rated 20 kA.

The main neutral and equipment neutral output shall be connected together internally, and shall have an MOV (or similar solid state device, or gas discharge tubes) rated at 20 kA between main neutral and ground terminals.

The PDA SPD must have a peak clamp voltage of 250V at 20 kA (voltage measured between equipment line out and equipment neutral out terminals, current applied between main line and ground terminals with ground and main neutral terminals externally tied together).

The PDA SPD must have a maximum let through voltage not exceeding 500 Vpk using an 8 by 20 μ s/1.2 by 50 μ s; 6 kV, 3 kA surge. The SPD must either be epoxy-encapsulated in a flame retardant material or utilize thermally protected varistors and be designed for continuous service current of 10A at 120 V_{AC} RMS. Power to the Type 170E controller and to the 24V power supply must be provided from the equipment line out terminal of the PDA SPD.

676-2.3.7.2 Inductive Loop Detector Protection: Protect each inductive loop detector input channel with an external SPD that meets or exceeds the following:

(a) The SPD must be a three-terminal device, two of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.

(b) The SPD must instantly clamp differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array shall be designed to appear as a very low capacitance to the detector.

(c) The SPD must clamp common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.

(d) Peak Surge Current

Differential Mode: 400A (8 by 20 μ s)

Common Mode: 1000A (8 by 20 μ s)

Estimated Occurrences: 500 @ 200A

(e) Response Time: 40 ns

(f) Input Capacitance 35 pF typical

(g) Clamp Voltage

30V max @ 400A (Differential Mode)

30V max @ 1000A (Common Mode)

676-2.3.7.3 Signal Load Switch Protection: The outputs of each load switch in the output file shall be provided with a MOV connected from the AC positive field terminal to the chassis ground. The MOV must be rated 150 V_{AC} and shall be a V150LA20A (or approved equal).

676-2.3.7.4 Communication Input Protection: Each low voltage communication input must be protected as it enters the cabinet with a hybrid two-stage SPD that meets or exceeds the following:

(a) The SPD must be a dual pair (four-wire) module with a double-sided, gold-plated printed circuit board connector.

(b) The SPD must be installed in a ten-circuit card edge terminal block (PCB1B10A).

(c) The SPD must be utilized as two independent signal pairs. The data circuits must pass through the SPD in a serial fashion.

(d) Peak Surge Current

10kA (8 by 20 μ s)

Occurrences at 2000A: greater than 100

(f) Response Time: less than 1 ns

(g) Clamp Voltage: 30V maximum

(h) Series Resistance: greater than 15 ohms per line

(i) Primary Protector: 3 element gas tube

(j) Secondary Protector: Solid state clamp (1.5 kW minimum)

The line side of the SPD must be connected to the communication field wires, the load side connected to the communication connector of the controller, and the ground terminal connected to chassis ground.

676-2.3.7.5 Low Voltage DC input protection: Each DC input must be protected by an SPD that meets or exceeds the following:

(a) The SPD must be a 5 terminal device. Two terminals must be connected to the line side of the low voltage pair, two terminals must be connected to the input file side, and the fifth terminal connected to chassis ground.

(b) Peak Surge Current

2 kA (8 by 20 μ s)

Occurrences at peak current: 100 (typical)

(c) Response Time: 5-30 ns

(d) Shock: Must withstand 10 foot drop on concrete

(e) Clamp Voltage: 30V

(f) Series Resistance: greater than 15 ohms each conductor

676-2.3.7.6 Preemption and 115V AC signal input protection: Each preemption or AC signaling input channel must be protected by an external SPD that meets or exceeds the following requirements:

(a) The SPD must be a 3 terminal device

(b) Peak Surge Current

2000A (8 by 20 μ s)

Occurrences at peak current: 25 (minimum)

(c) Response Time: less than 200 ns

(d) Peak Surge Trip Point: less than 890V nominal

676-2.3.8 Model 210 Conflict Monitor with Absence of Red Monitoring: The conflict monitor must be a Model 210 "PLUS" conflict monitor capable of detecting fault sequencing of signals on a per channel basis (i.e. short or absence of yellow interval and/or simultaneous dual indications). All integrated circuits having 14 pins or more must be socket-mounted.

