785 INTELLIGENT TRANSPORTATION SYSTEMS INFRASTRUCTURE. (REV 11-9-07) (FA 1-10-08) (7-08)

PAGE 755. The following new Section is added after Section 715:

SECTION 785
INTELLIGENT TRANSPORTATION SYSTEMS INFRASTRUCTURE

785-1 Description.

Furnish and install ITS infrastructure components as shown in the plans, meeting the general requirements of this specification and the specific requirements for each component as defined in 785-2 through 785-5.

Ensure that all materials furnished, assembled, fabricated, or installed are new products and approved by the Engineer.

785-2 Grounding and Transient Voltage Surge Suppression.

785-2.1 Description: Furnish and install grounding and transient voltage surge suppression for all ITS devices installed in the field or in remote locations to protect this equipment from lightning, transient voltage surges, and induced current.

785-2.2 Materials: Provide a grounding system that meets the grounding requirements of this section and also those defined in Section 620.

Install a transient voltage surge suppressor (TVSS) both ahead of and behind (i.e., on the supply side and the load side of) the ITS device electronics.

Install TVSS on all power, data, video and any other conductive connection.

785-2.3 Installation Requirements:

785-2.3.1 General: Achieve a resistance to ground measurement of 5 ohms (Ω) or less between the grounding electrode and the soil by using multiple electrodes, and if necessary, soil preparation that includes a grounding augmentation fill. References for this section include, but are not limited to, UL467, UL497A, and NEC. Ensure that lightning protection systems conform to the requirements of NFPA 780, Standard for the Installation of Lighting Protection Systems.

785-2.3.2 Grounding Specifications: Use a grounding electrode system (i.e., multiple electrodes as required to achieve a resistance to ground measurement of 5 Ω or less) as shown in the plans and approved by the Engineer. Ensure that ground rods are listed according to UL requirements as detailed in the standard UL 467, Grounding and Bonding Equipment. Use electrodes that are copper clad or solid copper. Make all connections to the grounding electrode using exothermic welds.

Connect all grounding electrodes related to the ITS device and its subsystems, and any grounded electrical system within a 100-foot radius (but not beyond the edge of the roadway) of the structural base of the ITS device, to a single point main grounding electrode, sometimes referred to as the ground window, which shall be driven a maximum of 3 feet from the structural base of the ITS device. Provide for each grounding electrode an interfacing hemisphere, which is an imaginary cylinder with a diameter and depth equal to the length of the electrode. Therefore, install a 20-foot grounding electrode a minimum of 40 feet away from any additional grounding electrodes and/or ground-mounted devices.

Install a minimum of one grounding radiant, plus additional radiants in a "Y" configuration as required to achieve a resistance to ground of 5 Ω or less, at each ITS device structure. In the event that the "Y" configuration cannot be placed in the right-of-way, change the 120-degree spacing of the radiants to make the grounding array fit in the space available, provided that the sphere of influence radius is maintained.

Install the grounding radiants using one main 20 foot grounding rod located at the structural base of the ITS device and attached to three additional 20 foot radiant grounding rods placed a minimum of 40 feet away from the main grounding rod. Bond the ITS device structure's equipment directly to the main grounding rod using an exothermic weld. Ensure that all grounding rod attachments use a minimum #2 tin-plated bare copper wire that is exothermically welded at all connection points.

Bond all metal components of the ITS device subsystem, such as the cabinets and steel poles, to the grounding system with a grounding cable that uses a mechanical connection on the equipment side and an exothermically welded connection at the down cable.

785-2.3.3 Use of Grounding Augmentation Fill: For each grounding rod, dig a minimum 12-inch diameter hole 12 feet deep using an augured shaft. Backfill the holes with grounding augmentation fill per the manufacturer's installation requirements. Insert 20-foot-long ground rods driven into the center of the shaft.

Install radial conductors in the center of a one foot by one foot trench backfilled with coke breeze material. Cover the top of the coke breeze trench with one foot of native soil. Neither charcoal nor petroleum-based coke breeze may be substituted for coke breeze from coal in coke ovens. Increase the shaft diameters and depth as required to meet the 5 Ω or less specification. Increase the rod length and volume of coke breeze as required to meet the specification.

With the Engineer's approval, use such alternative fills as engineered soils treated with moisture-absorbing materials such as bentonite, conductive cement, or homogenous clays in combination with native soils. Ensure that the grounding augmentation fill is environmentally safe and stable. Refer to the table below for materials and their characteristics.

Table 3.1 – Characteristics of Grounding Augmentation Fills

Material	Characteristics	Effect
Bentonite	Highly variable in volume and resistivity with respect to soil moisture.	2.5 ohm-meters
Clay-based material	High capability to retain moisture.	0.3 to 0.8 ohm-meters
Coke breeze	Carbon-based backfill material. Environmentally safe and not moisture dependent.	0.1 to 0.5 ohm-meters
Conductive cement	Retains moisture once hardened. Resists leaching from soil.	0.2 ohm-meters

785-2.3.4 Ground Resistance Testing and Certification: Measure the ground resistance with an instrument designed specifically to measure and document earth/ground

resistance, soil resistance, and current flow. Conduct the test by using the Fall-of-Potential method as described in the IEEE Standard 142-1991. Provide the Engineer with written test results for each testing location prior to backfilling the grounding electrode. Include in the test results the instrument model and date of calibration for the device used in the testing, the local environmental conditions at the time of testing, and a full Fall-of-Potential graph. Certify and sign the test results submitted.

785-2.3.5 Air Terminals: Ensure that lightning protection systems and air terminals installed conform to NFPA 780, Standard for the Installation of Lightning Protection Systems. Ensure that the air terminal extends at least 2 feet above the object or area it is to protect and is mounted at the top of the pole or structure in such a way as to allow for an exothermic weld connection to the grounding down cable. Ensure that all ITS devices attached to structures having air terminals are within the zone of protection determined by the 150-foot radius rolling sphere model described in NFPA 780.

Provide a lightning protection system as shown in the plans. Provide additional air terminals, static wires, and conductors as required by the manufacturer of large equipment such as DMS units that may necessitate more than one terminal to protect the structure and equipment. Use air terminals that are UL listed according to the UL 96A standard and that are suitable for use in a UL master label lightning protection system.

785-2.4 Transient Voltage Surge Suppression Devices:

785-2.4.1 General: Provide all ITS field installation sites with both primary and secondary surge protection on the AC power. Connect the primary surge protection at the service entrance or main disconnect. Connect the secondary surge protection on the power distribution to the equipment. Furnish only TVSS devices that have been approved in writing by the Engineer.

785-2.4.2 TVSS Device at Power Entry Point: Install a TVSS at the closest termination/disconnection point where the 120-volt (V) supply circuit enters the ITS device cabinet. Locate the TVSS on the load side of the service disconnect and ahead of any and all ITS electronic devices. Configure the TVSS to operate at 120 V single phase (i.e., two wires) or 120/240 V single phase (i.e., three wires) as required to match the supply circuit configuration. Verify that the TVSS has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449, Second Edition. Install a TVSS that complies with the requirements as detailed in Section 2.2.7 of the NEMA LS 1-1992 (R2000) standard.

