7850000 INTELLIGENT TRANSPORTATION SYSTEMS – INFRASTRUCTURE
COMMENTS FROM INTERNAL/INDUSTRY REVIEW

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Chris Sweitzer
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Comment: (6-29-10)
1. 785-2.3.1, in the last sentence, "Lighting" should be "Lightning" in the title of NFPA 780.

Response:

2. 785-4.2.9.6.3, suggest using "shall" rather than "must" to conform with general practice in the Specifications.

Response:

3. 785-5.3.10: Please replace "grass" with "performance turf" to match the wording in 570.

Response:

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Bruce Leach
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Comments: (7-1-10)
This spec. does not define how many ground rods are to be installed. It leaves contractors NO WAY To ESTIMATE this item.Very subject to a CLAIM.

Response:

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Peter Vega
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Comments: (7-1-10)
Section 785-5.3.6Fencing – Section only references the use of sliding gates for the equipment shelter gate. The smallest gate referenced by Index 803 is a 12’ sliding gate. Using this minimum size gate would increase the overall width of the fencing to accommodate the gate. We normally use a five foot swing type gate. The use of swing gates should be allowed.

Response:

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Florida Department of Transportation District 6

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Comments: (6-26-10) (Internal Review)

Please see attached D6 ITS review comments. Overall, the revisions are thought out and will make for clearer and open Standards. However, ITS D6 does have some concerns about the removal of certain previous requirements. ITS D6 would like these requirements to remain, or if necessary, reworded, but not deleted to avoid different interpretations.

1. 785-1 - Add APL requirement for all devices.
2. 785-2.1 – Disagree with the proposed change "Furnish and Install" is more direct and explicit than "Provide". Also, not sure why TBSS is being changed to SPD.
3. 785-2.1 – Spell out "MSTCSD" and other abbreviations throughout the specification.
4. 785-2.2 – Disagree with removing this statement entirely from the specifications "Install a SPD both ahead of and behind (i.e., on the supply side and load side of) the ITS device electronics". However, this requirement can be moved under the 785-2.3 Installation Requirements.
5. 785-2.3.1 – Description provided is in the Design Standards already. Hence, what is the purpose of repeating it? Also, make sure that description provided is consistent with Design Standards. Leave this section unchanged. Current requirement is good and does not need deletion.
6. 785-2.3.1 – Why is the requirement being reduced from multiple ground rods to four 20 feet rods? For locations where the 5 ohm requirement is not met even with multiple ground rods and with the removal of grounding augmentation, please detail what direction should the Engineer follow for approving these sites? Leave this section unchanged, especially leave grounding augmentation specifications as is. Current requirement is good and does not need deletion.
7. 785-2.3.2 – "All ground rods and connections must remain accessible for inspection, testing, and maintenance." Does this mean the Contractor needs to install multiple pull boxes? How will the effect quantity overruns for regular design bid projects? This statement needs further clarification as we may not want to end up with "radial" installed pull boxes at each ground rod connection.
8. 785-2.3.3 Provide a test procedure for the "fall-of-Potential" method mentioned in this section, or do not change; that is, cite IEEE Standard as is done with current Standard Specifications.
9. (blank)
10. 785-2.4.2 – SPD at Power Entry Point: "The results of testing this device maximum let-through voltage…shall be submitted for approval and for equal consideration…" Is the Engineer supposed to review and approve these test results? Need to mention APL approval requirement for these devices.
11. 785-4.2.9.6.2 – Automatic Transfer Switch: Suggest addition of "if shown on plans", an automatic transfer switch may be used…
12. 785-5.3.4 – ITS Shelter: Why delete this requirement from this section "Connect them to the existing grounding system with no less than the minimum wire size specified in 785-2, or the manufacturers' recommended wire size, whichever is larger, typically a AWG #2 solid bare copper wire". Current requirement is good and does not need deletion.

13. 785-5.3.4.1 - Interior Grounding – The revised spec calls for “green insulation” and not the actual size. Also, why are all references to AWG #2 deleted in this section? Current requirement is good and does not need deletion.

Response:

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Comments: (6-25-10)
I am curious as to how we decided to change ‘Furnish’ to ‘Provide’ throughout the document. Will this be a blanket change in all of our ‘Furnish’ specifications in FDOT standard specs or is this one special for some reason? I hesitate to change the word (legally), as the pay item description and subsequent pay item section is still labeled ‘Furnish’ and ‘Install’. Will there be ambiguity from the contractor because he does not have to ‘Furnish’ but rather ‘Provide’? Could this be misinterpreted as ‘Provide for’?

There is a lot of abbreviating throughout the document, and instead of “proper grammar” of spelling out numbers under ten, we are exchanging those numeric words for actual numbers. The numbers thing is not a huge deal, but it does represent a non-blanket change for the FDOT standard specifications. Some other abbreviating that stands out to me: “100 cubic feet per minute” is now “100 cubic feet per min.”. However, abbreviating ‘minute’ to ‘min’ is not consistent throughout the document.

Section 785-2.3.1:
“Submit site resistance measurement to the Engineer for review, consideration, and further direction”. My comment – Then what? We took out augmentation altogether as an alternative to not meeting grounding resistance, so I’m not sure what the Engineer with ‘consider’. The decision from one Engineer to another varies greatly and the costs could be all over the place for their solution. I could see this as being a potential problem for the Engineer during post design services, unless there are alternative solutions spelled out.

I see we’ve removed the augmentation due to the maintenance nightmare it creates (i.e. forms a solid, one strike and it’s basically a sheet of glass, etc). Has anyone done any research for other possibilities if we cannot reach 5 ohms? The alternatives the Engineer has available are not really spelled out.

Section 785-2.3.2 and 785-5.3.4.2:

"All ground rods and connections must remain accessible for inspection, maintenance….". My comment – This should be elaborated on that they must not remain 'above ground' do to mowing, exposure, etc., but rather "accessible" through a covered pull box.

That is my two cents so far, but I'd like to add your comments and submit them to FDOT as a whole. I'd like you all to review this spec. since it is likely very near and dear to our hearts when the owner comes back to the designer complaining of multiple failures at a location, due to surge and grounding, etc. It only takes an hour or two, so please do what you can.

Response:

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Comments: (6-29-10)
I have reviewed the above industry review specification. My only comments are to confirm that the following terms are defined somewhere in the section:

MSTCSD
AWG
NFPA 780
NPT
APL

Response:

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Martin A. Maners, III
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Comments: (7-13-10)
Our company has provided camera lowering systems throughout the state of Florida and the world. In fact, the first lowering device for CCTV was deployed by FDOT back in 1997 and provided by our company. To date, we remain the ONLY Camera Lowering Device Provider Listed on FDOT's APL. APL #78561601215013

We have a number of comments and concerns with the proposed specification change. In general, it seems that while some items are being given more stringent technical requirements it seems the most important technical aspects of a lowering device are being cast out. At the least, the logic behind many of the changes is confusing. Pursuant to your June 24, 2010 MEMORANDUM advising of proposed specification changes, **please find attached our official**

and specific set of comments in WORD document format.

I urge you and others to give these commented items serious review. I remain available for discussion via phone or even in person for those involved with this review. I will even be available to bring applicable component parts for your in persons examination and review. A final approval of the specification change pertaining to lowering device as originally proposed would mark a significant step backwards from the quality, performance and field support of the product currently supplied to FDOT. I certainly hope your receive a vast amount of additional comments from consultants, engineers and contractors statewide. Lastly, I would like to request the names of any other persons within FDOT responsible for final determination on these proposed specification changes. Please forward these (if there are any) to my attention.

Comments are provided in BLUE below to distinguish between current spec language and FDOT proposed new language in RED.

Comments provided by: Martin A. Maners, III / Vice President & General Counsel for MG Squared. Of note, MG Squared provided the first camera lowering device in the world in Jacksonville, FL in 1997. MG Squared together with ITS Products were the first camera lowering device on the FDOT APL (over a year ago) and as of June 2010, remain the only camera lowering device on the APL. I remain open for further discussion on any of these points below and can be reached at 205-823-6688 or martin@mgsquared.com

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

It should be noted that the Pole Fitter and the Disconnect unit Fitter are to be considered part of the "system support arm" for purposes of this requirement. Another lowering device provider experienced "cracks" or "failures" on the Pole Fitter which is where the support arm inserts. Without the inclusion of these fitters, while an arm (in between these fitters) may meet the strength requirements… the fitter may not… and continued failures of what previously happened is permissible.

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.*

The lowering device must be provided with 100 feet of composite power and signal cable prewired to the lowering device at the factory unless otherwise 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.*

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" NPT pipe connection point for attaching a camera. Ensure that the equipment connection box has an ingress protection rating of no less than IP55.
It is interesting that the specification fails to give any minimum requirements as to the weight of this box. It has been proven that without this box weighing at least 40-50lbs, due to the light weight of the cameras… the cameras would be easily subjected to wind either slamming them against the side of the pole during the raising and lowering operation or even wrapping the camera around the pole. We have successfully demonstrated in many installations in Florida and on the Sunshine Skyway Bridge in particular that a camera junction box (or Equipment Connection Box as you call it) weighing close to 50lbs ensures the camera not be overly swayed/pushed in winds gusting up to 40mph. This specification already lacks significant detail for this component… failing to have a minimum weight requirement could result in camera damage or worse.