676-2.3.8.1 Absence of Red Monitoring: The conflict monitor must be capable of monitoring for the absence of voltage on all of the inputs of a channel (defined here as red, yellow, and green). If an output is not present on at least one input of a channel at all times, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for more than 1000 milliseconds, the unit shall trigger as if a conflict had occurred, causing the intersection to transfer immediately into a flashing mode, and "stop-time" to be applied to the controller. A red signal shall require the presence of a minimum of 60 V_{AC}, plus or minus 10 V_{AC}, to satisfy the requirements of a red indication. The red input signals shall be brought into the conflict monitor through an auxiliary connector on the monitor's front panel. Provide a similar connector on the output file, with a removable harness connecting the two. Provide an indicator on the front panel of the monitor to identify the triggering of the monitor in response to the absence of red condition.

676-2.3.8.2 Red Monitor Harness: A connector and terminal assembly designated as P20 for monitoring the absence of red, shall be an integral part of the output file. The connector must terminate, and be compatible with, the cable and connector of a Type 170 conflict monitor unit (CMU), capable of monitoring the absence of red. Provide the pin assignments of the P20 connector and terminal assembly with the cabinet plans. The P20 connector shall be physically like the cable and connector of a Type 170 CMU to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

676-2.3.8.3 Programming of Unused Red Channels: Provide all cabinet assemblies with a means of programming unused red channels by installing jumpers from red monitor inputs to 115 V_{AC}. The connecting terminals for the jumpers must be accessible and located in the same terminal block for all 16 channels to assure full compatibility of all cabinet assemblies with "210 Plus" conflict monitor units.

676-2.3.9 Police Door and Panel: Provide cabinets with police doors and panels. The police panel must include text informing officers that yellow and all-red clearance intervals are timed internally.

676-2.3.9.1 Manual Control: Police switch panels must include a manual jack. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of six feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

676-2.3.10 Technician Service Panel: Provide cabinets with a technician service panel which is mounted on the back side of the police panel (inside the main cabinet front door).

676-2.3.10.1 Service Panel Switches: There must be two switches located on the technician service panel, clearly labeled according to the following functions:

(a) UCF – This toggle switch shall:

Place the intersection into Flashing Operation.

After meeting requirements for Flashing

Operations, all power shall be removed immediately from signal load switches.

(b) Signal On/Off – This toggle switch shall disconnect all power to the signal lights through the use of a 60A contact switch placed in series with the load switch packs.

Labels must be silk screened directly on the panel.

676-2.3.11 Swing-out Rack Assembly: Provide 552-A cabinets with a pullout and rotatable rack assembly as well as an interface panel mounted on the top of the rack assembly and attached to the top shelf. The rack assembly must be constructed to house components designed to be installed in a standard EIA 19 inch rack and shall house the Controller, Input File, Output File No. 1, PDA No. 2, and a storage compartment.

Construct the rack and slide/hinged mounting brackets so that when the rack assembly (fully loaded) can be pulled out with one hand with complete ease of operation including rotation of the assembly.

The rack assembly must have a spring-loaded latch mechanism to secure the rack assembly inside the cabinet while in the "rest" position. When pulled out of the cabinet at any point from its resting position (inside cabinet) to its full extension and rotation, the fully loaded rack assembly shall not cause any member of the assembly to bend, warp or bind. The rack must be made of one inch square aluminum tubing with welded joints and extend and retract smoothly without noticeable friction or stress on roller guides, extension brackets, or other

mechanical components. Clearance between the mounting rails shall be 17-3/4 inches. Maximum deflection of the entire rack assembly (with all equipment installed) shall not exceed 1/8 inch.

The rack assembly must have 12 technician test switches mounted to the interface frame assembly. Technician test switches must be of the momentary type and shall have eight vehicle and four pedestrian inputs.

The front of the rack assembly must be tapped with 10-30 threads with EIA universal spacing for 19 inch electrical equipment racks.

The rack assembly must be attached to the left cabinet wall through combination slide/hinged mounting brackets.

The slide/hinged mounting brackets must be fabricated from aluminum and/or stainless steel only.