Ensure that the TVSS for the ITS device's power source has an operating voltage of 120 V single phase and a maximum continuous operating voltage of 150 V single phase. The TVSS shall be rated at a minimum of 150 kiloamps (kA) per phase, or when protecting a panel board rated at 150 to 225 amps, the TVSS shall be rated at a minimum of 220 kiloamps (KA) per phase. The results of testing this device for maximum let-through voltage using the IEEE C62.41.2-2002 Category C3 and B3/C1 waveforms shall be submitted for approval and for equal comparison the following special test conditions shall be adopted: Apply the transient at the 90-degree phase angle, measured at a lead length of 6 inches outside of the device enclosure. The maximum ANSI/IEEE let-through voltage shall be 1000 V line to neutral, when measured according to the IEEE C62.41.2-2002 Category C3 at 20 kilovolts (kV) 1.2 by 50 microseconds (µs)/10 kA 8 by 20 µs waveform; and 500 V line to neutral for the Category B3/C1 at 6 kV 1.2 by 50 µs/3 kA, 8 by 20 µs waveform.

Ensure that the suppression device is a hybrid, multi-staged device with a visual indication system that monitors the weakest link in each mode and shows normal operation or failure status and also provides one set of normally open (NO)/normally closed

(NC) Form C contacts for remote alarm monitoring. The enclosure for a TVSS shall have a NEMA 4 rating.

785-2.4.3 TVSS Device at Point of Use: Install a TVSS at the point the ITS devices receive 120 V power. Ensure that the units are rated at 15 or 20 amps (A), as required, and configured for hardwiring or receptacles to meet the ITS device requirements. Receptacle configuration units may be grouped as long as all listing and performance requirements can be met. Verify that the TVSS has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449, Second Edition. Install a TVSS that complies with the requirements of Section 2.2.7 of the NEMA LS 1-1992 (R2000) standard.

Ensure that the TVSS for the ITS device's point of use has an operating voltage of 120 V single phase and a maximum continuous operating voltage of 150 V single phase. Ensure that the TVSS is rated at a minimum of 20 kiloamps (kA) per phase. The results of testing this device for maximum let-through voltage using the IEEE C62.41.2-2002 Category A1 waveform shall be submitted for approval and for equal comparison the following special test conditions shall be adopted. The transient shall be applied at the 270-degree phase angle and measured at a lead length of 6 inches outside of the device enclosure. The maximum allowable excursion of the let-through voltage from the service voltage sine wave when testing with the A1 waveform is 45 V line to neutral mode, 60 V line to ground mode, and 35 V neutral to ground mode.

Ensure that the suppression device is a hybrid, multi-staged device with a visual indication system that monitors the weakest link in each mode and shows normal operation or failure status. Hardwired type units shall also include one set of dry contacts to transmit this status information to other monitoring systems. Ensure that these units have internal fuse protection and provide both normal mode (L-N) and common mode (L+N-G) protection.

785-2.4.4 TVSS Device for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized TVSS at the supply and line sides of all low-voltage connections to the ITS device and its operating subsystems. These connections shall include, but are not limited to, Category 5 data cables, coaxial video cables, twisted pair video cables, and low-voltage control cables that comply with Electronic Industries Alliance (EIA) requirements as detailed in the EIA-232/422/485 standards. Ensure that these devices are of hybrid multi-staged design with maximum let-through voltage as shown in the accompanying table. Testing shall be for all available modes (i.e. power L-L, L-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

Table 4.1 – Values for Low-Voltage Circuits

Circuit Description	Continuous Current	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Let-Through Voltage (All voltages are measured from zero)
Coaxial Video	Up to 300 mA	Up to 1.5 GHz Up to 150 Mbps	10,000 amps per mode (8x20 µs)	<100 Vpk (IEEE Cat B3/C1 6 kV/3 kA)
Power and Control Up to 12 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5,000 amps per mode (8x20 µs)	<150 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)

Table 4.1 – Values for Low-Voltage Circuits				
Circuit Description	Continuous Current	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Let-Through Voltage (All voltages are measured from zero)
Power and Control Up to 24 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5,000 amps per mode (8x20 µs)	<175 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)
Power and Control Up to 48 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5,000 amps per mode (8x20 µs)	<200 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)
Power and Control Up to 120 VAC	Up to 30 A	Up to 60 Hz (sensitive loads)	20,000 amps per mode (8x20 µs)	<550 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)
RS422 Up to 12 V	Up to 500 mA	Up to 100 MHz Up to 10 Mbps	10,000 amps per mode (8x20 µs)	<30 Vpk (IEEE Cat B3/C1 6 kV/3 kA)
RS485 Up to 12 V	Up to 500 mA	Up to 100 MHz Up to 10 Mbps	10,000 amps per mode (8x20 µs)	<30 Vpk (IEEE Cat B3/C1 6 kV/3 kA)
T1 Up to 7.5 V	Up to 500 mA	Up to 100 MHz Up to 10 Mbps	10,000 amps per mode (8x20 µs)	<20 Vpk (IEEE Cat B3/C1 6 kV/3 kA)
Cat 5 Up to 12 V	Up to 500 mA	Up to 100 Mbps	3,000 amps per mode (10x1000 µs)	<30 Vpk (10 x 1000 µs)

Install a TVSS that has an operating voltage matching the characteristics of the device, such as 24 volts of direct current (V_{DC}) and less than 5 V_{DC} for data and video functions. Ensure that these specialized TVSS are UL 497B or UL 497C listed, as applicable.

785-3 Pole and Lowering Device.

785-3.1 Description: Furnish and install a steel or concrete pole, with or without a lowering device, as shown in the plans. Consider the lowering device and pole as two interdependent components of a single unit, and provide them together to ensure compatibility of the pole and lowering device.

785-3.2 Materials:

785-3.2.1 Pole: Use a pole as shown in the plans that meets the requirements of either Section 641 for prestressed concrete poles, Section 649 for steel poles, or Department requirements for centrifugally spun concrete poles. Provide shop drawings for poles in accordance with Section 5.

Use a pole that is equipped with a handhole of sufficient size to provide access to the pole interior and for temporarily securing and operating the lowering tool. Ensure that the pole-top tenon is rotatable.

785-3.2.2 Lowering Device: Use a lowering device as shown in the plans. Ensure that the lowering device provides the electrical connections between the control cabinet and the

equipment installed on the lowering device without reducing the function or effectiveness of the equipment installed on the lowering device or degrading the overall system in any way. Locate the stainless steel lowering cable inside conduit to avoid cable twisting and to ensure that only the lowering cable is in motion inside the pole when the lowering device is operated. Ensure that all other cables remain stable and secure during lowering and raising operations.

Ensure that the lowering device includes a disconnect unit for electrically connecting the equipment installed on the lowering device's equipment connection box to the power, data, and video cables (as applicable); a divided support arm, a pole adapter for the assembly's attachment to the rotatable pole-top tenon, and a pole-top junction box, as shown in the plans.

Ensure that all of the lowering device's external components are made of corrosion-resistant materials that are powder-coated, galvanized, or otherwise protected from the environment by industry-accepted coatings that withstand exposure to a corrosive environment.

785-3.2.2.1 Equipment Connection Box: Provide an equipment connection box for connecting the CCTV camera or other ITS device to the lowering device. Ensure that the equipment connection box has an ingress protection rating of no less than IP55.

