785 INTELLIGENT TRANSPORTATION SYSTEMS - INFRASTRUCTURE. (REV 8-03-10) (FA 8-16-10) (1-11)

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.

785-2 Grounding and Surge Protective Devices.

785-2.1 Description: Furnish and install grounding and Surge Protective Devices (SPDs) for all ITS devices to protect the devices from lightning, transient voltage surges, and induced current. References for this section include, but are not limited to: UL467, Grounding and Bonding Equipment; UL497A, Standard for Secondary Protectors for Communications Circuits, and the NEC. Ensure that lightning protection systems conform to the requirements of NFPA 780, Standard for the Installation of Lightning Protection Systems.

785-2.2 Materials: Provide a grounding system that meets the minimum requirements of this section and those defined in Section 620. Ensure that all SPDs comply with the environmental requirements of section A615 of the MSTCSD.

Install SPDs on all power, data, video and any other conductive circuit. Use only equipment and components that meet the minimum requirements of this specification, and are listed on the Department's Approved Product List (APL).

785-2.3 Installation Requirements:

785-2.3.1 General: A single point grounding system is required. Each ground rod electrode assembly must have a minimum length of 20 feet. Individual ground rod electrode assembly sections must have a minimum length of 8 feet. Ensure that ground rods are a minimum 5/8 inch in diameter. Bond multiple grounding rod electrode assemblies to each other with No. 2 AWG solid bare tinned copper wire that is exothermically welded at all connection points.

Bond the grounding system to a main ground bar within the site equipment cabinet. A single grounding rod electrode assembly bonded to the equipment cabinet constitutes a minimal grounding system with a main ground rod and primary radial. If this primary radial does not achieve a resistance to ground of 5 ohms or less, install an additional 20-foot grounding rod electrode assembly and connect it to the main grounding rod electrode assembly. If the array still does not achieve a resistance to ground of 5 ohms or less, install additional 20-foot grounding rod electrode assemblies, spaced 40 feet apart, until 5 ohms is achieved. If a resistance to ground measurement of 5 ohms or less between the grounding electrode and the soil cannot be achieved with a total of four 20-foot rods, submit the site resistance measurement to the Engineer. A grounding system consisting of four 20-foot rods is acceptable in cases where soil conditions prevent the grounding system from achieving a

resistance to ground of 5 ohms or less. Grounding systems formed from horizontally constructed conductive radials are permitted if site conditions prohibit the use of vertically driven rods.

785-2.3.2 Grounding Specifications: Provide a grounding system as shown in the plans. Ensure that grounding rod electrodes are UL 467 listed. Make all connections to the grounding electrode using exothermic welds. The main ground rod directly connected to the main ground bar within the site cabinet must remain accessible for inspection, testing, and maintenance. Place the main ground rod in the electrical pullbox nearest the site cabinet or as shown in the plans.

Install the main grounding rod electrode at the structural base of the ITS device. 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. Do not use split bolts for grounding system connections.

Connect all grounding electrodes related to the ITS device and any associated 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 bar inside the equipment cabinet or mounted to the base of the ITS structure and as shown in plans.

Place multiple grounding rod electrode assemblies in a radial "Y" configuration unless otherwise shown in the plans. In the event that the "Y" configuration cannot be placed in the right-of-way, change the configuration of the radials to make the grounding array fit in the space available, and/or increase the length of the ground rods to a maximum of 40 feet provided that the sphere of influence radius is maintained.

785-2.3.3 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. Provide the Engineer with written test results for each testing location. 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.

785-2.3.4 Air Terminals: Ensure that lightning protection systems and air terminals installed conform to NFPA 780. Ensure that the air terminal extends at least 2 feet above the object or area it is to protect and is bonded to the down conductor. Ensure that all ITS devices attached to poles or 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 may be required to establish a zone of protection in accordance with NFPA 780. Ensure that all air terminals are interconnected. Ensure air terminals are terminated to the main grounding rod electrode. Use air terminals that are UL listed.

785-2.4 Surge Protective 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.

785-2.4.2 Type 1 SPD at Power Entry Point: Install a SPD at the closest termination/disconnection point where the supply circuit enters the ITS device cabinet. Locate the SPD on the load side of the main disconnect and ahead of any and all ITS electronic devices. Configure the SPD to operate at 120 volt single phase (i.e., line, neutral and ground) or 120/240 volt single phase (line 1, line 2, neutral and ground) as required to match the supply circuit configuration. Verify that the SPD has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449, Third Edition.