Mounting bracket guides must utilize 7/8 inch stainless steel ball bearing rollers and allow extension and retraction of a loaded rack with minimal effort.

The rack assembly must be capable of rotating 210 degrees from its rest position after full extension from the cabinet.

The rack assembly must have an minimum 7/16 inch diameter aluminum rack stop rod attached to the inside left cabinet wall from the left side of the rack assembly to lock the rack into final position.

All cabinet harnesses must be long enough to maintain cabinet connections and functionality when the rack assembly is fully extended and rotated to its maximum limit. Harnesses must not bind or crimp when the rack is fully retracted, extended, or in motion.

676-2.3.12 Service Panels for 552A: The 552A cabinet must include a field service panel, auxiliary field service panel, and interface panel, all constructed of aluminum with a 1/8 inch minimum thickness. All components must be accessible from the front of the panels. Do not mount components or attach wires behind panels.

676-2.3.12.1 Field Service Panel: The field service panel must consist of terminal strips, circuit breakers, transient protection devices, load resistors, capacitors, cable tie mounts and associated wiring for making all field wiring connections. Mount the field service panel in the cabinet on the lower right exterior cabinet wall.

The field service panel must provide the necessary interconnecting junction points between the rack assembly and cabinet for the field service wires. The panel must be grouped for internal connections (jumpers) between terminals boards, wiring from the panel to the rack assembly, and wiring from the panel to the cabinet.

The field service panel wiring harness must have flexible wire covered by a flexible non-metallic conduit from the field service panel to the PDA, output file, and interface panel. The harness must have a metal clamp with a rubber grommet center attached to the field service panel to secure the harness to the panel for proper orientation of the harness with the rack assembly. Terminal strips for the panel shall be as listed below:

a) TBS1 - Terminal Block, Deadfront type, 3 position,
No. 4 to No. 14 AWG wire range, 70A, 600V.

b) TBS2 - Terminal Block, Barrier, 16 position, .375
Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V.

c) TBS3 - Terminal Block, Barrier, 20 position, .375
Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No 16 AWG (max), 15A, 250V.

d) TBS4 & TBS5 - Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

The panel must have a main cabinet circuit breaker rated at 30A and a cabinet accessory circuit breaker rated at 15A for cabinet fans and light. Mount the circuit breakers near the back cabinet door on the panel.

The panel must include load resistors for all Walk, Green, Green Arrow, Yellow and Yellow Arrow Switch Pack outputs to prevent the conflict-voltage monitor from going into "Flash" due to a failed signal lamp. Load resistors must be 2K, 10 watt.

MOVs must be physically tied to one side of each terminal on TBS4 and TBS5 and be physically secured to the field service panel with a 6-32 screw.

676-2.3.12.2 Auxiliary Field Service Panel: The auxiliary field service panel must be mounted on the lower left interior cabinet wall and consist of a minimum of four terminal strips, 18 detector surge protectors and one pedestrian button isolation board assembly. The 18 surge protectors must be a three-terminal device, two of which are connected across the signal inputs of the detector for differential mode protection and the third terminal is grounded to protect against common mode damage. Mount the pedestrian button isolation board on the auxiliary field service panel. Terminal strips for the panel shall be Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

Install a four-button pedestrian isolation board on the auxiliary field service panel to provide for the connection of the pedestrian buttons on phases 2, 4, 6 and 8. The board must provide electrical isolation of the field wiring to the internal cabinet wiring. The inputs to this isolation board shall be wired to terminal block TBA5 for connection to field wiring. The outputs of this board shall be carried through the harness to the input file to the proper wires that go to the interface extension panel of the controller.

The pedestrian button isolation board must include a PC board mounted on an aluminum panel with the following minimum dimensions:

Height: 2 inches

Width: 8 inches

Thickness: 1/8 to 3/16 inches

676-2.3.12.3 Interface Panel: The interface panel must consist of eight terminal strips, one telephone line suppressor and mounting fixture, two 24 V_{DC} relays and mounting fixtures, and all associated wiring for connecting the required interface equipment modules.

The front of the panel must be covered by a 1/4 inch clear plexiglass sheet, supported from the panel by four 1-1/2 inch separators. Secure the panels to the separators using wing nuts that are removable without the use of tools. The plexiglass cover shall have 1/2 inch slot, centered over each of the terminal strips. All covers and panels must be interchangeable.