785-3.2.2.2 Disconnect Unit: Ensure that the disconnect unit has a minimum load capacity of 200 pounds with a 4:1 safety factor. Ensure that the fixed and movable components of the disconnect unit have a locking mechanism between them. Provide a minimum of two mechanical latches for the movable assembly and, when latched, ensure that all weight is removed from the lowering cable. Ensure that the fixed unit has a heavy-duty cast tracking guide and a means to allow latching in the same position each time.

Ensure that the disconnect unit is capable of securely holding the lowering device and the equipment installed on the lowering device. Use interface and locking components that are stainless steel or aluminum.

785-3.2.2.2.1 Disconnect Unit Housing: Ensure that the disconnect unit housing is provided with a gasket to seal the interior from dust and moisture. Ensure that the disconnect unit housing has an ingress protection rating of no less than IP55.

785-3.2.2.2.2 Connector Block: Provide a connector block as shown in the plans and directed by the Engineer. Provide modular, self-aligning and self-adjusting female and male socket contact halves in the connector block. Equip the lowering device with enough contacts to permit operation of all required functions of the camera, up to a maximum of 20 contacts. Provide at least two spare contacts. Provide contact connections between the fixed and movable lowering device components that are capable of passing EIA-232, EIA-422, EIA-485, and Ethernet data signals and 1 volt peak to peak (Vp-p) video signals, as well as 120 V_{AC}, 9-24 V_{AC}, and 9-48 V_{DC} power. Ensure that lowering device connections are capable of carrying the signals, voltages, and current required by the device(s) connected to them under full load conditions. Submit documentation to the Engineer showing pin assignment for his approval.

Ensure that the connector block conforms to one of the two options described below:

Option 1 – Light-Duty Connector: Provide plastic female and male halves of the connector block that houses the connector pins.

Provide corrosion-resistant stainless steel hardware. Ensure that male contacts used for grounding mate first and break last. Ensure that all contacts and connectors are self-aligning and self-adjusting mechanical systems. Provide a spring-assisted

contact assembly to maintain constant pressure on the contacts when the device is in the latched position.

Because there are no individual gaskets on the top and bottom connectors, ensure that a gold or silver lining is provided in the interior to prevent degradation of the connectors due to moisture.

Option 2 – Heavy-Duty Connector: Ensure that the female socket contacts and the male contact halves of the connector block are made of molded synthetic rubber or molded chlorosulfonated polyethylene, or approved equal. Provide connector pins made of brass- or gold-plated nickel, or gold-plated copper.

Ensure that the current-carrying male and female contacts are a minimum of 0.102 inch in diameter. Provide two male contacts that are longer than the other contacts to mate first and break last.

Provide cored holes in the rubber to create moisture-tight seals when mated with the male connector. Permanently mold the wire leads from both the male and female contacts in a body of chlorosulfonated polyethylene, or an approved equal. Provide current-carrying wires and signal wires of American Wire Gauge (AWG) #18/1 jacketed wire.

Ensure that the contacts are self-wiping with a shoulder at the base of each male contact so that it is recessed in the female block, thereby giving each contact a rain-tight seal when mated.

785-3.2.3 Lowering Tool: Provide a metal-frame lowering tool with winch assembly and a cable with a combined weight less than 35 pounds; a quick release cable connector, and an adjustable safety clutch. Ensure that the lowering tool can be powered using a half-inch chuck, variable-speed reversible industrial-duty electric drill to match the manufacturer-recommended revolutions per minute, or supply a drill motor for the lowering tool as shown in the plans.

Ensure that the lowering tool supports itself and the load. Ensure that the lowering tool is equipped with a positive braking mechanism to secure the cable reel during raising and lowering operations, and to prevent freewheeling.

Use a lowering tool equipped with gearing that reduces the manual effort required to operate the lifting handle to raise and lower a capacity load. Provide the lowering tool with an adapter for operating the lowering device with the portable half-inch chuck drill using a clutch mechanism.

Ensure that the lowering tool is manufactured of durable, corrosion-resistant materials that are powder-coated, galvanized, or otherwise protected from the environment by industry-accepted coatings that withstand exposure to a corrosive environment.

Provide a minimum of one lowering tool plus any additional tools as required in the plans. Upon a project's final acceptance, deliver the lowering tool to the Department.

785-3.2.4 Lowering Cable: Provide a lowering cable with a minimum diameter of 0.125 inch. Construct it of stainless steel aircraft cable with a minimum breaking strength of 1,740 pounds, and with 7 strands of 19-gauge wire each. Ensure that the prefabricated components for the lift unit support system preclude the lifting cable from contacting the power or video cables.

785-3.2.5 Wiring: Ensure that all wiring meets NEC requirements and follows the equipment manufacturers' recommendations for each device connected on the pole, at the lowering device, and in the field cabinet.

785-3.2.6 External-mount Lowering System Enclosure for Mounting to Existing Structures: Furnish and install an external-mount lowering system enclosure for mounting to existing structures, as shown in the plans. Ensure that the system includes external conduit, cabling, and upper mounting box that is able to accept the respective (i.e., general/light or heavy-duty) lowering device. Ensure that the system includes a winch assembly permanently housed in a corrosion- resistant lower lockable box with gaskets, as shown in the plans. Provide all necessary mounting hardware for the upper and lower box, conduits, standoffs, and conduit mounts required for a complete and functional system.

785-3.3 Installation Requirements: Ensure that the divided support arm and receiver brackets self-align the contact unit with the pole centerline during installation, and that the contact unit cannot twist when subjected to the design wind speeds defined in the FDOT Plans Preparation Manual, Vol. I, Chapter 29, Table 29.1. Supply internal conduit in the pole for the power and video cabling if required by the Engineer.

Ensure all pulleys installed for the lowering device and portable lowering tool have sealed, self-lubricated bearings, oil-tight bronze bearings, or sintered bronze bushings.

Provide 1.25-inch-diameter PVC conduit in the pole for the lowering cable. Verify that a conduit mount adapter is furnished for the interface between the conduit and the internal back side of the lowering device.

Ensure that the poles and their foundations conform to the requirements of the PPM and Indexes 17723 and 17725 of the Design Standards, and with the AASHTO LTS-4 standard with current addenda. Use Vol. 1, Chapter 29, Table 29.1, Design Wind Speeds, of the PPM to compute the wind loads. Provide shop drawings that specify the overturning moment or ground line moment detail for the pole structure and all necessary design features.

785-4 ITS Field Cabinet.

785-4.1 Description: Furnish and install an ITS field cabinet for housing ITS equipment and network devices including, but not limited to, managed field Ethernet switches, hub switches, device servers, digital video encoders, fiber optic cable patch panels, and equipment racks for non-intrusive vehicle detection systems.

785-4.2 Materials:

785-4.2.1 Cabinet Shell: Furnish an ITS field cabinet that conforms to NEMA 3R requirements. Ensure that the ITS field cabinet is constructed using unpainted sheet aluminum alloy 5052-H32 with a minimum thickness of 0.125 inch. Ensure that the cabinet has a smooth, uniform natural aluminum finish without rivet holes, visible scratches or gouges on the outer surface. Other finishes are acceptable if approved by the Engineer.

The minimum dimensions for FDOT ITS field cabinets are listed below.