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. This is an outdated latch strength rating. Current equipment and the system currently on the APL carries a strength rating of 600lb with 4:1 safety factor. Specifying anything less here than what is available in the industry simply compromises the ultimate safety of the system. 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~~, ~~e~~*E*nsure that all ~~weight~~ *load* is *transferred*~~removed~~ 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 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. There is no need to identify a maximum number of contacts at 20. For at least 10 years now in the State of Florida (and elsewhere), lowering devices have been provided with 14 contacts… which has

been more than adequate to meet the needs of today's dome cameras. Most cameras are utilizing between 8-10 contacts (and sometimes less). Requiring a 20 pin max connector is not representative of what is utilized. Of further note, the Lowering Device currently on the APL is based upon a 14 pin configuration. 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 VAC, 9-24 VAC, and 9-48 VDC 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. NOTE… documentation regarding the actual pin assisgnment will always be the responsibility of the camera installer/integrator. Lowering devices come with numbered or colored pins/wires and it has always been the discretion of the installer/integrator as to which number/color will be assigned a particular function.

~~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.*09*~~102~~ inch in diameter *and firmly affixed to the connector block*. ~~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.~~

The proposed spec has made two critical depreciations in quality of connector with the above language or lack thereof. Specifically, it is odd that the minimum pin diameter has been reduced from 0.102 to a 0.09 diameter. The lowering device currently on the APL utilizes a pin diameter of at least 0.125 diameter. Reducing the diameter of the pin will always equate to a less durable pin, less surface contact area and less capacity of handling/surviving transient surges. The specification should follow at least what is currently on the APL.

Secondly, the proposed language has eliminated both the requirement of a durable material actually designed for outdoor use as the connector block body… as well as the requirement that the male contacts create a moisture tight seal when mated. The connector is the Heart of the

lowering device. Failure here will cripple the ITS deployment. Time and circumstance have proven that the best material with extreme heat and cold resistance is synthetic rubber. The pins must be more than "FIRMLY AFFIXED TO THE CONNECTOR BODY"… they should be Molded into the body. A connector body fabricated from rubber will allow this. When the pins are molded into the body, there is no risk for the pins to "push out or become dislodge" in their respective sockets after countless insertions. Also, by requiring the connector body to be a molded rubber also allows the requirement of "O-rings" or "shoulders" at the base of each male which enable the male to actually seal when engaging the female.

I find it odd that the proposed specification goes to great length at requiring the Equipment connection box and the disconnect unit housing to have an ingress protection rating, but fails to give any requirement for the actual Electrical contact block that is responsible for providing continuous signal through the life of the system regardless of the weather. One must understand that despite requiring the Disconnect Unit Housing (The Bell Housing that encloses the contacts) to be IP55… there will still be a large and regular amount of condensation occurring within the Disconnect Unit Housing. That considered, the two halves of the contact block MUST provide a means for sealing each individual pin. The language struck-through in this section pertaining to this should be reinstated. The lowering device on the APL currently utilizes a synthetic rubber contact block where the pins and wire leads are permanently molded into the block and the male pins have "o-rings" at the base of each creating a moisture tight seal when mated. The FDOT specification should require nothing less.

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 pounds; a quick release cable connector, and ~~an adjustable safety clutch~~*a torque limiter that will prevent over-tensioning of the lowering cable*. It should be noted that the portable lowering tool shall come with a manual hand crank. The additional language is unclear as to whether the torque limiter is to be a piece of equipment utilized with the electric drill (as in the past) or if such is to be incorporated into the manual hand crank. It appears language further below expects the provider to include this torque limiter as part of the manual winch handle. Please clarify. 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. The specification fails to address how the pole is affixed to the respective poles. The most reliable and safe manner has been to require the lowering tool to actually fasten to the pole/handhole itself. This is typically accomplished by a simple ½ inch bolt passing through the winch frame and into the pole itself. For safety sake… this should be added. Ensure that the lowering tool is equipped with a *winch with a minimum drum size width of 3.75"* (The winch used across the country and that is currently the design submitted and approved on the APL utilizes a drum size width of 2.0". This allows up to 125ft of winch cable to be spooled. It is unclear why FDOT desires to increase the size which will changes the standard model to a more expensive winch. Please reconsider.) *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 (and self re-setting… if it is not self resetting then getting the winch re-operable after a over torque event may cause unnecessary delay at best or difficulty*

at worst) 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.

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.

All roller fairlead frames shall be corrosion resistant stainless steel or aluminum It is unclear why this comment appears here within the "Lowering Tool" section. Roller fairleads are applicable to the standard External Mount system as is currently on the APL. NOTE… if the new requirement listed further below under the External Mount Device pertaining to a 3" conduit vs. a 2" conduit… then roller fairleads will NO LONGER BE USED.

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. Please state clearly if the minimum of "one lowering tool" is to include the electric drill and clutch mechanism. The manual hand crank alone often suffices for poles less than 70ft. One can manually crank down a camera from 50ft in less than 90 seconds. A drill/clutch assembly allows such to happen in about 38 seconds.

785-3.2.4 Lowering Cable: Provide a lowering cable with a minimum diameter of 0.125 inch. *The cable must be* ~~Construct it of~~ stainless steel *type 316* aircraft ~~cable~~ *type (7strands x 19 gauge)* with a minimum breaking strength of 1,7640 THE number 4 should be removed pounds, ~~and with 7 strands of 19-gauge wire each~~. *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 1760 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. The ONLY way one can ever ensure that the lowering cable will never contact or twist with other cables in the pole is to require the lowering cable to be contained within conduit. Even if an installer should successfully keep the lowering cable separate from the power/signal cables during the initial install… we have seen instances where DOT went back a year or more later and had a RTMS unit or antenna installed on the same pole. In doing so, the installer (different than the one on the initial project) unknowingly drops the cable for the new equipment down the pole and tangles such with the lowering cable. In section ***785-3.3.1 General further below… the specification does make mention of the requirement of 1.25 inch PVC conduit to house the lowering cable. Basically, that requirement would be more appropriate here in the section actually on lowering cable.***

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 respective (i.e.,general/light or heavy-duty) This language about light or heavy duty connectors should be removed here and to simply reflect or acknowledge that all of the previous sections on lowering devices still apply here unless specifically noted otherwise lowering device. Ensure that the system includes a winch assembly permanently housed in a corrosion- resistant lower lockable *pole-mounted cabinet* ~~box with gaskets, as shown in the plans~~. *Ensure the upper mounting/junction box includes a maintenance access door with captive attachment hardware.* Provide all necessary mounting hardware ~~for the upper and lower box~~, conduits, standoffs, and conduit mounts required for a complete and functional system. This has always been the responsibility of the installation contractor or integrator.

Ensure the cabinet minimum dimensions are 12" x 18" x 10" 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". 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" 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 2 keys with each cabinet. The cabinet door handle must include a lock hasp that will accommodate a padlock with a 7/16" 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" at the lower winch cabinet entrance and allow the lowering cable to wind evenly on the winch drum without binding. The Device currently on the APL utilizes 2" conduit mount for both the upper and lower boxes. Increasing to a minimum 3 inch INSIDE Dia. Will increase the costs unjustifiably. Reconsider. All conduit couplings and connections between the pole-mounted cabinet and upper mounting/junction box must be watertight

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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. This requirement of 1.25 inch PVC conduit ONLY applies to the lowering device being mounted on a properly customized concrete or steel pole. This does not apply to the External System specified immediately prior.

785-3.3.1 ***2*** **Concrete Poles:** Install foundation and pole in accordance with 641-4.2, except footing dimensions shall be in accordance with Design Standard 18113.

785-3.3.2 ***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 that on-site instruction regarding the safe operation of the lowering system is provided by the lowering device manufacturer. Contractors responsible for the installation of a lowering device must be certified by the lowering device manufacturer. This certification must show evidence that the installer has been trained in the proper and safe installation and inspection of the manufacturer's lowering device system.*~~

~~*Ensure that any personnel responsible for operation or maintenance of the lowering device are trained and certified by lowering device manufacturer or a contractor certified by the lowering device manufacturer.*~~

Removal of the above language seriously compromises the safety and operation of the entire system. This kind of language has and continues to exist in the specification for Highmast Light towers… and justifiably so. It is unclear why FDOT would desire to remove a key safety driven specification. By requiring the installation contractor on a job by job basis to receive authorized factory oversight of the first 2-3 lowering systems installed on a job it greatly increases the potential for a safe and proper installation. Further, it affords them as well as local maintenance personel to receive hands-on operation training. Considering the millions of dollars spent on ITS camera deployments, the relatively small cost adder for such a requirement is well worth the time and effort.

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. It is unclear whether this preceeding sentence is addressing the external mount or internal mount system. It should clarify as the Internal Mount system. 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. Again, wire function labeling is the responsibility of the installer/integrator.

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. The only way this can be ensured is by proper adherence to the written or in person directions provided by the lowering device manufacturer. 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. The only way this can be ensured is by proper adherence to the written or in person directions provided by the lowering device manufacturer. Ensure the lowering cable strands do not twist or unwind when the lowering device is operated.