The panel wiring must provide the necessary interconnecting junction points between interface equipment cable harnesses and controller cabinet input and output signal. The panel wiring provides the functional wiring information for connecting the interface equipment in the cabinet.

The panel wiring must be grouped for internal connections (jumpers between terminal boards) as well as wiring from the controller and related cabinet functions to the terminal boards on the interface panel.

Ground wires must be No. 14 AWG wire, minimum. The internal harnesses must be located between TB1, TB2 and TB3. The external and internal wiring must be located outside of TB1 and TB4, between TB2 and TB3.

Terminal strips shall be Barrier type, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V. Terminals must use nickel/cadmium plated brass screws. All terminals and facilities on panels must be clearly identified using permanent silk-screened

The K1P and K2F relays shall be 15A miniature relays with polycarbonate cover, 2 form C (CO) contact arrangement, DC coil input, socket mount, .187 inch quick connect/solder terminals, AgCdO (15A) contacts, and 24V_{AC} coil voltage with matching socket and hold down spring. All screws on the relay socket must be brass with nickel/cadmium plating.

676-2.3.13 Storage Compartment: Mount an aluminum storage compartment in the rack assembly. The storage compartment must have telescoping drawer guides for full extension of drawer from rack assembly and have a continuous front lip for opening the compartment top for storage. The top of the compartment must be non-slip plastic laminate.

Install a communication port on the right hand side of the drawer at the front for connecting to the communications port of the controller unit via the cabinet harness.

676-2.3.14 Cabinet Rails: Provide the cabinet with four cabinet rails for mounting wiring panels and various brackets. Rails must be keyhole design with slots 2 inches on center with a top opening diameter of 5/8 inches to allow the insertion of a 5/8 inch by 1 inch carriage bolt. The rails must be approximately 1-1/2 inch to 2 inches wide by 1/2 inches deep. Do not use unistruts or other rails.

676-2.3.15 Electrical: Do not use printed circuit boards in any controller cabinet subsystem file or panel, including but not limited to the output file (except for the red monitor program board), service panel, interface panel, and input file.

676-2.3.15.1 Wiring: Cut all wires to the proper length and neatly laced into cables with nylon lacing. No wire shall be doubled back to take up slack. Cables in the cabinet must not interfere with the routing and connection of field wiring. Cables must be secured with nylon cable clamps, unless specified otherwise. The position of cables 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 controller cabinet.

Fabricate ground buss bars of a copper alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached. Mount a 6 inch ground buss bar with screw terminals on the bottom flange on each side of the cabinet for connection of AC neutral wires and chassis ground. Attach a flexible ground strap between the left side ground buss bar and the left side bottom rear of the rack assembly. Wiring harnesses must be covered by a flexible non-metallic conduit. Panel wire size must be a minimum of No. 18 AWG unless otherwise specified.

676-2.3.15.2 Terminals: Terminal connections must be soldered or constructed using a calibrated ratchet type crimping tool. Wiring must be traceable and without entanglement.

676-2.4 Controller Cabinet Flashing Operation: When a non-emergency flashing operation is required, the selected operation shall be performed by the UCF format. The following shall utilize UCF format:

- a) Flash Switch located on the cabinet service panel
- b) Time Base Coordination Flash
- c) Time Switch

When flashing operation is initiated, the controller assembly shall transfer from normal operation to flashing operation only at the end of the common major street red interval, the common minor street yellow interval, or the all red interval.

UCF shall be an internal function of the controller unit and must not be inhibited by the hold command. External logic will not be allowed to provide this function.

In the event of an emergency when flashing operation is required, the controller assembly shall immediately place the intersection on flash. Emergency flash may be initiated by the following:

- a) Auto/Flash Switch - A switch located on the cabinet police panel
- b) Conflict-Voltage Monitor senses a conflicting indication or system

error

When emergency flash is initiated, the controller assembly shall immediately transfer to flashing operation.