Ensure that the SPD has 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 SPD shall have a NEMA 4 rating.

785-2.4.3 SPD at Point of Use: Install a SPD at the point the ITS devices receive 120 volt power. Ensure that the units are rated at 15 or 20 amps load and a minimum of 20kA of surge current capacity and configured with receptacles.

Ensure that these units have internal fuse protection and provide common mode (L+N-G) protection.

785-2.4.4 SPD for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized SPD on all conductive circuits including, but not limited to, data communication cables, coaxial video cables, and low-voltage power cables. Ensure that these devices comply with the functional requirements shown in Table 785-1 for all available modes (i.e. power L-N, N-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

Table 785-1				
SPD Minimum Requirements				
Circuit Description	Clamping Voltage	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Maximum Let-Through Voltage
12 VDC	15-20 V	N/A	5kA per mode (8x20 µs)	<150 Vpk
24 VAC	30-55 V	N/A	5kA per mode (8x20 µs)	<175 Vpk
48 VDC	60-85 V	N/A	5kA per mode (8x20 µs)	<200 Vpk
120 VAC at POU	150-200 V	N/A	5kA per mode (8x20 µs)	<550 Vpk
Coaxial Composite Video	4-8 V	Up to 1.5 GHz	10kA per mode (8x20 µs)	<100 Vpk

Table 785-1				
SPD Minimum Requirements				
Circuit Description	Clamping Voltage	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Maximum Let-Through Voltage
RS422/RS485	8-15 V	Up to 10 Mbps	10kA per mode (8x20 µs)	<30 Vpk
T1	13-30 V	Up to 10 Mbps	10kA per mode (8x20 µs)	<30 Vpk
Ethernet Data	7-12 V	Up to 100 Mbps	3kA per mode (10x1000 µs)	<30 Vpk

Install a SPD that has an operating voltage matching the characteristics of the circuit. Ensure that these specialized SPDs 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 concrete or steel pole in accordance with Design Standard 18111 or 18113 and listed on the Department's Qualified Products List (QPL).

For concrete poles, use concrete meeting the requirements of Section 346 and construct in accordance with Section 450. Obtain concrete poles from a manufacturing plant that is currently on the Department's list of Producers with Accepted Quality Control Programs. Producers seeking inclusion on the list shall meet the requirements of 105-3. Assume responsibility for performance of all quality control testing and inspection required by Sections 346 and 450; however the PCI personnel and plant certifications are not required.

Ensure that the pole-top tenon is rotatable.

785-3.2.2 Lowering Device: Use a lowering device as shown in the plans. Use only lowering device equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL). The lowering device must be permanently marked with the APL certification number, manufacturer name, model number, and date of manufacture.

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. The lowering device system support arm must be capable of withstanding service tension and shear up to 1 kip (kilopound) minimum.

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. All finished castings must have a smooth finish free from cracks, blow-holes, shrinks, and other flaws. All roller fairlead frames shall be corrosion resistant stainless steel or aluminum.

The lowering device must be provided with a minimum of 100 feet of composite power and signal cable prewired to the lowering device at the factory unless otherwise shown in the plans.

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. The equipment connection box must include a 1.5 inch National Pipe Thread (NPT) pipe connection point for attaching a camera. 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 600 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. Ensure that all load is transferred from the lowering cable to the mechanical latches when the system is in the latched position. 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 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 showing pin assignment for approval.

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.

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 0.09 inch in diameter and firmly affixed to the connector block. Ensure mated connectors do not allow water penetration.

785-3.2.3 Lowering Tool: Provide a portable metal-frame lowering tool with winch assembly and a cable with a combined weight less than 35 lbs.; a quick release cable connector, and a torque limiter that will prevent over-tensioning of the lowering cable. 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 securely supports itself and the load. Ensure that the lowering tool is equipped with a winch with a minimum drum size width of 3.75 inch and a positive braking mechanism to secure the cable reel during raising and lowering operations, and to prevent freewheeling. Ensure the lowering cable winds evenly and does not bind on the lowering tool winch drum during operation. Ensure the winch includes a manual winch handle that incorporates a non- shear pin type torque limiter that can be used repeatedly and will prevent damage to the lowering system.