~~*Ensure that power and communication cables attached to the lowering device are secured and do not move when the lowering system is being operated. Label all wire leads with their function, label spares as spares.*~~

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

Response:

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Comments: (7-21-10)
I would remove reference to the IEEE C62 series specifications. These are wonderful guidelines for design, but are largely applicable to a controlled test environment and not really construction friendly. I did notice that the spec references a Section 620 which states: • "Use solid No. 6 AWG copper insulated (green) conductor for electrical or lightning protection ground from the system ground bus or barrier plate(s) to the grounding electrodes and from grounding electrode to grounding electrode." While the modified spec states: • "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." I think the Section 620 should be updated and changed to reflect using a #2 AWG wire from electrode to electrode. The Bill Cook modifications delete the distance the main ground electrode is placed from the ITS device or structure. This distance is referenced in Index #18102 which states min 12" and max 36" from structure. I added a reference (within 3') shown in green. Bill had also deleted reference to the wire size for the ITS Equipment Shelter "halo" ground wire. Per ANSI J-STD-607-A, Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications the minimum bonding conductor size shall be a #6 AWG. I made this change also shown in green. Otherwise, Bill has done a very good job with his spec changes.

Response:

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Comments: (7-21-10)
785-3.2.2.2.2 Connector Block: Our standard connector has 14 pins, 20 pins can be provided if necessary on a particular project. By taking out all sealing requirements the connector may be subject to weathering and corrosion. Sealing around each pin assures the best protection and longest life of the contact block 785-3.2.3 Lowering Tool: I would add that the torque limiter be a non-friction self re-setting type to assure that you will get the type of torque limiter that was provided to TERL as a sample. 785-3.3.4 Lowering Device: I strongly recommend that the on-site installation and operation instruction be re-instated in the spec.

Response:

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Comments: (7-22-10)

As stated in the accompanying email, the District Seven ITS Project Manager Vaughn Cooper, P.E., chaired a meeting with industry professional to review and comment on the proposed changes and existing content of FDOT Supplemental Specification 785. Below is a compilation of the comments that were arrived at with consensus by all present.

1. Section 785-2.2: Due to some discrepancies with Section 620, please add the following: "…Section 620. If this section differs from Section 620, this section shall govern."
2. Section 785-2.2, Second Paragraph: Change "connection" to "circuit."
3. Section 785-2.3.1: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:

a. Salinity of soil can dramatically affect the maintenance of ground rods. Thus, utilizing stainless steel ground rods in these environments should be considered to reduce future maintenance expenses.
b. South Florida has allot of coral that makes it very difficult to drive a ground rod to depth. Therefore, angling or placing horizontal is an option.
c. A minimum of two ground rods should be used for redundancy.

785-2.3.1 General: Ensure that the grounding rod electrode assemblies used in the grounding system consist of a minimum of 2 copper-clad ground rod electrodes unless the plans identify a high concentration of salinity in the soil, in which case stainless steel ground rods shall be used as shown in the plans. 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. If the depth of ground rods cannot be achieved, angled or horizontal installation, ranging from 20 feet to 40 feet, may be permitted at the discretion of the Engineer at no additional cost. Bond the grounding system to a main ground bar within the site equipment cabinet. A two ground rod electrode array bonded to the equipment cabinet constitutes a minimal grounding system with a main and secondary ground rod array. If this array does not achieve a resistance to ground of 5 ohms or less, install additional 20-foot grounding rod electrode assemblies and connect them to the main grounding rod electrode array. If the array still does not achieve a resistance to ground of 5 ohms (Ω) or less, install additional 20 foot grounding rods , spaced 40 feet apart, until 5 ohms is achieved. References for this section include, but are not limited to: UL467 (Latest Edition), Grounding and Bonding Equipment (Latest Edition); UL497A, Standard for Secondary Protectors for Communications Circuits (Latest Edition), and the NEC (Latest Edition). Ensure that lightning protection systems conform to the requirements of NFPA 780, Standard for the Installation of

Lighting Protection Systems (Latest Edition).

4. Section 785-2.3.2: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:

a. One of the biggest issues during construction and maintenance is not properly creating a neutral-ground bond. By having the contractor identify it, two things happen. The first is that the contractor needs to acknowledge it. The second is that the CEI now knows to look for it.
b. Accessing the ground rod needs to be defined so that it can be measured. Therefore, clarifying accessibility would be advisable.
c. Mechanical connections oftentimes include split bolts, which are problematic for maintenance. Requiring a compression mechanical connection eliminates this issue.

785-2.3.2 Grounding Specifications: Provide a grounding system as shown in the plans. Ensure that grounding rod electrodes are listed according to UL requirements as detailed in the standard UL 467. Identify the neutral-ground bond and ensure that it meets the requirements of the NEC (Latest Edition). Make all connections to the grounding electrode using exothermic welds The two ground rods in the primary array must remain accessible for inspection, testing, and maintenance as shown in the plans. Accessible is defined as 6-8" of ground rod exposed in a pull box such that a "fall of potential" or "clamp-on" meter can access the ground rod for testing. Subsequent ground rods, in addition to the two primary rods, installed to improve the array resistance, may be below grade and not accessible for inspection after completion of the ITS site. These will be interconnected to the primary array with #2 AWG solid tin plated copper wire and exothermically welded at all connection points.
Connect all grounding electrodes related to the ITS device and any grounded electrical system within a 100-foot radius (but not beyond the edge of the roadway pavement or onto private property unless permanent access has been obtained) 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 "T" configuration. In the event that the "T" 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.
Install the main grounding rod electrode in the electrical pull box 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 compression mechanical connection on the equipment side and an exothermically welded connection at the down cable.

5. Section 785-2.3.2: Suggest utilizing a 24x13 or 12x12 pull box without a concrete apron to provide access to the second ground rod. A detail in the Standards may be advisable.
6. Section 785-2.3.3: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:

a. The Fall-of-Potential Method is not widely understood. Therefore, clarification is advisable.

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. It is acceptable to use the 62% procedure which states that the "P" probe measurement will be located at the 62% distance between the earth rod and the "C" test probe. That includes the 52%, 62% & 72% readings showing that the resistance results do not deviate by more than +/- 10 feet between the 52% – 62% reading and the 62 – 72% reading. It is essential to test that the 62% point is outside of the "sphere of influence" of the grounding array. Using these three reading will clearly identify that the 62% is truly the resistance of the array. If the difference between the 52% & 62% points is greater than 10 feet then the "C probe must be move further from the array under test and a new 62% point established. This must be continued until the 52% – 62% and 62% – 72% readings are within the acceptable 10 foot value. 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. Certify and sign the test results submitted.

7. Section 785-2.3.3: Has a required level of certification been considered. This is a general comment not only for 785, but also for the entire 780 series.
8. Section 785-2.4.1: There is no introduction of the low-voltage SPD's. Suggest adding the following at the end of the paragraph: "Provide a specialized SPD at both ends of all low-voltage connections between the device and its operating subsystems, except when the device and the subsystems are mounted such that they are on the same structure and the cable does not proceed below ground. In which case only one SPD will be required prior to the operating subsystem unless otherwise shown in the plans."
9. Section 785-2.4.2: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:

a. This section was modified based on research of existing SPD's in the industry.

785-2.4.2 SPD at Power Entry Point (Primary SPD): Install a SPD at the closest termination/disconnection point where the 120-volt (V) 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 V single phase (i.e., line, neutral and ground) or 120/240 V 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, (Latest Edition).

Ensure that the SPD for the ITS device's power source has an operating voltage of 120 V single phase and a maximum continuous operating voltage of no more than 150 V single phase. The SPD shall be rated at a minimum of 50 kiloamps (kA) per mode, and a minimal nominal current (In) of 10 kA based on the UL1449 (Latest Edition) tests. Each individual MOV shall be a minimum of 20 KA. The results of testing this device for let-through voltage will be indicated on the UL label on the

device and can be verified by accessing the UL web site (www.ul.com) and verifying the UL test results..
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.

10. Section 785-2.4.3: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:
    a. This section was modified based on research of existing SPD's in the industry.

785-2.4.3 SPD at Point of Use (Secondary SPD): Install a SPD at the point the ITS devices receive 120 V power. The device will be a "series" connected SPD device. Ensure that the units are rated at 15 or 20 amps load and a minimum In of 3kA of surge current capacity. Verify that the SPD has been labeled to indicate that the unit is UL recognized or UL Listed (Latest Edition).
Ensure that the SPD at point of use has an operating voltage of 120 V single phase and a maximum continuous operating voltage of no more than 150 V single phase. Ensure that the SPD is rated at a minimum of 3 kiloamps (kA) In per mode as defined by UL 1449 (Latest Edition).
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 common mode (L+N-G) protection.

11. Section 785-2.4.4: A number of changes are suggested. The modified section is shown below. Also, please see the modified specification with "track changes." The reasoning is as follows:

a. The wording supply and load side has presenting difficulties in construction with regards to the contractual requirements, since supply and load side is relative to what you consider your demarcation point.

785-2.4.4 SPD for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized SPD at both ends of all low-voltage connections between the device and its operating subsystems, except when the device and the subsystems are mounting such that they are on the same structure and the cable does not proceed below ground. In which case only one SPD will be required prior to the operating subsystem unless otherwise shown in the plans. 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 that optimizes performance with maximum let-through voltage as shown in the accompanying table.

TABLE NOT SHOWN.

Install a SPD that has an operating voltage matching the characteristics of the circuit.