The transfer of the controller assembly from flashing operation to normal operation shall cause the controller unit to revert to its start-up sequence unless the conflict-voltage monitor has transferred the controller assembly to flashing operation. If transferred to flashing operation by the conflict-voltage monitor, the controller assembly shall remain in flashing operation until the monitor unit is reset and automatic operation can be implemented through the normal start-up sequence.

676-2.5 Intelligent Transportation System Cabinets: The cabinet shell must conform to NEMA 3R requirements, be constructed of unpainted sheet aluminum alloy 5052-H32 with a minimum thickness of 0.125 inches and have a smooth, uniform natural aluminum finish without rivet holes, visible scratches or gouges on the outer surface. Other finishes are acceptable if approved.

The minimum dimensions for cabinets are listed below.

Table 1 Minimum Cabinet Dimensions in Inches			
Cabinet Type	Height	Width	Depth
336	36" - 39"	24" - 26"	20" - 22"
336S	46" - 48"	24" - 26"	22" - 24"
334	66" - 68"	24" - 26"	30" - 32"

The cabinet must be weather resistant and constructed with a crowned top to prevent standing water. All exterior cabinet welds must be gas tungsten arc (TIG) welds and all interior cabinet welds must be gas metal arc (MIG) or TIG welds. All exterior cabinet and door seams must be continuously welded and smooth and all inside and outside edges of the cabinet must be free of burrs, rounded and smoothed for safety. All welds must be neatly formed and free of cracks, blow holes and other irregularities. Use ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements for welding on aluminum. Procedures,

welders and welding operators must conform to AWS requirements as contained in AWS B3.0 and C5.6 for aluminum.

The cabinet must have a lifting eye plate on either side of the top for lifting the cabinet and positioning it. Each lifting eye opening must be a minimum diameter of 0.75 inches and capable of supporting a weight load of 1,000 pounds. All external bolt heads must be tamperproof.

Ground-mount cabinets must include a removable base plate and two aluminum plates, welded inside, for anchoring the cabinet to a concrete or composite type base as shown in the Plans. Fabricate the plates from aluminum alloy 5052-H32 a minimum of 4 inches wide by 0.125 inches thick. Provide the cabinet with four 1 inch diameter holes for anchoring.

676-2.5.1 Doors: Provide cabinets with front and rear doors, each equipped with a lock and handle. Doors must be full size, matching the height and width dimensions of the cabinet enclosure, with no fewer than three stainless steel hinges or; alternately, one full-length “piano” hinge. Hinges must be constructed of 14 gauge stainless steel with stainless steel hinge pins that are spot-welded at the top. Mount the hinges so that they cannot be removed from the door or cabinet without first opening the door. Brace the door and hinges to withstand 100 pounds per vertical foot of door height load applied vertically to the outer edge of the door when standing open. Ensure there is no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.

Door opening must provide a flange that allows the door gasket to mate with a flat surface. Include a gasket made of closed-cell material resistant to UV, weathering, elevated temperatures, and permanent deformation that is permanently bonded to the inside of each door forming a weather-tight seal when the door is closed.

676-2.5.2 Latches: Provide all cabinets with a three-point draw roller latching system for the doors. The latching system must have the following latching points.

1. Center of the cabinet (lock).
2. Top of the cabinet – controlled by the door handle.
3. Bottom of the cabinet – controlled by the door handle.

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Provide the cabinet with a door stop that retains the main door open in a 90 degree and 120 degree position.

Outfit the doors with an industrial standard pin tumbler lock with No. 2 key, or an approved alternate, and hardware that allows the door to be secured using a padlock. Provide two keys for each cabinet lock.

676-2.5.3 Rails: Provide the cabinet with four cabinet rails that form a cage for mounting miscellaneous wiring panels and various mounting brackets. Use rails constructed of either 0.1345 inch thick plated steel or 0.105 inch thick stainless steel that extend the length of the cabinet’s sides, starting from the bottom of the enclosure. Rails must be keyhole designed with slots 2 inches on center with a top opening of 5/8 inch in diameter to allow the insertion of a 5/8inch by 1 inch carriage bolt. Rails must be 1-1/2 to 2 inches wide by 1/2 inches deep, drilled and tapped for 10-32 screws or rack screws with EIA universal spacing. Do not use unistruts or other rail types.