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

Ensure that the ITS field cabinet enclosure top is crowned to prevent standing water. Construct the field cabinet so that it is weather resistant under all conditions. Ensure all exterior cabinet and door seams are continuously welded and smooth. All welds shall be neatly formed and free of cracks, blow holes and other irregularities. Verify that all exterior cabinet welds are made using the gas tungsten arc (TIG) welding method. Ensure that all internal cabinet welds are done using the gas metal arc (MIG) or TIG process. Other welding methods may be used only if approved by the Engineer. Ensure that all inside and outside edges of the cabinet are free of burrs. Ensure that all edges are filled to a radius of 0.03125 inch minimum. Use ER5356 aluminum alloy bare welding electrodes conforming to American Welding Society standard AWS A5.10 requirements for welding on aluminum. Procedures, welders and welding operators shall conform to AWS requirements as contained in AWS B3.0 and C5.6 for aluminum.

Ensure that the field cabinet is furnished with two lifting eye plates on either side of the top for lifting the cabinet and positioning it. Ensure that each lifting eye opening has a minimum diameter of 0.75 inch and that each eye is able to support the weight load of 1,000 pounds. Ensure that all external bolt heads are tamperproof.

785-4.2.2 Doors: Provide an ITS field cabinet with front and rear doors, each equipped with a lock and handle. Ensure that each cabinet door is full size, matching the height and width dimensions of the cabinet enclosure, and has no fewer than three stainless steel hinges or alternately, one full-length “piano” hinge. Provide hinges that are made of 14-gauge stainless steel and ensure that the stainless steel hinge pins 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 a 100-pound-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.

Ensure that both door openings are double flanged on all four sides, and that the doors include a closed-cell, neoprene gasket seal that is permanently bonded to the inside of each door such that the neoprene forms a weather-tight seal when the door is closed. The Engineer may approve alternative cabinet designs that use special material combinations and gauges.

785-4.2.3 Latches: Furnish all ITS field cabinets with a three-point latching system for the doors. Ensure that the latching system consists of 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.

Ensure that latching points 2 and 3 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. Ensure that the locking mechanism is equipped with nylon rollers to secure the top and bottom of the door.

Furnish the ITS field 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 #2 key, or an approved alternate if shown in the plans, and hardware that allows the door to be secured using a padlock. Provide two keys for each cabinet lock.

785-4.2.4 Rails: Provide the ITS field cabinet with four cabinet rails that form a cage for the purpose of mounting miscellaneous wiring panels and various mounting brackets. Use rails that extend the length of the cabinet's sides, starting from the bottom of the enclosure. Provide rails that are either 0.1345-inch thick plated steel or 0.105-inch thick stainless steel. Ensure that the rails are 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. Ensure that the rails are 1 1/2 to 2 inches wide by 1/2 inch deep. Do not use unistruts or other rail types.

Provide rails that have been drilled and tapped for 10-32 screws or rack screws with EIA universal spacing.

785-4.2.5 Racks: Ensure that the ITS field cabinet includes a standard 19-in EIA/TIA equipment rack centered in the cabinet for mounting of the devices to be installed inside. Verify that the clearance in the rack between the rails is 17.75 inches.

785-4.2.6 Shelf: Provide a level, rollout internal shelf with a minimum work area measuring 10 inches by 10 inches. Ensure that the shelf is capable of sustaining a constant 20-pound load. Ensure that the shelf position is adjustable, with a maximum of 2-inch increments, from the top of the load panel to 12 inches from the top of the controller cabinet.

785-4.2.7 Sunshield: If the ITS field cabinet is provided with sunshields outside to deflect solar heat away from the cabinet, as indicated in the plans, the sunshields must be offset a minimum of one inch from the exterior cabinet walls. Ensure that the sunshields are fabricated from 5052-H32 aluminum sheet that is 0.125 inch thick, and that sunshield corners are rounded and smoothed for safety. Mount the sunshields on standoffs at the top and each side of the cabinet.

785-4.2.8 Ventilation: Ensure that the cabinet provides ventilation through the use of a louvered vent at the bottom of the main door. Verify that the louvered vent depth does not exceed 0.25 inch. Ensure that the intake vent is made rain tight through the use of a water-deflecting ventilation panel on the inside of the main door securing the filter to the door. This panel should form a shell over the filter to give it mechanical support, and should be louvered to direct the incoming air downward.

Provide an easily removable, reusable filter held in place with a bottom trough and a spring-loaded upper clamp. Provide a filter that measures no less than 16 inches by 12 inches by 7/8 inch thick. No incoming air shall bypass the filter. Ensure that the bottom trough holding the filter is able to drain any accumulated moisture to the outside of the field cabinet.

Equip the ITS field cabinet with dual thermostatically controlled fans located inside at the top of the cabinet. Use UL-listed exhaust fans having a minimum air flow rating of 100 cubic feet per minute. Ensure that the electric fan motors have ball or roller

bearings. Provide fans that are rated for continuous duty and have a service life of at least three years. Vent the exhaust air from openings in the roof of the field cabinet.

Ensure the thermostats that activate the fans are mounted on the inside top of the cabinet. Ensure that the thermostat is user adjustable to allow temperature settings ranging from a minimum of 70° Fahrenheit (F) to a maximum of 160° F. Ensure that the thermostat activates the fans within ±3 degrees of the set temperature.

785-4.2.9 Electrical Requirements: Ensure that all equipment furnished conforms to applicable UL, NEC, EIA, ASTM, ANSI and IEEE requirements. Provide transient voltage surge suppressors (TVSS) for the main AC power input at the service panel assembly and on both sides of all electronics as required by 785-2. Ensure that the TVSS is accessible from the front of any panel used in the cabinet. Connect the TVSS for the cabinet's main AC power input on the load side of the cabinet circuit breaker.

Ensure that the wiring in the ITS field cabinet conforms to NEC requirements. Use only conductors that are stranded copper. Lace all wiring.

785-4.2.9.1 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, TVSS, and grounding only as required for the ITS device-connected load served by the cabinet, including ventilation fans, internal lights, electrical receptacles, etc., as shown on the plans.

785-4.2.9.2 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.

Wire into the cabinet's circuitry the connector harnesses for the ITS devices and other accessory equipment to be housed therein.

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.

785-4.2.9.3 Ground Bus Bar: Ensure that ground bus bars are fabricated from a copper alloy material compatible with copper wire. Use ground bus bars that have at least two positions where a #6 AWG stranded copper wire can be attached.

Mount the ground bus 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 bus bar is used in a cabinet, use a minimum of a #10 AWG copper wire to interconnect them.

785-4.2.9.4 Power Distribution Assembly: Furnish a power distribution assembly that fits in the EIA 19-inch rack and provides for protection and distribution of 120/240 V_{AC} power.

785-4.2.9.5 Interior Lighting: If shown on the plans, provide the field cabinet with two 20-watt fluorescent lamps and clear shatter-proof shield assemblies which are mounted on the inside front and rear top of the cabinet. Ensure that these lamps are unobstructed and able to cast light on the equipment. Equip the field cabinet with door-actuated switches so that the lamps automatically turn on when either cabinet door is opened and go off when the doors are closed.

785-4.2.9.6 Generator and Auxiliary Power Connection: If shown on the plans, furnish an ITS field cabinet that has provisions for the connection of an external power source, such as a portable generator, through a weatherproof, water-resistant, secure interface. This feature should allow authorized personnel to access, connect, and secure an external power source to the cabinet in order to restore power within 5 minutes of arrival at the ITS field cabinet.