12. Section 785-3.2.1: Define what "sufficient size" of the hand hole is it relates to minimum dimensions. There have been maintenance concerns in the past when the hand hole has been too small.
13. Section 785-3.2.2, fourth paragraph: Add the following at the end of the paragraph: "… plans or unless additional cable is required due to the height or configuration of the mounting structure."
14. Section 785-3.2.3, first paragraph: add "at a minimum" after "electric drill."
15. Section 785-4.2.9.3: Change the bus bar to accommodate a 2 AWG copper wire, since this is the size of wire being used for the grounding array.

Response:

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District ITS Program Manager
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Comments: (7-23-10)
(Document attached)

Response:

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Comments: (7-22-10)
(Document attached)

Response:

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Comments: (7-22-10)

Comments from Blackhawk Enterprises and Camera Lowering Systems (NorthStar Lighting) are provided in Green.

Comments are provided in BLUE below to distinguish between current spec language and FDOT proposed new language in RED.

Comments provided by: Martin A. Maners, III / Vice President & General Counsel for MG Squared. Of note, MG Squared provided the first camera lowering device in the world in Jacksonville, FL in 1997 (this first lowering device was actually manufactured by Camera Lowering Systems and distributed by MG2, not manufactured by MG2). MG Squared together with ITS Products were the first camera lowering device on the FDOT APL (over a year ago) and as of June 2010, remain the only camera lowering device on the APL.
(The CLS product has been submitted to TERL and is awaiting APL listing at this time). I remain open for further discussion on any of these points below and can be reached at 205-823-6688 or martin@mgsquared.com

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. *The lowering device system support arm must be capable of withstanding service tension and shear up to 1 kip (kilopound) minimum.*
It should be noted that the Pole Fitter and the Disconnect unit Fitter are to be considered part of the "system support arm" for purposes of this requirement. Another lowering device provider experienced "cracks" or "failures" on the Pole Fitter which is where the support arm inserts. Without the inclusion of these fitters, while an arm (in between these fitters) may meet the strength requirements… the fitter may not… and continued failures of what previously happened is permissible. ***This is total heresay and conjecture. The CLS lowering device has been successfully tested to the FDOT TERL strength requirements by independent laboratories. Mr. Maners refers to former failures and continued failures of competitors equipment. Once again, this is heresay. You can ask FDOT personnel in District Offices and at TERL, and they will attest that there have been failures of the MG2 system in the State of Florida. We do not engage in smear campaigns against our competition, and we let our product value, quality and service sell our product for us.***
We do agree that the castings between the arm be included as part of the support arm. A recent test by an independent testing laboratory proves that Camera Lowering Systems meets or exceeds the FDOT TERL strength requirements.

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. The lowering device must be provided with 100 feet of composite power and signal cable prewired to the lowering device at the factory unless otherwise 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.*

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" NPT pipe connection point for attaching a camera.* Ensure that the equipment connection box has an ingress protection rating of no less than IP55.

It is interesting that the specification fails to give any minimum requirements as to the weight of this box. It has been proven that without this box weighing at least 40-50lbs, due to the light weight of the cameras… the cameras would be easily subjected to wind either slamming them against the side of the pole during the raising and lowering operation or even wrapping the camera around the pole. We have successfully demonstrated in many installations in Florida and on the Sunshine Skyway Bridge in particular that a camera junction box (or Equipment Connection Box as you call it) weighing close to 50lbs ensures the camera not be overly swayed/pushed in winds gusting up to 40mph. This specification already lacks significant detail for this component… failing to have a minimum weight requirement could result in camera damage or worse.

We agree that in most cases counterweight(s) should be provided with the junction box for the purposes stated above. Depending on the weight of the junction box itself, the height of the pole, other circumstances like on a bridge, etc., the amount of weight can vary. We do not believe that an absolute weight needs to be defined, but maybe a statement to the effect *"the weight of the junction box (camera connection box) should weigh at least 40lbs. The weight should be sufficient to prevent the camera from swaying or hitting the pole during the raising/lowering process".*

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.

This is an outdated latch strength rating. Current equipment and the system currently on the APL carries a strength rating of 600lb with 4:1 safety factor. Specifying anything less here than what is available in the industry simply compromises the ultimate safety of the system.

We do not have issue with this proposed change to the specification. It is known that both commercially available lowering devices used a 200lb with 4:1 safety factor for many years and has had no problems. The 600lb. with 4:1 safety factor basically became a game of specmanship, (totally irrelevant to the performance of the system in this application). Both products currently exceed this newer spec.

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, e*E*nsure that all weight *load* is *transferred* removed 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 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.

There is no need to identify a maximum number of contacts at 20. For at least 10 years now in the State of Florida (and elsewhere), lowering devices have been provided with 14 contacts… which has been more than adequate to meet the needs of today's dome cameras. Most cameras are utilizing between 8-10 contacts (and sometimes less). Requiring a 20 pin max connector is not representative of what is utilized. Of further note, the Lowering Device currently on the APL is based upon a 14 pin configuration. **In our typical application we have video (2 wires), data (5 wires) and power (2 wires) for a total of 9 required pins. There may be instances where multiple cameras are installed on the same lowering device, which is why a higher number has always been specified.** 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 VAC, 9-24 VAC, and 9-48 VDC 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.

NOTE… documentation regarding the actual pin assisgnment will always be the responsibility of the camera installer/integrator. Lowering devices come with numbered or colored pins/wires and it has always been the discretion of the installer/integrator as to which number/color will be assigned a particular function.

To date, we agree with the comments above that color assignment is the responsibility of the installing Contractor. The State may want to consider standardizing on a cable construction and color coding, and therein specify the assignments of each conductor. Several other states have implemented this methodology for consistency of wiring on all lowering devices from any manufacturer. South Carolina DOT was the first to adopt such a methodology.

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.*09*102 inch in diameter *and firmly affixed to the connector block*. 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.

The proposed spec has made two critical depreciations in quality of connector with the above language or lack thereof. Specifically, it is odd that the minimum pin diameter has been reduced from 0.102 to a 0.09 diameter. The lowering device currently on the APL utilizes a pin diameter of at least 0.125 diameter. Reducing the diameter of the pin will always equate to a less durable pin, less surface contact area and less capacity of handling/surviving transient surges. The specification should follow at least what is currently on the APL.

We strongly disagree with our competitor's statements above. The statements are made with nothing to support or substantiate the statement. A .09" diameter pin is an extremely durable pin and has never bent or degraded in any way. The .09" diameter pin has a U. L. current rating of 20 Amps and will handle any surges coming from the cabinet. The original State of Florida specifications were written around the legacy MG2 specification/product, and then opened up for competition which is good for the state of Florida. "Less durability and less capacity of handling transient surges" is a false statement to get a product sole sourced. There is no hard data or proof that the .09 dia. pins are less durable. Further, these systems are carrying 1V p-p video signals and 5V RS-422 signals, with typically 24VAC power. Regular camera cables, and data cables, typically use 22ga or 24ga. wires. Anything larger is not necessary.

Secondly, the proposed language has eliminated both the requirement of a durable material actually designed for outdoor use as the connector block body… as well as the requirement that the male contacts create a moisture tight seal when mated. The connector is the Heart of the lowering device. Failure here will cripple the ITS deployment. Time and circumstance have proven that the best material with extreme heat and cold resistance is synthetic rubber. The pins must be more than "FIRMLY AFFIXED TO THE CONNECTOR BODY"… they should be Molded into the body. A connector body fabricated from rubber will allow this. When the pins are molded into the body, there is no risk for the pins to "push out or become dislodge" in their respective sockets after countless insertions. Also, by requiring the connector body to be a molded rubber also allows the requirement of "O-rings" or "shoulders" at the base of each male which enable the male to actually seal when engaging the female.

This paragraph is once again an effort to promote a sole source specification in the state of Florida. The CLS connector system uses an outdoor, high temp, extreme heat/cold resistant material in its construction. The difference is the pins are not molded into the connector body, but rather spring-loaded, locked, and entirely potted and sealed. When mated, the connector system is moisture resistant. There have never been any reports of pins becoming "pushed out" or "dislodged" in over 12 years of manufacturing these systems. The comments by our competitor are merely heresay.

I find it odd that the proposed specification goes to great length at requiring the Equipment connection box and the disconnect unit housing to have an ingress protection rating, but fails to give any requirement for the actual Electrical contact block that is responsible for providing continuous signal through the life of the system regardless of the weather. One must understand that despite requiring the Disconnect Unit Housing (The Bell Housing that encloses the contacts) to be IP55… there will still be a large and regular amount of condensation occurring within the

Disconnect Unit Housing. That considered, the two halves of the contact block MUST provide a means for sealing each individual pin. The language struck-through in this section pertaining to this should be reinstated. The lowering device on the APL currently utilizes a synthetic rubber contact block where the pins and wire leads are permanently molded into the block and the male pins have "o-rings" at the base of each creating a moisture tight seal when mated. The FDOT specification should require nothing less.

We strongly disagree with these comments for the reasons stated above. The CLS lowering device has been used throughout Florida, the U.S., and throughout the world with no problems reported with regard to the hypothetical potentials put forth by our competitor.

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 pounds; a quick release cable connector, and an adjustable safety clutch*a torque limiter that will prevent over-tensioning of the lowering cable*.

It should be noted that the portable lowering tool shall come with a manual hand crank. The additional language is unclear as to whether the torque limiter is to be a piece of equipment utilized with the electric drill (as in the past) or if such is to be incorporated into the manual hand crank. It appears language further below expects the provider to include this torque limiter as part of the manual winch handle. Please clarify.