676-2.5.4 Racks: The cabinet must include a standard 19 inch EIA/TIA equipment rack centered in the cabinet for mounting devices to be installed inside. Clearance in the rack between the rails must be 17-3/4 inches.

676-2.5.5 Shelf: Provide a level, rollout internal shelf with a minimum work area measuring 10 inches by 10 inches. The shelf must be capable of sustaining a constant 20 pound load and the shelf position must be adjustable.

676-2.5.6 Sunshield: Sunshields must be mounted on standoffs that provide an air gap of at least of one inch between the exterior cabinet walls and the sunshields. Construct sunshields of 0.125 inch thick 5052-H32 aluminum sheet with corners that are rounded and smoothed for safety.

676-2.5.7 Ventilation: Provide ventilation through the use of a louvered vent at the bottom of the door. Vent depth must not exceed 0.25 inch. Provide an air filter a minimum of 192 square inches and 1 inch thick behind the vent. The filter must be removable and held firmly in place so that all intake air is filtered.

Provide a bottom trough and a spring-loaded upper clamp to hold the filter in place. The bottom trough must drain any accumulated moisture to the outside of the field cabinet.

ITS field cabinets must have dual thermostatically controlled fans, rated for continuous duty with a service life of at least three years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70°F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. Use UL-listed exhaust fans having a minimum air flow rating of 100 cubic feet per minute. Electric fan motors must have ball or roller bearings. Vent the exhaust air from openings in the roof of the field cabinet.

676-2.5.8 Electrical Requirements: All equipment must conform to applicable UL, NEC, EIA, ASTM, ANSI, and IEEE requirements. SPD's must be accessible from the front of any panel used in the cabinet. Connect the SPD for the cabinet's main AC power input on the load side of the cabinet circuit breaker. All wiring must be laced. All conductors must be stranded copper.

676-2.5.8.1 Service Panel Assembly: Provide a service panel assembly to function as the entry point for AC power to the cabinet and the location for power filtering, transient suppression and equipment grounding. Provide branch circuits, SPDs, and grounding as required for the load served by the cabinet, including ventilation fans, internal lights, electrical receptacles, etc.

676-2.5.8.2 Terminal Blocks: Terminate electrical inputs and outputs on terminal blocks where the voltage and current rating of the terminal block is greater than the voltage and current rating of the wire fastened to it.

Terminate conductors on terminal blocks using insulated terminal lugs large enough to accommodate the conductor to be terminated. When two or more conductors are terminated on field wiring terminal block screws, use a terminal ring lug for termination of those conductors. Number all terminal block circuits and cover the blocks with a clear insulating material to prevent inadvertent contact.

676-2.5.8.3 Ground Buss Bar: Fabricate ground buss bars of copper alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached.

Mount the ground buss bar on the side of the cabinet wall adjacent to the service panel assembly for the connection of AC neutral wires and chassis ground wires. If more than one ground buss bar is used in a cabinet, use a minimum of a No. 10 AWG copper wire to interconnect them. Connect the equipment rack to the ground buss bar in the cabinet to maintain electrical continuity throughout the cabinet.

Follow the PANI recommendations of USDA-RUS-1751 for connections to the ground buss bar. Producer (P) or electrical power and sources of stroke current connections shall be on the left end of the buss bar. Absorbing (A) or grounding wires shall be connected immediately right of the P connections. Non-isolated (N) connections such as doors and vents shall be connected to the right of the A connections. Isolated (I) equipment grounds from equipment in the cabinet shall be connected on the right end of the buss bar.

676-2.5.8.4 Power Distribution Assembly: Furnish a power distribution assembly that fits in the EIA 19 inch rack and provides for protection and distribution of 120 V_{AC} power unless otherwise shown in the Plans.

676-2.5.8.5 Interior Lighting: Provide the ITS cabinet with two light fixtures, each capable of producing a minimum of 950 lumens, with clear shatter-proof shields. Mount a fixture on the inside front and rear top of the cabinet and include door switches so that the lights automatically turn on when a cabinet door is opened and turn off when the door is closed. Light fixtures must be unobstructed and able to cast light on the equipment in the cabinet.