Provide the field cabinet with a transfer switch rated for the design load of the cabinet's main breaker to provide an alternate power source using a generator. Use a transfer switch that can be permanently mounted inside the cabinet. Ensure that the transfer switch meets UL Standard 1008.Ensure that the transfer switch does not allow simultaneous active power from two sources.

Include a generator connection panel consisting of, at a minimum, the manual transfer switch and twist-lock connector for generator hookup. Locate and label the transfer switch knob and twist lock connector on a panel easily accessible behind a lockable exterior door. Ensure that this access door is equipped with a tamper-resistant hinge, and that the door assembly is weatherproof and dustproof. Provide the access door with a weatherproof opening for the generator cable. Locate this generator panel as close as possible to the main AC circuit breaker. Never locate the generator access panel on the main cabinet door or back door.

Connect the power service wiring entering the cabinet to the transfer switch. Connect the alternate power source's wiring on the transfer switch to a receptacle that can accept a 120 V_{AC} generator cord. Install a power service wire between the transfer switch and the existing power service panel in the cabinet.

785-4.3 Installation Requirements.

Mount the ITS field cabinet to a concrete base or attach it to the ITS device pole or support structure, 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.

Supply the base-mounted field cabinet with a removable base plate. Ensure that the cabinet has welded inside two aluminum plates for anchoring the cabinet to a concrete or composite type base as shown in the plans. Fabricate the plates from aluminum alloy 5052-H32 and ensure they are 4 inches wide by 0.125 inch thick and shall have four 1-inch diameter holes.

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.

Ensure that the cabinet manufacturer's name and FDOT certification number appear only on the inside of the main cabinet door, along with the year and month of the cabinet's manufacture. Attach this information to the door by a method that is water resistant. Provide the field cabinet with a unique serial number that is engraved on a metallic plate epoxied to the inside of the cabinet on the upper right-hand side wall.

Mount 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 that may be subject to damage when exposed to sunlight or moisture.

Place all equipment in the cabinet according to the recommendations of the manufacturers. A minimum clearance of 6 inches shall be provided between the top of the cabinet and the top of any equipment placed on the top shelf of the cabinet. A minimum clearance of 2 inches shall be provided between each side of the cabinet and the equipment placed on the cabinet shelves.

785-5 ITS Equipment Shelter.

785-5.1 Description: Furnish an equipment shelter of concrete or concrete composite in a size as detailed in the plans and that is capable of providing a controlled environment for housing the electronic communication equipment, power supplies, and related components necessary for the proper operation of an intelligent transportation system (ITS) deployment.

785-5.2 Materials:

785-5.2.1 General: Ensure that the shelter comes complete with a secure door, power distribution panels; a heating, ventilation, and air conditioning (HVAC) system; lightning protection, grounding, and any other components necessary for a completely integrated communication building. Ensure that the shelter is constructed and installed according to local building codes.

Ensure that all materials and installation practices are in accordance with the applicable OSHA requirements in 29 Code of Federal Regulations (CFR) Part 1926, Safety and Health Standards for Construction.

Provide an equipment shelter capable of withstanding minimum loads as follows: Wind, 150 mph; floor, 200 pounds per square foot (psf); slab, 200 psf; roof, 100 psf. Furnish drawings that are signed and sealed by a registered Professional Engineer indicating the shelter meets these minimum values.

Provide the shelter's exterior with a concrete aggregate finish. Ensure that the shelter has a bullet-resistant exterior surface in accordance with the UL 752 standard. Ensure that the shelter's exterior color is earth tone to blend with its surroundings. Alternative exterior finishes or colors must be approved by the Engineer.

Ensure that the equipment shelter's heat transfer coefficient does not exceed 0.07 British Thermal Units (BTUs) per hour per square foot per degree Fahrenheit (F) for the roof insulation and 0.28 BTUs per hour per square foot per degree F for the exterior wall insulation.

785-5.2.2 Shelter Floor and Foundation: Ensure that the equipment shelter floor is constructed of concrete or concrete composite material.

Ensure that the foundation is a monolithic slab with footing, and that the top of the foundation is a minimum of 2 feet above final grade, or as shown in the plans.

Provide an equipment shelter with sufficient cross bracing to prevent the shelter's structure from bending or breaking during moving, towing, or hoisting, and to ensure minimum warping after the shelter has been placed on the foundation with the communication equipment installed.

Ensure that the equipment room's interior floor covering is an industrial-grade vinyl flooring fastened to the shelter floor with waterproof glue. Provide an air gap between the equipment shelter floor and the slab, or alternatively, construct the slab with a vapor barrier of 0.2-inch polyethylene sheeting beneath the concrete and a layer of #30 asphalt impregnated membrane above the slab to prevent moisture penetration. Insulate the floor with polystyrene foam to provide a minimum insulating factor of R11.

785-5.2.3 Door: Ensure that the exterior door is an insulated, bullet-resistant, galvanized steel door with baked enamel finish, a door check, and doorstop. Ensure that the exterior door is 36 inches in width by 78 inches in height with a mortised deadbolt security common-keyed lock. Provide the Department with the keys to the door's lock. Ensure that the door has a handle on both the inside and outside.

785-5.2.4 Walls: Supply the walls with a vapor shield to prevent moisture penetration. Insulate the walls using a minimum insulating factor of R14. Provide interior surfaces that have a white textured finish wall covering with molding on all corners. Ensure that all floor/wall intersections have 4-inch vinyl baseboards installed using waterproof glue.

785-5.2.5 Ceiling and Roof: Ensure that the ceiling is no less than 8 feet above the floor and is capable of supporting the proposed electrical fixtures and cable trays. Construct the roof section with a 1/8-inch per foot minimum pitch for drainage. Fill all voids between the ceiling and roof with minimum Type R21 insulation and include a vapor shield.

785-5.2.6 Entrance: Provide the shelter's entrance with concrete steps and hand rail installed so that the distance from the grade or final step to the shelter floor does not exceed 8 inches.

785-5.2.7 Lighting: Supply a sufficient quantity of fluorescent light fixtures to provide a uniform initial light level of 125 to 150 foot candles at 4 feet above the floor with a 3-to-1 ratio of maximum to minimum light levels as measured throughout the shelter's interior. Mount an interior light switch adjacent to the entry door.

Furnish and install one 35-watt, high-pressure sodium floodlight that is vandal resistant and mounted on the outside near the entrance door. Furnish this floodlight with a photocell and interior light switch. For lighting during power outages, furnish and install an interior two-headed emergency light with rechargeable batteries, a charger pilot, and test light that are wired unswitched to the interior lighting circuit.

785-5.2.8 HVAC System: Provide exterior vertical wall-mounted air conditioners for the equipment shelter. Ensure that the HVAC system has an alarm that indicates failure (i.e., a dry contact closure alarm point). Provide an adjustable time delay initially set to 5 minutes to prevent compressor damage or generator stall if electric service is prematurely restored following a power failure.

Ensure that the HVAC unit has a hard start device installed to reduce the starting current required during a cold start or under high-head pressure conditions. Ensure that the unit is capable of safely operating when the outside temperature falls below 60º F, allowing continuous interior equipment cooling and dehumidification in cold weather. Ensure that the unit has sufficient capacity to cool from a 95º F ambient temperature to 75º F, including the equipment heat load.