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.

The specification fails to address how the pole is affixed to the respective poles. The most reliable and safe manner has been to require the lowering tool to actually fasten to the pole/handhole itself. This is typically accomplished by a simple ½ inch bolt passing through the winch frame and into the pole itself. For safety sake… this should be added.

We agree that the standard procedure for mounting the winch to the handhole in the pole is with a ½" bolt passing through into a threaded flange at the bottom of the handhole.

Ensure that the lowering tool is equipped with a *winch with a minimum drum size width of 3.75"* (The winch used across the country and that is currently the design submitted and approved on the APL utilizes a drum size width of 2.0". This allows up to 125ft of winch cable to be spooled. It is unclear why FDOT desires to increase the size which will changes the standard model to a more expensive winch. Please reconsider.)

We believe this larger drum is with regard to external mounted lowering devices and with permanently mounted winches in a cabinet at the bottom of the pole. Although a winch with a 2" drum width is supposed to hold 125ft of cable, the cable will only fit on the drum if it is wound perfectly on the drum. It will realistically handle approximately 80% of the cable, or 100ft. Winches in need of cable in access of 100 ft should use a wider drum.

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*

(and self resetting… if it is not self resetting then getting the winch re-operable after a over torque event may cause unnecessary delay at best or difficulty at worst)

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.

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. *All roller fairlead frames shall be corrosion resistant stainless steel or aluminum*

It is unclear why this comment appears here within the "Lowering Tool" section. Roller fairleads are applicable to the standard External Mount system as is currently on the APL. NOTE… if the new requirement listed further below under the External Mount Device pertaining to a 3" conduit vs. a 2" conduit… then roller fairleads will NO LONGER BE USED.

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.

Please state clearly if the minimum of "one lowering tool" is to include the electric drill and clutch mechanism. The manual hand crank alone often suffices for poles less than 70ft. One can manually crank down a camera from 50ft in less than 90 seconds. A drill/clutch assembly allows such to happen in about 38 seconds.

This is a generic spec. Individual project specifications typically dictate the qty of lowering tools required on a project. We don't believe these specifications should address any quantity. If someone was adding 1 lowering device onto an existing system where the DOT already had 10 lowering tools, they would not need another lowering tool.

785-3.2.4 Lowering Cable: Provide a lowering cable with a minimum diameter of 0.125 inch. *The cable must be* Construct it of stainless steel *type 316* aircraft cable *type (7strands x 19 gauge)* with a minimum breaking strength of 1,7*6*40 THE number 4 should be removed pounds, and with 7 strands of 19-gauge wire each. *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 1760 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.

The ONLY way one can ever ensure that the lowering cable will never contact or twist with other cables in the pole is to require the lowering cable to be contained within conduit. Even if an installer should successfully keep the lowering cable separate from the power/signal cables during the initial install… we have seen instances where DOT went back a year or more later and had a RTMS unit or antenna installed on the same pole. In doing so, the installer (different than the one on the initial project) unknowingly drops the cable for the new equipment down the pole and tangles such with the lowering cable. In section ***785-3.3.1 General further below… the specification does make***

mention of the requirement of 1.25 inch PVC conduit to house the lowering cable. Basically, that requirement would be more appropriate here in the section actually on lowering cable. We agree that a conduit should be provided inside each pole for the reasons listed. This is actually required and depicted in Florida Standard 18110.

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 respective (i.e.,general/light or heavy-duty)

This language about light or heavy duty connectors should be removed here and to simply reflect or acknowledge that all of the previous sections on lowering devices still apply here unless specifically noted otherwise

(the entire "heavy-duty", "light-duty" was an interim step to allow competition when the original specification was written sole source. The new goal was to have a single powering device that meets FDOTs requirements and allows competition without sacrificing safety or performance).

lowering device. Ensure that the system includes a winch assembly permanently housed in a corrosion- resistant lower lockable *pole-mounted cabinet* box with gaskets, as shown in the plans. *Ensure the upper mounting/junction box includes a maintenance access door with captive attachment hardware.* Provide all necessary mounting hardware for the upper and lower box, conduits, standoffs, and conduit mounts required for a complete and functional system.

This has always been the responsibility of the installation contractor or integrator.

Agreed

Ensure the cabinet minimum dimensions are 12" x 18" x 10" 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". 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" 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 2 keys with each cabinet. The cabinet door handle must include a lock hasp that will accommodate a padlock with a 7/16" 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" at the lower winch cabinet entrance and allow the lowering cable to wind evenly on the winch drum without binding.

The Device currently on the APL utilizes 2" conduit mount for both the upper and lower boxes. Increasing to a minimum 3 inch INSIDE Dia. Will increase the costs unjustifiably. Reconsider.

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.

This requirement of 1.25 inch PVC conduit ONLY applies to the lowering device being mounted on a properly customized concrete or steel pole. This does not apply to the External System specified immediately prior.

785-3.3.1 ***2*** **Concrete Poles:** Install foundation and pole in accordance with 641-4.2, except footing dimensions shall be in accordance with Design Standard 18113.

785-3.3.2 ***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 that on-site instruction regarding the safe operation of the lowering system is provided by the lowering device manufacturer. Contractors responsible for the installation of a lowering device must be certified by the lowering device manufacturer. This certification must show evidence that the installer has been trained in the proper and safe installation and inspection of the manufacturer's lowering device system. Ensure that any personnel responsible for operation or maintenance of the lowering device are trained and certified by lowering device manufacturer or a contractor certified by the lowering device manufacturer.*

Removal of the above language seriously compromises the safety and operation of the entire system.

This kind of language has and continues to exist in the specification for Highmast Light towers… and justifiably so. It is unclear why FDOT would desire to remove a key safety driven specification. By requiring the installation contractor on a job by job basis to receive authorized factory oversight of the first 2-3 lowering systems installed on a job it greatly increases the potential for a safe and proper installation. Further, it affords them as well as local maintenance personel to receive hands-on operation training. Considering the millions of dollars spent on ITS camera deployments, the relatively small cost adder for such a requirement is well worth the time and effort.

We agree that having on-site representation should be required for any contracting crew that has not been trained or installed a lowering device in the past. However, if a crew or personnel have been trained and have installed these devices in the past, we don't agree that the State should have to pay to have a factory representative on-site for every installation. Take the example that ABC Contracting just installed 40 lowering devices in District 4. If ABC Contracting bids another project to install 2 more devices in District 4 with the same personnel, why should they need to have the factory onsite?

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.

It is unclear whether this preceeding sentence is addressing the external mount or internal mount system. It should clarify as the Internal Mount system.

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.

Again, wire function labeling is the responsibility of the installer/integrator.

The State should consider a standard cable construction and color code to be followed for all installs of any lowering device.

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.
The only way this can be ensured is by proper adherence to the written or in person directions provided by the lowering device manufacturer.
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.
The only way this can be ensured is by proper adherence to the written or in person directions provided by the lowering device manufacturer.
Ensure the lowering cable strands do not twist or unwind when the lowering device is operated.
Ensure that power and communication cables attached to the lowering device are secured and do not move when the lowering system is being operated. Label all wire leads with their function, label spares as spares.
Provide manufacturer recommended field installation instructions, inspection instructions (including, recommended schedules and procedures), and operating instructions.

Response:

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John Roth, Sales Engineer
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Comments: (7-23-10)
785 Infrastructure, Table 4-1 - Values for Low-Voltage Circuits.
1. The power and control devices all have "up to 30A" as continuous current. A 12V device that can carry 30A would be incredibly expensive and have wires similar to your car battery. Don't think that fits an ITS application. They should be more realistic values. A 120V parallel device at 30A is reasonable.
2. The T-1 industry standard is 1.54MHz, not 100MHz. And it is 12Vdc
3. The Cat5 industry standard is 5Vdc and 100MHz. The 10/1000us waveform at 3kA is unrealistic. We know of no device on the market that can even approach that specification. 30Vpk at .5kA, 8 x 20us is realistic.
I have attached a spreadsheet, based on Table 4-1, that has industry standard specifications.
<<FDOT Infrastructure 785 Values for Low Voltage, Table 4-1.xls>>

Power to 12V	24575	Up to 30A	60Hz	5kA mode/line, 8x20us	<150Vpk, IEEE Cat B3/C1, 6kV/3kA <50Vpk, IEEE Cat A1 Ringwave 2kV
Power to 24V	24580	Up to 30A	60Hz	5kA mode/line, 8x20us	<175pk, IEEE Cat B3/C1,6kV/3kA <50Vpk, IEEE Cat A1Ringwave 2kV
Power to	24585	Up to 30A	60Hz	5kA mode/line, 8 x	<200Vpk, IEEE Cat B3/C1. 6kV/3kA

48V				20us	
					<50Vpk, IEEE Cat A1, Ringwave 2kV
Power to 120V	24572	Unlimited in	60Hz	13kA, mode/line, 8x20us	<550Vpk, IEEE Cat B3/C1, 6kV/3kA
	22035	Parallel	60Hz	20kA, mode/line, 8x20us	<50Vpk, IEEE Cat A1, Ringwave 2kV
RS422	24528	Up to 500mA	Up to 100MHz	10kA,mode/line, 8x20us	<30Vpk, IEEE Cat B3/C1, 6kV/3kA
RS485	24587	Up to 500mA	Up to 100MHz	10kA, mode/line, 8x20us	<30Vpk, IEEE Cat B3/C1, 6kV/3kA
T-1	24558	Up to 500mA	1.54MHz,	10kA, mode/line, 8x20us	<20Vpk, IEEE B3/C1, 6kA/3kA
CAT5	24540	Up to 500mA	100MHz	1kA, mode/line, 8 x 20us	<30Vpk, .5kA, 8x20us

Response:

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Comments (7-26-10)
(Document attached)

Response:

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Florida Department of *Transportation*

STEPHANIE KOPELOUSOS

605 Suwannee Street

OR **SECRETARY**

Tallahassee, FL 32399-0450

M E M O R A N D U M

DATE: June 24, 2010

TO: Specification Review Distribution List

FROM: Rudy Powell, Jr., P.E., State Specifications Engineer

SUBJECT: Proposed Specification: 7850000 Intelligent Transportation Systems - Infrastructure

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

This change was proposed by Gene Glotzbach to update technical requirements for Surge Protective Devices.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or to my attention via e-mail at ST986RP or rudy.powell@dot.state.fl.us. Comments received after **July 22, 2010** may not be considered. Your input is encouraged.