676-2.6 Generator and Auxiliary Power Connection: Traffic signal controller cabinets must include a generator and auxiliary power connection. ITS cabinets must include a generator and auxiliary power connection unless otherwise shown in the Plans.

Cabinets with generator and auxiliary power connection must include provisions for the connection of an external power source, such as a portable generator, through a weatherproof, secure interface. This feature must allow authorized personnel to access, connect, and secure an external power source to the cabinet in order to restore power within five minutes of arrival time at the cabinet.

Provide the cabinet with either a manual or automatic transfer switch as shown in the Plans. The transfer switch must meet UL 1008 and be rated equal to or higher than the design load of the cabinet's main breaker and the generator input twist-lock connector rating. The transfer switch must provide a means of switching between normal utility power and auxiliary backup generator power. Switching time cannot exceed 250 milliseconds. Ensure that the transfer switch does not allow simultaneous active power from more than one source and does not allow generator backflow into normal utility AC circuits.

676-2.6.1 Manual Transfer Switch: Provide a two-position manual transfer switch with the switch positions labeled "Generator Power" and "Utility Power".

Equip the transfer switch with a "Utility-on" indicator, which will illuminate when normal utility power service is available and the switch is in the "Generator Power" position. The indicator must turn off when the transfer switch is moved to the "Utility Power" position. The Utility-on indicator must be clearly visible outside the cabinet and the indicator's on/off state must be obvious from a distance of 30 feet.

676-2.6.2 Automatic Transfer Switch: An automatic transfer switch may be used instead of a manual transfer switch to provide for automatic transition from generator power back to normal utility service after utility power is restored. Provide the automatic transfer switch with indicators that display the status of connected power sources and indicate which power source is actively energizing the cabinet.

If a relay circuit is used to provide switching, the normally closed circuits must be connected to normal utility power. The relay must be energized solely by the generator. When energized, the relay must break the connection to normal utility power and make connection to the generator power input. Any automatic transfer switch or relay operated switch must include a bypass switch that disables automatic switching and permits manual selection of the power sources connected to the cabinet.

676-2.6.3 Generator Access Panel: Include a generator connection panel consisting of, at a minimum, the manual transfer switch and a three-prong, 30 amp twist-lock connector with recessed male contacts for generator hookup. Locate the access panel as close as possible to the main AC circuit breaker with the bottom of the access panel no less than 24 inches above the bottom of the cabinet. Do not place the generator access panel on the main cabinet door or back door. Locate and label the transfer switch and twist lock connector on a panel easily accessible behind a weatherproof lockable exterior access door equipped with a tamper-resistant hinge. Label this access door "Generator Access Door" Provide the access door with a No. 2 lock unless otherwise specified in the Plans.

The access door must include a weatherproof opening for the generator cable. The generator hookup compartment must be recessed no more than six inches into the cabinet but be deep enough to allow closing and locking of the access door when the generator cable is connected. Avoid blocking access to any other equipment in the cabinet.

676-2.7 Small Equipment Enclosures: Small equipment enclosures, such as equipment cabinets less than 13 inches high by 10 inches wide by 11 inches deep, may be constructed of aluminum or non-metallic materials. Enclosures must include a safe means of removing power from the installed equipment for servicing and replacement, such as a switch, fuse, or breaker. Discrete markings, such as manufacturer name and model, are permitted on the outside of small enclosures.

All fasteners less than 5/8 inch exposed to the elements must be Type 304 or 316 stainless steel.

Construct aluminum enclosures of 5052 sheet aluminum alloy with a minimum thickness of 0.090 inches. Aluminum enclosures must have a uniform natural finish or be powder coat painted in accordance with AAMA-2603-02 specifications. All welds, bends, and seams must be neatly formed and free of cracks, blow holes and other irregularities. All inside and outside edges of the enclosure must be free of burrs, rivet holes, visible scratches, and gouges and have a smooth, uniform finish.

Non-metallic enclosures must be UL 508A listed, be rated for outdoor use, and resist chemicals, corrosion, and ultraviolet rays. Enclosures must be NEMA 3R (IP 66) rated, minimum.

Enclosure doors must include a vandal resistant hinge and be secured with a locking latch or a minimum of two quick-release Type 304 or 316 stainless steel latches with padlock hasps. Removal of the hinge or hinge pin must not be possible while the enclosure is closed. Provide two sets of keys with each lock.