785-5.2.9 Cable Trays: Provide cable trays that are 12 inches wide and of sufficient strength to support the transmission lines, control and data wires, and alarm wires associated with the communication equipment. Use cable trays constructed of irradiated steel, aluminum, or painted steel. Suspend the cable trays from the ceiling. Ensure that all cable trays are fabricated in an open ladder type arrangement to permit easy cable routing. In addition, electrically bond by mechanical means all rack and cable tray units together. Use flat washers to facilitate rack bonding on nonpainted surface areas. After bonding, cover these areas with an antioxidant compound. Ensure that cable trays and rack frames are connected to the shelter interior ground.

Ensure that clearance height between the floor and bottom of the cable tray is no less than 86 inches.

Equip the cable trays with overhead quad receptacles for 120 V_{AC} and 20-amp twist-lock receptacles for 240 V_{AC}, as shown in the plans. Put each receptacle on its own breaker.

785-5.2.10 Equipment Rack: Ensure that the equipment shelter includes one or

more standard 19-in EIA/TIA equipment racks for mounting of the devices to be installed, as indicated in the plans. Secure the top of each rack to the cable tray above using C channel or J-hook hardware. Ensure that the racks meet the equipment installation needs in terms of rack height and load requirements. Include provisions for vertical and horizontal cable management and for power strips. Secure the racks to the floor in the location shown in the plans or as directed by the Engineer.

785-5.2.11 Fire/Smoke Detection and Suppression: Include with the equipment shelter one smoke detector that operates on alternating current. Mount the smoke detector on the ceiling and ensure that it includes a dry contact closure that will activate during smoky conditions.

Where the equipment shelter is to be furnished with an automatic fire protection system, ensure that it is an FM-200 waterless, residue-free fire suppression system that conforms to the NFPA 2001 and ISO 14520 standards.

If a fire extinguisher is specified, mount on the wall near the door a hand-held carbon dioxide fire extinguisher suitable for use on electrical fires. Verify that the extinguisher has a valid inspection tag and is refillable.

785-5.2.12 Alarm Specification: Wire and terminate all alarms on a Contractor-provided Type 66 block. Label each termination. Provide the following equipment shelter alarms:

1. A magnetic dry contact door alarm.
2. A dry contact air conditioner failure alarm for each installed unit.
3. Dry contact fire alarms.
4. Dry contact high- and low-temperature alarms with thresholds adjustable between 50º and 90ºF.
5. A power failure alarm that is wired from a dedicated circuit breaker.
6. A main fuse alarm that is wired from the main fused disconnect.

785-5.2.13 Electrical Specifications: Ensure that the standard electrical configuration for the shelter is single-phase 120/240 V_{AC} at 60 hertz (Hz) with a 150-amp minimum service and a 42-circuit distribution panel. Provide the necessary power service drop and site-specific power needs for the equipment shelter installation, following the requirements of Section 639.

785-5.2.13.1 Primary AC-Powered Transient Voltage Surge Suppression Device: Furnish the equipment shelter with a primary AC transient voltage surge suppressor (TVSS) that meets or exceeds all of the requirements of 785-2.4.1 and 785-2.4.2.

785-5.2.13.2 Secondary AC-Powered Transient Voltage Surge Suppression Devices: Furnish the equipment shelter with a secondary AC TVSS that meets or exceeds all requirements in 785-2.4.1 and 785-2.4.3. These devices will generally have special requirements for installation and interface with the ITS circuits or devices as shown in the plans.

785-5.2.13.3 Tertiary AC-Powered Transient Voltage Surge Suppression Devices: Furnish the equipment shelter with a tertiary AC TVSS at each outlet that meets or exceeds all of the requirements of 785-2.4.1 and 785-2.4.3.

785-5.2.14 Communication Cable Wall Entry: Furnish the equipment shelter with four 4-inch diameter ports with weather-sealed boot systems for telephone/signal cable and fiber optic cable entry. Locate these ports as shown in the plans.

785-5.2.15 Circuit Termination Backboard: Provide each equipment shelter with a backboard for the termination of communication circuits. Furnish a backboard of 3/4-inch

AC-grade plywood no less than 48 inches square and painted with two coats of gray, flame-retardant paint. Ensure that all ground wires and conductors are insulated from the backboard, which must be mounted securely to the wall and able to support the weight of the hardware fastened to it.

785-5.3 Installation Requirements.

785-5.3.1 General: Provide a drawing that depicts the details of the proposed equipment shelter installation, including site layout, fencing, and all other features. Submit this drawing to the Engineer for approval prior to the start of construction.

Furnish concrete in accordance with Section 346. Perform all concrete work in accordance with Section 400. Obtain precast products from a plant that is currently on the list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3.

Contact local building officials for permit applications and submit them to the Engineer for approval and execution. The Contractor shall be responsible for obtaining all permits and their associated applications, filling out the applications, obtaining a Department signature, and then submitting the permit application to the regulating agency.

785-5.3.2 Electrical Installation: Provide for electrical power to the equipment shelter and ensure that power is properly connected. Route all wires and cables in a neat, orderly fashion. Electrical connectors and all costs associated with providing power shall be the Contractor's responsibility. Provide underground power service unless otherwise specified in the plans.

Provide all electrical connections from the service drop to the equipment shelter's receptacles. Wire the receptacles, switches, and light fixtures using a minimum of AWG #12 copper wires. Run all wire in a minimum 0.75-inch inside diameter electrical metallic tubing. Divide the electrical loads among as many load centers as necessary to contain the quantity of circuit breakers required to protect the equipment shelter facility.

Ensure that the load centers contain separate, appropriately sized circuit breakers for the HVAC units, each major branch as is necessary, each receptacle, and each remaining location in the 42-circuit panel. Ensure that the shelter includes duplex receptacles on each of the four walls at a height of 18 inches above the floor, as shown in the plans. Protect each wall with a separate 20-amp circuit breaker. Provide a separate 20-amp single-pole circuit breaker to protect the lighting circuits.

785-5.3.3 Provision for Backup Power: Ensure that the main power enters the equipment shelter at a primary power switch to allow for the disconnection of commercial power, and then is routed to an automatic transfer switch that will switch to emergency generator power in the event commercial power is lost. Also ensure that emergency generator power enters the equipment shelter through a power switch prior to connection to the automatic transfer switch panel. Ensure that the equipment shelter is able to utilize a mobile emergency generator during power outages. Route the main power from the automatic transfer switch to a manual transfer switch located with the mobile emergency generator connection installed on the outside of the shelter. The emergency generator connection shall allow Department personnel to power the site from a portable generator in the event that both the commercial power and emergency power is lost. Route the resulting main power to a 42-circuit distribution panel and through the associated AC TVSS devices, as described in the plans.

785-5.3.4 Grounding Installation: Install a grounding system that meets the requirements in 785-2, in the NEC, and that meets the grounding requirements of the local building code.

Install all grounds for the equipment shelter on the side of the building that utilities, communication cables, and fiber enter. Install the grounding system for the surge protection devices according to the manufacturer's recommendations. Connect them to the existing grounding system with no less than the minimum wire size specified in 785-2, or the manufacturer's recommended wire size, whichever is larger, typically a AWG #2 solid bare copper wire.