RP/ft Attachment

785 INTELLIGENT TRANSPORTATION SYSTEMS INFRASTRUCTURE. (REV ~~1-26-09~~*~~11-18-095-17-106-14-10~~6-22-10*) ~~(FA 2-4-09) (7-09)~~

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~~*Surge Protective Devices*.

785-2.1 Description: ~~Furnish and install~~*Provide* grounding and *surge protective devices (SPDs)*~~transient voltage surge suppression~~ for all ITS *infrastructure components* installed in the field or in remote locations to protect ~~this equipment~~*them* 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. *Ensure that all SPDs comply with the environmental requirements of section A615 of the MSTCSD.*

~~Install a *SPD*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 *SPDs*~~TVSS~~ on all power, data, video and any other conductive connection*s*. Use only equipment and components that meet the *minimum* requirements of th*is*~~ese minimum~~ specifications, and are listed on the Department's Approved Product List (APL).

785-2.3 Installation Requirements:

785-2.3.1 General: *Ensure the grounding electrode assemblies used in the grounding system ~~earthing array~~ consist~~s~~ of a minimum of ~~two~~2 copper-clad ground~~ing~~ rod~~s~~ electrodes coupled together. Each grounding electrode assembly must have a minimum length of 20 feet. Individual G~~g~~rounding electrode assembly sections must have a minimum length of 8 feet. Ensure that grounding electrodes have a minimum diameter of 5/8~~"~~-inch. ~~Interconnect~~ Bond ~~all~~ multiple grounding electrode assemblies to each other with ~~#~~No. 2 AWG ~~tinned~~ tin-plated bare solid copper wire that is ~~e~~xothermically welded at all connection points.*

Install a minimal grounding system that is a single grounding electrode assembly (also referred to as a main grounding electrode assembly) bonded to the main ground bar within the equipment cabinet. If this minimal grounding system does not achieve a resistance to ground of 5 ohms (Ω) or less, create a grounding electrode array by installing up to three additional 20-foot grounding electrode assemblies, spaced 40 feet apart, and bonding them ~~at a right angle~~ to the ~~primary array~~ main grounding electrode assembly. If this array does not achieve a resistance to ground of 5 Ω or less after each successive grounding electrode assembly is installed, submit the site resistance measurement to the Engineer for review, consideration, and further direction. ~~and if necessary, soil preparation that includes a grounding augmentation fill.~~

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 Lighting Protection Systems.

785-2.3.2 Grounding Specifications: *Provide*~~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

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Deleted: *grounding rod electrode*
Comment [CHC31]: Add the words "coupled together" at the end of this sentence? See Standard Specifications Section 620-3.2.
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Comment [CHC32]: Delete this sentence? This is already stated in Section 620-3.2 of the Standard Specifications.
Deleted: *ground rod electrode*
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Deleted: *rod*~~s~~
Comment [CHC33]: This is the phrase used in Design Standard Index Drawing 18102.
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Comment [CHC34]: The term "primary radial" is not defined anywhere – here, Standard Specs., or the Design Stds. Consider deleting this term. Also consider combining the first two sentences of this paragraph thus: "Install a minimal grounding system that is a single grounding electrode assembly (also referred to as a main grounding electrode assembly) bonded to the main ground bar within the equipment cabinet."
Deleted: *Bond the grounding system~~array~~ 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*
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Deleted: *install additional 20~~-~~foot grounding rod~~s~~ electrode assemblies ~~to any existing radial~~, spaced 40 feet~~-~~ apart, until 5 ohms is achieved. If* ~~Achieve~~ a resistance to ground measurement of 5 ohms (Ω) or less between the grounding electrode and the ¶ soil *cannot be achieved with a total of ~~five~~four 20~~-~~foot rods~~, by using multiple electrodes~~.
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plans ~~and approved by the Engineer~~. Ensure that *grounding electrode*s are listed according to UL requirements as detailed in UL 467. ~~Grounding and Bonding Equipment. Use electrodes that are copper clad or solid copper.~~ Make all connections to grounding electrode*s* using exothermic welds. *All grounding electrodes and connections must remain accessible for inspection, testing, and maintenance.*

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 *bar inside the equipment cabinet or mounted to the base of the ITS structure and as shown in plans* ~~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.~~

Place multiple grounding electrode assemblies ~~Install a minimum of one grounding radiant, plus additional radial/nts~~ in a "Y" *radial* 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" *radial* configuration cannot be placed in the right-of-way, change the ~~120-degree spacing~~ *configuration* of the radia*ls* ~~nts~~ to make the grounding *electrode* array fit in the space available, *and/or increase the length of all grounding electrode assemblies equally to a maximum of 40 feet* provided that the spheres of influence *between grounding electrode assemblies do not overlap*.

Install the ~~grounding radiants using one~~ main ~~20-foot~~ *grounding electrode assembly* ~~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,~~ *~~as required, to achieve the required resistance to ground~~*. ~~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, 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 *conductor*.

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.~~

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Comment [CHC35]: Is this to be a "ground bar" or a "grounding bar"? See above.

Comment [CHC36]: Should "and" be changed to "or"?

Deleted: *grounding rod electrode*

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Comment [CHC37]: All grounding electrodes must be at essentially the same depth in the soil so that the Fall-of-Potential resistance measurement will not be skewed.

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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.~~

785-2.3.4*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 ~~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.

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

Table 785-1

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	Up to 300	Up to 1.5 GHz	10*kA*,000 amps	<100 Vpk (IEEE Cat B3/C1 6

785-2.3.5*4* Air Terminals: Ensure that lightning protection systems and air terminals *are* installed *and* 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~~ *conductor*. Ensure that all ITS devices attached to *poles or* structures *(with or without* air terminals*)* are within the zone of protection determined by the 150-foot radius rolling sphere *method* described in NFPA 780.

Provide a lightning protection system as shown in the plans. Provide additional air terminals, static wires, and conductors as ~~r~~*may be r*equired *to establish a zone of protection in accordance with NFPA 780*~~by the manufacturer of large equipment such as DMS units that may necessitate more than one terminal to protect the structure and equipment~~. *Ensure that all air terminals are interconnected. Ensure air terminals are terminated to the main grounding electrode assembly* ~~*bar*~~. 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.

Comment [CHC38]: Since we cite the requirement to use NFPA 780, and NFPA 780 strongly supports the use of air terminals, we should require the mandatory use of air terminals for all of our ITS field devices, except in cases of steel uprights/poles where the designer can show that the skin thickness of the uprights/poles are adequate and the uprights/poles are electrically continuous, etc., etc. This specification is not strongly worded enough to the designer to force him/her to provide a design that includes the needed and wanted air terminals.

Comment [CHC39]: If a steel pole does not have an air terminal which is allowed if the pole skin thickness is adequate and the pole is electrically continuous, etc., etc., the ITS device still needs to be placed within the zone of protection. Perhaps this statement should be placed at another spot in this specification.

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785-2.4 ~~Transient Voltage Surge Suppression~~*Surge Protective* Devices:

785-2.4.1 General: Provide all ITS field installation sites with both primary and secondary surge protection on the *alternating current (*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 *surge protective* devices that have been approved in writing by the Engineer.~~

785-2.4.2 ~~TVSS Device~~ *SPD* at Power Entry Point: Install a *SPD*~~TVSS~~ at the closest termination/disconnection point where the 120-volt (V) supply circuit enters the ITS device cabinet. Locate the ~~TVSS~~ *SPD* on the load side of the ~~service~~ *main* disconnect and ahead of any and all ITS electronic devices. Configure the *SPD*~~TVSS~~ to operate at 120 V single phase (i.e., *line, neutral and ground* ~~two wires~~) or 120/240 V single phase (*line 1, line 2, neutral and ground* ~~i.e., three wires~~) as required to match the supply circuit configuration. Verify that the *SPD*~~TVSS~~ has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449[,] ~~Install a TVSS *SPD* that complies with the requirements as detailed in Section 2.2.7 of the NEMA LS 1-1992 (R2000) standard.~~

Ensure that the ~~TVSS~~ *SPD* 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~~ *SPD* 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 *Std* C62.41.2*™*-2002 Category *B*~~C3~~ and ~~B3~~/C~~1~~ 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 *Std* C62.41.2*™*-2002 Category C~~3~~ 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~~/C~~1~~ at 6 kV 1.2 by 50 µs/3 kA, 8 by 20 µs waveform.