Enclosures may be vented. Holes larger than 1/8 inches must be covered by heavy duty screen.

Post mounted enclosures must be supplied with mounting hardware for attaching the enclosure to a 4-1/2 inch (OD) aluminum post.

676-3 Installation Requirements.

376-3.1 General: Ground all cabinets in accordance with the requirements of Section 620. Keep the ground wire from the cabinet ground bussbar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet. Controller cabinets shall be wired in accordance with the signal operating plan specified in the Contract Documents. If phases are omitted for future use, the cabinet must be wired for these future phases. However, the load switches for the future phases do not have to be furnished. All field drilled conduit entrance holes or other holes must be reamed and free of burrs. All conduit connections to the cabinet must be weatherproof.

676-3.2 Traffic Signal Controller Cabinet Installation: Install traffic signal controller cabinets in accordance with the Design Standards, Index No. 17841.

676-3.2.1 Pole Mounted Cabinets[MRG3]:

(a) Fasten the pole mounted hardware which is furnished with the cabinet to the cabinet, making all connections watertight.

(b) Use stainless steel bands for mounting cabinets onto steel strain poles.

(c) Use stainless steel bands or lead anchors (or equivalent) for mounting cabinets onto concrete strain poles.

(d) Use stainless steel bands or lag bolts for mounting cabinets onto wood poles.

676-3.2.2 Base Mounted Cabinets:

(a) Use anchor bolts to fasten base mounted cabinets to the concrete base.

(b) Seal the joint between the bottom of the cabinet and the concrete base (inside and outside of cabinet) with a clear silicone rubber sealant.

(c) Construct the base for the cabinets with concrete in accordance with Section 347. Make the concrete base for the cabinet level, free of honeycombs and as smooth as possible. Temporarily seal the end of conduit risers located in the base before placing the concrete. Position the end of the conduit risers a minimum of 2 inches above the finished surface of the concrete base.

676-3.2.3 Field Wiring:

(a) Terminate signal cable, interconnect cable, and loop lead-in wires on the appropriate terminal strips in the controller cabinet with insulated terminal lugs. Use a calibrated ratchet type crimping tool to install the insulated terminal lugs onto the field wires.

(b) Label spare circuits of the signal and interconnect cables and connect them to the cabinet ground bussbar.

(c) Neatly bundle and identify all field wiring cables in the controller cabinet.

676-3.3 Intelligent Transportation System Cabinet Installation: Mount the cabinet as shown in the Plans, and provide the cabinet with the necessary base or pole mount hardware. Ensure that pole and structure-mounted field cabinets have mounting brackets on the side so that both cabinet doors are fully functional.

Make provisions for all telephone, data, control, and confirmation connections between the ITS device and field cabinet and for any required wiring harnesses and connectors.

Place a heavy-duty resealable plastic bag on the backside of the main cabinet door for containing cabinet prints, a list of terminal block connections, and other documentation.

Place all equipment in the cabinet according to the recommendations of the manufacturer. Maintain a minimum clearance of 6 inches between the top of the cabinet and the

top of any equipment placed on the top shelf of the cabinet and a minimum clearance of 2 inches between each side of the cabinet and any equipment placed on the cabinet shelves.

676-3.4 Small Enclosure Installation: Mount the enclosure on a pole or support structure as shown in the Plans, and provide any hardware necessary for a complete and accepted installation.

676-4 Warranty.

Ensure traffic cabinets have a manufacturer's warranty covering defects for a minimum of two years from the date of final acceptance in accordance with 5-11 and Section 608. The warranty must include providing replacements, within 10 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or maintaining agency.

676-5 Method of Measurement.

The Contract unit price each for traffic cabinet, furnished and installed, will include all materials specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

No separate payment will be made for a traffic cabinet when included with the controller assembly as per Section 670.

676-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

- | | |
|------------------|-------------------------------------------|
| Item No. 676- 1- | Traffic Signal Controller Cabinet - each. |
| Item No. 676- 2- | ITS Cabinet - each. |
| Item No. 676- 3- | Small Equipment Enclosure - each. |