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 and torque limiter.

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. The cable must be stainless steel type 316 aircraft type (7 strands x 19 gauge) with a minimum breaking strength of 1,760 lbs. Ensure the lowering cable assembly (as installed with thimble and crimps on one end and a cable clamp inside the latch on the lowering device end), has a minimum breaking strength of 1,760 lbs. Ensure all lowering cable accessories, such as connecting links, have a minimum workload rating that meets or exceeds that of the lowering cable. 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/junction box that is able to accept the lowering device. Ensure that the system includes a winch assembly permanently housed in a corrosion- resistant lower lockable pole-mounted cabinet. Ensure the upper mounting/junction box includes a maintenance access door with captive attachment hardware. Provide all necessary mounting hardware, conduits, standoffs, and conduit mounts required for a complete and functional system.

Ensure the cabinet minimum dimensions are 12 inches x 18 inches x 10 inches and that the cabinet and door do not interfere with the operation of the winch. The

cabinet must provide adequate clear area for operation of the winch manually and with an electric drill.

The cabinet must be constructed of 5052 sheet aluminum with a minimum thickness of 1/8 inch. All inside and outside edges of the cabinet must be free of burrs. The outside surface of the cabinet must have a smooth, uniform natural aluminum finish. All welds must be neatly formed, free of cracks, blow holes, and other irregularities. Cabinet hinges must be vandal resistant and made of 14 gauge diameter stainless steel or 1/8 inch diameter aluminum and include stainless steel hinge pins. Cabinet door must not sag. Door opening must be double flanged. Door must include neoprene closed-cell gaskets permanently secured on the interior door surfaces that contact the door opening. The cabinet must be NEMA 4 rated.

Door must include a pin tumbler lock. Provide locks keyed for use with a #2 key unless otherwise directed. Provide two keys with each cabinet. The cabinet door handle must include a lock hasp that will accommodate a padlock with a 7/16 inch diameter shackle.

Ensure external conduit used to connect the winch cabinet to the upper mounting/junction box is galvanized schedule 40 with NPT threads. The conduit must have a minimum ID of 3 inches at the lower winch cabinet entrance and allow the lowering cable to wind evenly on the winch drum without binding. All conduit couplings and connections between the pole-mounted cabinet and upper mounting/junction box must be watertight.

785-3.3 Installation Requirements:

785-3.3.1 General: 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 Structures Manual, Volume 9. 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.

785-3.3.2 Concrete Poles: Install foundation and pole in accordance with 641-4.2, except footing dimensions shall be in accordance with Design Standard 18113.

785-3.3.3 Steel Poles: Install foundation and pole in accordance with 649-5 and 649-6.

785-3.3.4 Lowering Device: Ensure that the lowering device can be safely operated and is installed in a manner that does not place the operator directly under the device when it is being raised or lowered.

Ensure the lowering device support arm self-aligns the disconnect unit and attached device with the pole centerline and remains centered after installation without moving or twisting. Ensure the connection between the lowering device and tenon is weather resistant to prevent the entrance of water. For externally-mounted lowering systems, use conduit straps to secure lowering cable conduit to the pole. Do not use stainless steel bands to secure conduit to the pole. Place the stainless steel lowering cable inside conduit. 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. Label all wire leads with their function, label spares as spares.

Ensure that crimps and other cable connection hardware associated with the lowering cable cannot come in direct contact with the winch tool or guides when operating the system. Ensure the correct length of lowering cable is installed and that the installed length prevents cable slack and prevents cable from jumping off the winch spool. Ensure the lowering cable strands do not twist or unwind when the lowering device is operated.

Provide manufacturer recommended field installation instructions, inspection instructions (including recommended schedules and procedures), and operating instructions.

785-4 ITS Field Cabinet.

785-4.1 Description: Furnish and install a 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. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

785-4.2 Materials:

785-4.2.1 Cabinet Shell: Ensure the cabinet shell conforms to NEMA 3R requirements. Ensure that the cabinet shell 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.

The minimum dimensions for cabinets are listed below.

Table 785-2			
Required 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

Ensure that the 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 gas tungsten arc (TIG) welds. Ensure that all internal cabinet welds are gas metal arc (MIG) or TIG welds. 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 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 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 lbs.. Ensure that all external bolt heads are tamperproof.