Ensure that the ~~suppression device~~ *SPD has* ~~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 *1* set of normally open (NO)/normally closed (NC) Form C contacts for remote alarm monitoring. The enclosure for a ~~TVSS~~ *SPD* shall have a NEMA 4 rating.

785-2.4.3 ~~TVSS Device~~ *SPD* at Point of Use: Install a ~~TVSS~~ *SPD* at the point the ITS devices receive 120 V power. Ensure that the units are rated at 15 or 20 amps ~~(A)~~ *load and a minimum of 20kA of surge current capacity*~~, 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~~ *SPD* has been labeled to indicate that the unit is UL *recognized.* ~~listed and meets the requirements of UL 1449, Second Edition. Install a TVSS *SPD* that complies with the requirements of Section 2.2.7 of the NEMA LS 1-1992 (R2000) standard.~~

Ensure that the ~~TVSS~~ *SPD at* ~~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~~ *SPD* is rated at a minimum of 20 kA per phase. The results of testing this device for maximum let-through voltage using the IEEE *Std* C62.41.2*™*

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2002 Category A~~1~~ 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 270degree 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.~~*The let-through voltage must not exceed 240 V* ~~*volts*~~.

Ensure that the *SPD* 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~~*SPD* for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized ~~TVSS~~ *SPD* 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~~*N*, ~~L~~*N*-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

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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

Table 785-1

Table 4.1 – Values for Low-Voltage Circuits				
Circuit	Continuous	Frequency/		Let-Through Voltage (All

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

785-3 Pole and Lowering Device.

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

Table 785-1

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*kA*,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*kA*,000 amps per mode (8x20 µs)	<150 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)
Power and Control Up to 24 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5*kA* ,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*kA*,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*kA*,000 amps per mode (8x20 µs)	<550 Vpk (IEEE Cat B3/C1 6 kV/3 kA) <50 Vpk (IEEE Cat A1 Ringwave 2 kV)

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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.

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.~~ *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.*

The lowering device must be provided with 100 feet of composite power and signal cable prewired to the lowering device at the factory unless otherwise 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 APL. *The lowering device must be permanently marked with the APL certification number, manufacturer name, model number, and date of manufacture.*

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" 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 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, e~~*E*nsure that all ~~weight~~ *load* is *transferred*~~removed~~ 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 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 EIA232, EIA-422, EIA-485, and Ethernet data signals and 1 volt peak to peak (Vp-p) video signals, as well as 120 VAC, 9-24 VAC, and 9-48 VDC 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:~~

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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.*09*~~102~~ inch in diameter *and firmly affixed to the connector block*. ~~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 *portable* 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~~*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 supports itself and the load. Ensure that the lowering tool is equipped with a *winch with a minimum drum size width of 3.75" 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.

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. *All roller fairlead frames shall be corrosion resistant stainless steel or aluminum.*

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* ~~Construct it of~~ stainless steel *type 316* aircraft ~~cable~~ *type (7 strands x 19 gauge)* with a minimum breaking strength of 1,7*6*40 pounds*~~, and with 7 strands of 19 gauge wire each~~*. *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 1760 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 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 *pole-mounted cabinet*~~box with gaskets, as shown in the plans~~*. Ensure the upper mounting/junction box includes a maintenance access door with captive attachment hardware.* Provide all necessary mounting hardware ~~for the upper and lower box~~, conduits, standoffs, and conduit mounts required for a complete and functional system.

Ensure the cabinet minimum dimensions are 12" x 18" x 10" 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". 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" 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 2 keys with each cabinet. The cabinet door handle must include a lock hasp that will accommodate a padlock with a 7/16" 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" 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.~~1~~ *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.~~2~~ *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 that on-site instruction regarding the safe operation of the lowering system is provided by the lowering device manufacturer. Contractors responsible for the installation of a lowering device must be certified by the lowering device manufacturer. This certification must show evidence that the installer has been trained in the proper and safe installation and inspection of the manufacturer's lowering device system.*~~

Ensure that any personnel responsible for operation or maintenance of the ~~*lowering device are trained and certified by lowering device manufacturer or a contractor certified by the lowering device manufacturer.*~~

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.

Ensure that power and communication cables attached to the lowering ~~*device are secured and do not move when the lowering system is being operated. Label all wire leads with their function, label spares as spares.*~~

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 ~~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. Use only equipment and components that meet the *minimum* requirements of these specifications, and are listed on the Department's API~~L~~.

785-4.2 Materials:

785-4.2.1 Cabinet Shell: ~~Furnish~~ *Ensure the* ~~an ITS field~~ cabinet *shell* ~~that~~ conforms to NEMA 3R requirements. Ensure that the ~~ITS field~~ 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 ~~by the Engineer~~.

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	0.1 to 0.5 ohm-meters

The minimum dimensions for ~~FDOT ITS field~~ cabinet~~s~~ *s* are listed below.

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) weld~~ing method~~. Ensure that all internal cabinet welds are ~~done using the~~ gas metal arc (MIG) or TIG *welds*~~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~~*2* 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 *lb* ~~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, *1* ~~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* ~~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.

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Ensure that both door openings are double flanged on all ~~four~~*4* 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~~ *Provide* 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~~ *Provide* 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~~*2* keys for each cabinet lock.

785-4.2.4 Rails: Provide the ~~ITS field~~ cabinet with ~~four~~ *4* 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.

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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*lb* ~~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 mounted on standoffs that provide an* ~~sunshields must~~ *air gap of at least* ~~be offset a minimum~~ of one inch *between* ~~from~~ 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. ~~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~~ measur*ing*~~es~~ 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 min~~ute~~. 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 *3*~~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 *SPD*~~*surge protective devices*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 *SPD*~~TVSS~~ is accessible from the front of any panel used in the cabinet. Connect the ~~TVSS~~ *SPD* 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~~*SPDs*, 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 ~~#~~*No.* 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 ~~#~~*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 120/240 VAC power.

785-4.2.9.5 Interior Lighting: ~~If~~ *Unless otherwise* shown ~~on~~ *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*~~go~~ off when the doors are closed.

785-4.2.9.6 Generator and Auxiliary Power Connection: ~~If~~ *Unless otherwise* shown ~~on~~ *in* 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 *time* at the ~~ITS field~~ cabinet. Provide the ~~field~~ cabinet with 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 ~~Standard~~ 1008. Ensure that the transfer switch does not allow simultaneous active power from *more than one*~~two~~ source~~s~~ 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* ~~T~~To provide for automatic transition from generator power back to normal utility service after utility power is restored~~, an automatic transfer switch may be used instead of a manual transfer switch~~. 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* ~~permits the~~ automatic switching ~~function to be disabled~~ 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~~ *A* 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. ~~Provide t~~*T*he access door *must include*~~with~~ a weatherproof opening for the generator cable. The generator hookup compartment ~~itself~~ *must*~~shall~~ 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 VAC 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 ~~ITS field~~ cabinet to a concrete base or attach it to ~~the ITS device~~*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 ~~the base~~*ground*-mounted field cabinet*s* 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 e~~*E*nsure the *plates* ~~y~~ are *a minimum of* 4 inches wide by 0.125-inch thick. *Ensure the cabinet includes* ~~and shall have~~ 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 ~~FDOT~~ *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 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~~*MPH*; floor, 200 *lb* ~~pounds~~ per square foot (psf); slab, 200 psf; roof, 100 psf. *Provide*~~Furnish~~ drawings that are signed and sealed by a registered Professional Engineer indicating the shelter meets these minimum values.

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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 *Type* 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 *Type* 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~~ 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~~*Provide* one 35-watt, high-pressure sodium floodlight that is vandal resistant and mounted on the outside near the entrance door. ~~Furnish~~ *Provide* this floodlight with a photocell and interior light switch. ~~For lighting during power outages, furnish and install~~*Provide* 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 VAC and 20*A* ~~amp~~ twist-lock receptacles for 240 VAC, 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*ch* 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 *1* ~~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 handheld 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.
1. A power failure alarm that is wired from a dedicated circuit breaker.
2. 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 VAC at 60 ~~hertz (~~Hz~~)~~ with a 150 *A* ~~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~~*Surge Protective* Device: ~~Furnish~~ *Provide* the equipment shelter with a primary AC ~~transient voltage surge suppressor~~*surge protective device* (~~TVSS~~*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 Secondary AC-Powered ~~Transient Voltage Surge Suppression~~*Surge Protective* Devices: *Provide*~~Furnish~~ the equipment shelter with a secondary AC ~~TVSS~~*SPD* 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. *Ensure that all outlets within the equipment shelter are protected.*

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~~ *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. ~~Furnish~~ *Provide* a backboard of 3/4-inch AC-grade plywood no less than 48 inches square and painted with *2* ~~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~~ *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 ~~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 #~~*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~~ *4* walls at a height of 18 inches above the floor, as shown in the plans. Protect each wall with a separate 20 ~~amp~~ *A* circuit breaker. Provide a separate 20 *A* ~~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~~ *SPDs*, as described in the plans.