Ensure that the grounding system is bonded at a single point so that the communication cables, AC power, emergency generator, and equipment frames are connected by the shortest practical route to the grounding system. Protect the lead lengths from each device to the TVSS. Ensure that the grounding is minimized for all devices according to installation requirements. Ensure that the TVSS lead lengths do not exceed 10 inches.

Use an exothermic bonding process for all below-ground connections. Do not backfill the openings where the underground exothermic bonds are made until the Engineer has inspected and approved the grounding system.

Use an exothermic bonding process or compression type connection for all above-ground exterior connections to bond ground conductors to the exterior of the equipment shelter. Note that the only exception to this is grounding connections made to ground bus bars. For connections to bus bars, use mechanical connections having two bolts on a double-lug connector. After achieving a firm connection to the connectors, apply an anti-oxidant compound.

Ensure that all connections to fence components are mechanical bonds. After a firm connection has been achieved, apply an anti-oxidant compound.

For connection of conductors to interior equipment, such as panels and cable trays, use tow bolts on a double-lug connector, or clamps appropriate to the size and type of wire and the requirements of the equipment being grounded. Crimp and solder all wires connected to lugs or clamps for reliable electrical contact. Remove all non-conducting surface coatings before each connection is made. Apply an anti-oxidant compound. Install star washers, or another means that accommodates the fasteners used, to achieve reliable electrical connections that will not deteriorate.

Ensure that ground conductors are downward coursing and vertical, and as short and straight as possible. Ensure that the minimum bending radius for interior equipment shelter grounds is 8 inches. Avoid sharp bends and multiple bends in conductors in all cases.

785-5.3.4.1 Interior Grounding: Install an AWG #2 solid bare copper wire approximately 1 foot above the floor on each wall and mount it using insulated standoffs. Ensure that the AWG #2 solid bare copper wire encircles the equipment room, forming a ring or continuous loop along the lower interior perimeter ground, except at the doorways. Do not allow any breaks or splices in the ground loops. Mechanically connect the transmission line entrance panels, automatic transfer switches, manual transfer switches, distribution panels, and primary AC TVSS to the lower interior perimeter ground.

Install a AWG #2 solid bare copper wire approximately 1 foot below the ceiling on each wall and mount it using insulated standoffs. Ensure that the AWG #2 solid bare copper wires encircle the equipment room, forming a ring or continuous loop along the upper interior perimeter ground, and include the wall area above the door. Provide a break in this ground loop for an "open halo" so that the interior grounding system does not act as

a capacitor. Mechanically connect the cable trays to the upper interior perimeter ground using AWG #2 solid bare copper wires with bolted terminal connectors at the cable tray ends. Make all points where cable tray sections meet electrically continuous by use of a short jumper wire with terminals attached at each end.

Directly bond all other metallic objects, such as door frames and doors, air conditioners, alarm systems, wall-mounted communication equipment, etc., to the closest interior perimeter ground with the shortest possible AWG #2 solid bare copper wire. Bond the door to the doorframe using flexible welding cable. Make a bond between the lower and upper internal perimeter grounds using AWG #2 solid bare copper wires at each corner of the room. Continue to provide a bond between the internal and external grounding systems using AWG #2 solid bare copper wires.

785-5.3.4.2 Exterior Grounding: Install an exterior grounding system consisting of multiple ground rods around the perimeter of the equipment shelter to achieve the resistance to ground required in Section 785-2.3. Space the rods according to 785-2.3.2 and drive them into the ground using the proper tool to prevent rod deformation. Place the rods a minimum of 2 feet from the building foundation and bury each with the top of the rod a minimum of 2.5 feet below the grade. Bond the ground rods together using AWG #2 solid tinned bare copper wires and an exothermic bonding process. Bury the bonding wires a minimum of 2.5 feet below the grade. Also bond the following items to the shelter's external grounding system using AWG #2 solid tinned bare copper wires:

1. Metal building parts not grounded by the internal grounding rings, such as downspouts and siding.
2. Ground rods provided by power or telephone utilities for grounding of AC power or surge protection devices, as permitted by local codes.
3. Shelter support skids, bases, or foundations, if applicable.
4. Any metal object larger than 4 square feet.

785-5.3.4.3 Punch Block TVSS Grounding: For all Type 66 punch blocks, install AWG #2 solid bare copper wires to ground external line surge protection devices. Install the AWG #2 solid bare copper wires in accordance with the TVSS manufacturer's recommendations and mechanically connect them to the shelter's interior perimeter ground.

785-5.3.5 Site Preparation: Ensure that all provisions of Section 110 are met in preparing the site. Coordinate with the Engineer on the extent and schedule for all land clearing activities to ensure that there is no interference with concurrent operations at the site. Comply with all environmental protection requirements.

785-5.3.6 Fencing: Furnish Type B chain-link perimeter fencing and gates according to the requirements of Section 550. Install the fence to form a rectangle or square shape, unless otherwise specified in the plans. Allow for a minimum space of 5 feet between the fence and any enclosed item. Ensure that the fencing materials, including posts and bracing, are metal and comply with Section 965.

Construct the fence in accordance with Index No. 802 of the Design Standards. Ensure that the basic fence is a minimum height of 6 feet and is topped with barbed wire that is held outward from the fence at a 45-degree angle with galvanized hardware. Fasten the fence fabric to a top rail installed on top of the fence.

Include a gate made of the same material as the fence. Construct the gate in accordance with Index No. 803 of the Design Standards and configured as shown in the plans.

Provide a hardened, four-digit combination gate lock manufactured by Medeco Co., or approved equivalent. Set the combination as directed by the Engineer.

785-5.3.7 Fence Grounding: Ensure that the metal Type B fence is grounded to fence perimeter ground wires consisting of AWG #2 solid, tinned, bare copper wires that encircle the entire compound to achieve the resistance to ground required in Section 785-2.3.

Exothermically bond any splices in the ground wire. Bury the fence perimeter ground wire a minimum of 2.5 feet below finished grade. Bond all fence posts to the fence perimeter ground wire using AWG #2 solid, tinned, bare copper wires. Bond the gate and gatepost together with a flexible ground, such as welding cable wires. Ground the gatepost to the fence perimeter ground wire using AWG #2 solid, tinned, bare copper wires. Exothermically bond all connections to the fence perimeter ground wire.

Connect the fence's top rail to each corner post and in the middle of each side. Ground the fence fabric with AWG #2 solid, tinned, bare copper wires connected to the fence posts. Connect the fence perimeter wires to the ground rods of the equipment shelter's ground system with AWG #2 solid, tinned, bare copper wires, as shown in the plans.

Ensure that all ground leads are AWG #2 solid, tinned, bare copper wires for all above- and underground grounding wire installations. Ensure that all exothermic bonds are appropriate for the application. Do not use welding or other forms of bonding without prior written approval from the Engineer.

785-5.3.8 Weed Prevention: Treat the fenced area with a Department-approved herbicide and cover it with weed prevention material. Place a woven plastic weed barrier on the ground before gravel installation. Install the barrier with a minimum 10% overlap for each barrier section and secure the edges of the mat with stakes.

785-5.3.9 Compound Gravel: Place gravel or crushed rock covering all unimproved areas inside the new fenced area to a depth of 6 inches. Ensure that the size does not exceed 3 inches in diameter so that foot traffic is not difficult.