785-4.2.2 Doors: Provide a 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 lb.-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.

785-4.2.3 Latches: Provide all 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 two and three remain in the locked position until the main cabinet door lock is unlocked. Ensure that the locking mechanism is 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 #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.

785-4.2.4 Rails: Provide the 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 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-lb. load. Ensure that the shelf position is adjustable.

785-4.2.7 Sunshield: If the cabinet is provided with sunshields, as indicated in the plans, the 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. 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.

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 measuring 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°F to a maximum of 160°F. Ensure that the thermostat activates the fans within plus or minus 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 surge protection for the main AC power input at the service panel assembly and at the point of use for electronics as required by 785-2. Ensure that the SPD is 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.

Ensure that the wiring in the 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, SPDs, and grounding as required for the load served by the cabinet, including ventilation fans, internal lights, electrical receptacles, etc.

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.

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 No. 2 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 No. 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 $120V_{AC}$ power unless otherwise shown in the plans.

785-4.2.9.5 Interior Lighting: Unless otherwise shown in 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 turn off when the doors are closed.

785-4.2.9.6 Generator and Auxiliary Power Connection: Unless otherwise shown in the plans, furnish a 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 time at the cabinet. Provide the cabinet with either a manual or automatic transfer switch as shown in the plans. Provide a transfer switch rated equal to or higher than the design load of the cabinet's main breaker and the generator input twist-lock connector rating. Ensure that the transfer switch provides a means of switching between normal utility power and auxiliary backup generator power. Ensure that the switching time between sources is no longer than 250 milliseconds. Ensure that the transfer switch meets UL 1008. 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.

785-4.2.9.6.1 Manual Transfer Switch: Ensure the manual transfer switch is a two-position switch. Label the switch positions as "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. Ensure that the Utility-on indicator is clearly visible outside the cabinet and that the indicator's on/off state can be visually determined from a distance of 30 feet.

785-4.2.9.6.2 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. Ensure that the automatic transfer switch has 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 shall be energized only by the generator, not by the electric utility service. 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.

785-4.2.9.6.3 Generator Access Panel: Include a generator connection panel consisting of, at a minimum, the manual transfer switch and three-prong, 30-amp twist-lock connector with recessed male contacts for generator hookup. Locate and label

the transfer switch and twist lock connector on a panel easily accessible behind a lockable exterior door. Ensure that this access door is labeled as “Generator Access Door”, equipped with a tamper-resistant hinge, and that the door assembly is weatherproof and dustproof. The access door shall be provided with a #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 into the cabinet and be deep enough to allow closing and locking of the access door when the generator cable is connected. Limit the generator hookup compartment and access panel’s intrusion into the cabinet interior to no more than 6 inches. Avoid blocking access to any other equipment in the cabinet. Locate this generator panel as close as possible to the main AC circuit breaker. Ensure that the bottom of the access panel is no less than 24 inches above the bottom of the cabinet. Never locate the generator access panel on the main cabinet door or back door.

Connect wiring from the Cabinet AC+ Input Terminal 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 distribution panel in the cabinet.

785-4.3 Installation Requirements.

Mount the cabinet to a concrete base or attach it to a 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 ground-mounted field cabinets 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. Ensure the plates are a minimum of 4 inches wide by 0.125 inch thick. Ensure the cabinet includes four 1-inch diameter holes for anchoring.

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 APL 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 and install 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 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 lbs. per square foot; slab, 200 lbs. per square foot; roof, 100 lbs. per square foot. Provide 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 UL 752. Ensure that the shelter's exterior color is earth tone to blend with its surroundings. Alternative exterior finishes or colors must be approved.

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 R-11.

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 R-14. 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 R-21 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 3:1 ratio of maximum to minimum light levels as measured throughout the shelter's interior. Mount an interior light switch adjacent to the entry door.

Provide one 35-watt, high-pressure sodium floodlight that is vandal resistant and mounted on the outside near the entrance door. Provide this floodlight with a photocell and interior light switch. Provide an interior emergency light.

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 60ºF, allowing continuous interior equipment cooling and dehumidification in cold weather. Ensure that the unit has sufficient capacity to cool from a 95ºF ambient temperature to 75ºF, 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 communication equipment. Use cable trays constructed of 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 20A 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-inch 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.

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 NFPA 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 Hz with a 150 A 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 Surge Protective Device: Provide the equipment shelter with a primary AC surge protective device (SPD) that meets or exceeds all of the requirements of 785-2.4.1 and 785-2.4.2 that is connected to the electrical system at all times, whether the site is operating on utility or emergency power.

785-5.2.13.2 SPDs at Point of Use: Provide the equipment shelter with SPDs that meet or exceed all requirements in 785-2.4.3 and 785-2.4.4. These devices will generally have special requirements for installation and interface with the ITS circuits or devices as shown in the plans. Ensure that all outlets within the equipment shelter are protected.

785-5.2.14 Communication Cable Wall Entry: Provide 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. Provide 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 for approval prior to the start of construction.

Provide 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 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 No. 12 AWG 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 A circuit breaker. Provide a separate 20 A 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 surge protective 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 main ground bar on a suitable wall of the building. Connect all earth grounds to this point, including the grounding system for the surge protection devices (SPDs). Make all connections to SPDs according to the manufacturer's recommendations.

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 SPD.

Use an exothermic bonding process for all external connections. Ensure that external connections and ground rods remain accessible for inspection, testing, and maintenance during and after construction.

Use compression type connection for all interior connections to bond ground conductors to equipment in the shelter. 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 ground 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 two 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 a No. 2 AWG solid bare copper wire approximately 1 foot below the ceiling on each wall and mount it using insulated standoffs. Ensure that the wire encircles the equipment room, forming a ring or continuous loop along the upper interior perimeter ground, and includes the wall area above the door. Mechanically connect the cable trays to the upper interior perimeter ground using stranded copper wires with green insulation and 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 stranded copper wire with green insulation. Bond the door to the doorframe using flexible welding cable.

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 in a suitable access point. Ensure that 6 to 10 inches of the ground rod is accessible for inspection, testing, and maintenance during and after construction. Bond the ground rods together using No. 2 AWG solid bare tinned copper wire and an exothermic bonding process. Bury the bonding wires a minimum of 18 inches below grade. Also bond the following items to the shelter's grounding system using No. 2 AWG solid bare tinned copper wire:

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.
5. External metal fencing.

785-5.3.4.3 Punch Block SPD Grounding: For all Type 66 punch blocks, install No. 2 AWG solid bare tinned copper wire to ground external line surge protection devices. Install the No. 2 AWG solid bare tinned copper wire in accordance with the SPD 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 the extent and schedule for all land clearing activities with the Engineer 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. 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.

Ensure that all gates are made of the same material as the fence. Construct sliding gates in accordance with Index No. 803 and configure as shown in the plans. Provide a hardened, four digit combination gate lock. Set the combination as directed.

785-5.3.7 Fence Grounding: Ensure that the metal Type B fence is grounded to fence perimeter ground wires consisting of No. 2 AWG solid bare tinned 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 No. 2 AWG solid bare tinned copper wire. 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 No. 2 AWG solid bare tinned copper wire. 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 No. 2 AWG solid bare tinned copper wire connected to the fence posts. Connect the fence perimeter wires to the ground rods of the equipment shelter's ground system with No. 2 AWG solid bare tinned copper wire, as shown in the plans.

Ensure that all ground leads are No. 2 AWG solid bare tinned 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.

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 performance turf 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. 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. Measure the resistance at each ground rod using a clamp-on earth tester. The measurement at any individual rod will be the cumulative resistance of all rods in a parallel circuit. The grounding system resistance must be no more than 5Ω. 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, 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 SPDs, 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 Lowering Devices: Ensure that the lowering devices furnished, assembled, fabricated, or installed are warranted by the manufacturer 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 Surge Protective Devices: Provide a SPD 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 SPD device manufacturer's standard warranty period, whichever is greater.

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

Parallel-connected, power-rated SPD 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 SPD device or a signal lead is permanently connected to ground.

In the event that the SPD, including any component of the unit, should fail during the warranty period, the entire SPD shall be replaced by the manufacturer at no cost to the Department. Costs relating to the removal of the SPD, shipping and handling, and the reinstallation of the SPD shall be paid by the Department.

785-6.4 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 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.

785-6.5 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 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.