785-5.3.10 Site Restoration: Provide grass in accordance with Section 570.

785-5.4 Inspection and Verification.

785-5.4.1 General: Perform an inspection that is witnessed by the Engineer. Notify the Engineer at least 10 days prior to completion of the installation. After installation of the shelter equipment, verify in conjunction with the Engineer that all equipment is correctly installed and functional.

For grounding system inspections, notify the Engineer at least five days prior to completion of the installation. Do not backfill below-grade grounding installations and grounding connections until inspected and approved by the Engineer. Record all test results in a standardized format approved by the Engineer prior to testing. All recorded test report data shall be dated, witnessed, and signed by at least one representative of the Department and the Contractor. Remedy all deficiencies at no cost to the Department.

785-5.4.2 Mechanical Inspection: Inspect all equipment to be mounted to the shelter walls to ensure adequate support has been provided. Test the HVAC system for adequate heating, cooling, and dehumidification. Inspect the building for the proper sealing of transmission lines, waveguide ports, telephone/signal cables, and ground wire penetrations. Correct any deficiencies at no cost to the Department.

785-5.4.3 Electrical Inspection: Verify that the shelter lights and smoke detectors operate properly. Verify proper power load balances and provide a report to the Engineer prior to acceptance of the site. Correct any deficiencies at no cost to the Department.

785-5.4.4 Grounding Inspection: Inspect the grounding system for proper connection types, tightness, and workmanship, as well as conformance to the approved design. Repair with new bonds any exothermic bonds that are deemed unsatisfactory. Repair or replace any mechanical connections that are deemed unsatisfactory. Correct all deficiencies at no cost to the Department.

785-5.4.5 Site Inspection: Inspect the site and verify that it is free of debris, and that excavations are backfilled and restored.

785-5.4.6 Performance Period: Following the completion of all acceptance testing and inspections, subject the installed site to a minimum 20-day performance period, or alternately, the operational test period for the ITS deployment project, whichever is greater.

For the purpose of a successful performance period, failure of operation is defined as the failure of a major site component (i.e., HVAC systems, lighting, alarms, fire or smoke detection, etc.). Degradation of performance is not a failure if function and proper operation is maintained. Conduct the performance verification with the Engineer present. Upon acceptance of the test criteria by the Engineer, the 20-day performance period shall begin.

Accomplish this performance testing during a period of time not to exceed 45 consecutive days after equipment shelter installation and inspection. If a successful performance period cannot be accomplished within 45 consecutive days after the shelter installation and inspection, the Department reserves the right to deem the Contractor in default and enforce the provisions set forth in the Contract.

785-6 Guaranty Provision.

785-6.1 General: Ensure that the manufacturers' warranties on poles and lowering devices, TVSS, ITS field cabinets, and ITS equipment shelters are fully transferable from the Contractor to the Department. Ensure that these warranties require the manufacturer to furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department within 10 calendar days of notification by the Department.

785-6.2 Poles and Lowering Devices: Ensure that the poles and the lowering devices furnished, assembled, fabricated, or installed are warranted by the manufacturers against defects in materials or workmanship for a period of no less than three years from the date of final acceptance by the Engineer in accordance with 5-11 of all work to be performed under the Contract. If the manufacturer's warranties for the components are for a longer period, those longer period warranties will apply.

785-6.3 Transient Voltage Surge Suppressors: Provide a TVSS that is warranted by its manufacturer against any failures caused by electrical events, including direct lightning strikes, for a period of not less than 10 years or the TVSS device manufacturer's standard warranty period, whichever is greater.

The term "failure" for warranty replacement is defined as follows:

Parallel-connected, power-rated TVSS units are considered in failure mode when any of the indicating lamps shows failure mode when power is applied to the terminals at the unit's rated voltage, or the properly functioning over-current protective device will not reset after tripping.

Series-connected, low-voltage power, data, or signal units are considered in the failure mode when an open circuit condition is created and no data/signal will pass through the TVSS device.

In the event that the TVSS, including any component of the unit, should fail during the warranty period, the entire TVSS shall be replaced by the manufacturer at no cost to

the Department. Costs relating to the removal of the TVSS, shipping and handling, and the reinstallation of the TVSS shall be paid by the Department.

785-6.3 ITS Field Cabinet: Ensure that the ITS field cabinet has a manufacturer's warranty covering defects in assembly, fabrication, and materials for a minimum of two years from the date of final acceptance by the Engineer in accordance with 5-11 of all work to be performed under the Contract. If the manufacturer's warranties for the cabinet and components are for a longer period, those longer period warranties will apply.

785-6.4 ITS Equipment Shelter: Ensure that the equipment shelter, its components, and hardware have a manufacturer's warranty covering defects in assembly, fabrication, and materials for a minimum of one year from the date of final acceptance by the Engineer in accordance with 5-11 of all work to be performed under the Contract. If the manufacturer's warranties for the equipment shelter or components are for a longer period, those longer period warranties will apply.

785-7 Method of Measurement.

785-7.1 General: Poles, with or without the lowering devices; ITS field cabinets, and equipment shelters, shall be measured for payment in accordance with the following tasks.

The work specified for grounding and transient voltage surge suppression will not be paid for directly, but will be considered incidental to the installation of ITS devices and systems.

785-7.2 Furnish and Install: The Contract unit price per pole furnished and installed will include furnishing, placement, and testing of all equipment and materials, and for all tools, labor, cables, hardware, operational software package(s) and firmware(s), supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

Except in the case of a retrofit, the work specified for furnishing and installing a lowering device will not be paid for directly, but will be considered incidental to the installation of a steel or concrete pole.

The Contract unit price for each ITS field cabinet, furnished and installed, will include furnishing, placement, and testing of all equipment and materials, and for all tools, labor, hardware, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

The Contract unit price for each ITS equipment shelter, furnished and installed, will include furnishing, placement, and testing of the shelter, all its materials and equipment, and for all tools, labor, equipment, hardware, site preparation, site restoration, fencing, supplies, shop drawings, documentation, and incidentals necessary to complete the work.

785-7.3 Furnish: The Contract unit price per pole furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

Except in the case of a retrofit, the work specified for furnishing a lowering device will not be paid for directly, but will be considered incidental to the furnishing of a steel or concrete pole.

The Contract unit price per each ITS field cabinet, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

The Contract unit price per ITS equipment shelter, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

785-7.4 Install: The Contract unit price per pole installed will include placement and testing of all equipment and materials, and for all tools, labor, hardware, operational software package(s) and firmware(s), supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

Except in the case of a retrofit, the work specified for installing a lowering device will not be paid for directly, but will be considered incidental to the installation of a steel or concrete pole.

The Contract unit price per each ITS field cabinet, installed, will include placement and testing of all equipment and materials, and for all tools, labor, hardware, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

The Contract unit price per ITS equipment shelter, installed, will include placement, and testing of the shelter, all its materials and equipment, and for all tools, labor, equipment, hardware, site preparation, site restoration, fencing, supplies, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment shelter specified in the Contract Documents.

785-8 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section. Payment will be made under:

Item No. 785-1	ITS Pole, per each.
Item No. 785-2	ITS Field Cabinet, per each.
Item No. 785-3	ITS Equipment Shelter, per each.