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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 ear~~e~~th grounds to this point, including* the grounding system for the *SPDs. Make all connections to SPDs* 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~~*SPD*. ~~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~~*external* connections. *Ensure that external connections and grounding electrode assemblies remain accessible for inspection, testing, and maintenance during and after construction.* ~~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~~*interior* connections to bond ground conductors to ~~the exterior of the~~ equipment *in the* 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 *2*~~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~~*2* 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.

Comment [CHC314]: See earlier comment about this term.

Comment [CHC315]: Shouldn't all earth grounds be connected to the main grounding electrode assembly which is also bonded to the main ground bar?

Deleted: surge protection devices *(*

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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~~ *stranded* copper wire *with green insulation* approximately 1 foot below the ceiling on each wall and mount it using insulated standoffs. Ensure that the ~~AWG #2 solid bare~~ *green* ~~copper~~ wires encircle*s* the equipment room, forming a ring or continuous loop along the upper interior perimeter ground, and include*s* the wall area above the door. ~~Provide a break in this ground loop for an "open hale" 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~~*stranded* copper wires *with green insulation and* ~~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~~ *stranded* copper wire *with green insulation*. 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 *in a suitable access point. Ensure that 6 to* ~~10"~~ *inches of the ground rod* ~~*is will is*~~*remain accessible for inspection, testing, and maintenance during and after construction* ~~and bury each with the top of the rod a minimum of 2.5 feet below the grade~~. Bond the ground rods together using *No. 2* AWG ~~#2~~ solid *bare* ~~t~~ tinned ~~bare~~ copper wire~~s~~ and an exothermic bonding process. Bury the bonding wires a minimum of ~~2.5 feet~~*one 18 inches* ~~*foot*~~ below ~~the~~ grade. Also bond the following items to the shelter's ~~external~~ grounding system using *No. 2* AWG ~~#2~~ solid ~~tinned~~ bare *tinned* 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.

- Shelter support skids, bases, or foundations, if applicable.
- Any metal object larger than 4 square feet.
- *External metal fencing.*

785-5.3.4.3 Punch Block ~~TVSS~~ *SPD* Grounding: For all Type 66 punch blocks, install *No. 2* AWG ~~#2~~ solid bare *tinned* copper wires to ground external line surge protection devices. Install the *No. 2* AWG ~~#2~~ solid bare *tinned* copper wires in accordance with the ~~TVSS~~ *SPD* manufacturer's recommendations and mechanically connect them to the shelter's interior perimeter ground.

Comment [CHC316]: See earlier comment about this term.

Comment [CHC317]: See earlier comment about this term.

Comment [CHC318]: See earlier comment about this term.

Comment [CHC319]: See earlier comment about this term.

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 *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: *Provide* ~~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.

Ensure that all ~~Include a~~ gate*s are* made of the same material as the fence. Construct *sliding*~~the~~ gate*s* in accordance with Index No. 803 ~~of the Design Standards~~ and configure~~d~~ 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 *No. 2* AWG ~~#2~~ solid~~,~~ *bare*~~tinned, bare~~ *tinned* copper wire*s* 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 ~~#2~~ solid *bare*~~, tinned~~*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 *No. 2* AWG ~~#2~~ solid *bare*~~,~~ tin*ned*~~ned, 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 *No. 2* AWG ~~#2~~ solid *bare tinned*~~, 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 *No. 2* AWG ~~#2~~ solid *bare tinned*~~, tinned, bare~~ copper wires, as shown in the plans.

Ensure that all ground leads are *No. 2* AWG ~~#2~~ solid *bare tinned*~~, 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.

Comment [CHC320]: See earlier comment about this term.

Comment [CHC321]: See earlier comment about this term.

Comment [CHC322]: See earlier comment about this term.

Comment [CHC323]: See earlier comment about this term.

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Comment [CHC324]: See earlier comment about this term.

Comment [CHC325]: See earlier comment about this term.

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 *1*~~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 grouning electrode assembly , using a clamp-on earth tester. The measurement at any individual grounding electrode assembly will be the cumulative resistance of all rods in a parallel circuit. The grounding system resistance must be no more than 5Ω~~ohms~~.* Correct all deficiencies at no cost to the Department.

Deleted: *d rod*

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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~~*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 ~~Poles and~~ Lowering Devices: Ensure that the ~~poles and the~~ lowering devices furnished, assembled, fabricated, or installed are warranted by the manufacturer~~s~~ 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~~*Surge Protective Devices*: Provide a ~~TVSS~~ *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 ~~TVSS~~ *SPD* device manufacturer's standard warranty period, whichever is greater.

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

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

In the event that the ~~TVSS~~*SPD*, including any component of the unit, should fail during the warranty period, the entire ~~TVSS~~ *SPD* shall be replaced by the manufacturer at no cost to the Department. Costs relating to the removal of the ~~TVSS~~*SPD*, shipping and handling, and the reinstallation of the ~~TVSS~~ *SPD* 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 *2*~~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 *1*~~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.

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Item No. 785-3 ITS Equipment Shelter, per each.

Advanced Protection Technologies

FDOT 785-2.4 SPD Specification Comments & Opinions

Lou Farquhar, PE, CEM, GBE
VP – APT Engineering Services
July 21, 2010

(There are graphic animations later in presentation. To see animations, view as Slide Show, not Normal view)

APT is relatively new to FDOT:
I.e., Please forgive us as we step on folk's toes

- APT applied for AVL & APL approval – Oct 2009
- Jeff Morgan SPD letter – Oct 2009
- Working with District 7 – Spring/Summer 2010
- Many FDOT Contractors have attended recent APT SPD Training Seminars

Much of the following info is better suited to verbal discussion. We volunteer to discuss. Please contact Lou Farquhar at (800) 237-4567 or lfarquhar@apttvss.com

Surge Industry has undergone Huge changes in recent months. UL 1449 has changed, NEC has changed, UL 96A has changed, NFPA 780 has changed, etc.

- UL 1449 added Nominal Discharge Current Testing (I-n)
- UL 1449 changed to Voltage Protection Ratings (VPRs)
- UL 1449 attempts to harmonize with IEC 61643

We are not convinced that FDOT's surge spec captured the previous UL 1449 changes effective in 2007. (Which changed the products that FDOT uses)

FDOT's surge spec has not kept up. These recent revisions help, but are not enough. (Analogy: these most recent edits are like a new ribbon for a typewriter in a word processor world.)

The Draft Revised 785 SPD Spec does not meet NFPA 780 nor UL 96A lightning protection standards.

NFPA 780 & UL 96A would not accept these SPDs. (By extension, underwriters would not either.)

Why should FDOT?

Given that FDOT has one of the more severe surge environments in the world, not adopting solid relevant standards seems puzzling.

We suggest embracing up-to-date surge standards. They were specifically developed to make life easier for all users (like FDOT). And they're Free & Easy To Use!

FDOT Improvement Suggestions:

UL 1449-3 Listed (for FDOT's ease of product review)
UL 20kA I-n rating (Good enough for UL 96A – good enough for FDOT)
UL VPRs of 700V or less for L-N and L-G (1.) Low clamping voltage & better performance, 2.) Positively creates L-G protection)
Minimum MOV size of 32mm round (more robust MOVs & SPDs)
Diagnostic Monitoring for Every MOV (Lets FDOT know if SPD is fully functional or not. Also prevents SPD manu. from sidestepping warranty & game-playing)
UL declared MCOV of 150V (prevents game-playing)
No Gas Tubes or Spark Gaps (prevents high clamps)
SCCR =>50kA (safety and protect FDOT & Engineer of Record)
Thermal Disconnectors required for all MOVs (safety)
50kA per mode, 100kA per phase (generally adequate, assuming 20kA I-n's are adopted)

Forget about:

Category A or A1 Ringwaves (1.) A1's don't exist. 2.) Cat A's are 'least case' scenarios, plus there are two Cat A' waveshapes (Combo Wave & Ringwave, one would need identified. Not to mention, FDOT has no way to police bogus test results.)
Anything NEMA LS-1 related (LS-1 is rescinded)

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785-2.4 ~~Transient Voltage Surge Suppression~~*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.

~~Furnish only TVSS *surge protective* devices that have been approved in writing by the Engineer.~~

785-2.4.2 ~~TVSS Device~~*SPD* at Power Entry Point: Install a *SPD*~~TVSS~~ at the closest termination/disconnection point where the 120-volt (V) supply circuit enters the ITS device cabinet. Locate the ~~TVSS~~ *SPD* on the load side of the ~~service~~ *main* disconnect and ahead of any and all ITS electronic devices. Configure the *SPD*~~TVSS~~ to operate at 120 V single phase (i.e., *line, neutral and ground*~~two wires~~) or 120/240 V single phase (*line 1, line 2, neutral and ground*~~i.e., three wires~~) as required to match the supply circuit configuration. Verify that the *SPD*~~TVSS~~ has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449, ~~Second~~ *Third* Edition. ~~Install a TVSS *SPD* that complies with the requirements as detailed in Section 2.2.7 of the NEMA LS-1-1992 (R2000) standard.~~

Ensure that the ~~TVSS~~ *SPD* 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~~ *SPD* 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 *Std.* C62.41.2-2002 Category *B*~~C3~~ and ~~B3~~/C~~1~~ 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 *Std.* C62.41.2-2002 Category C~~3~~ 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 B~~3~~/C~~1~~ at 6 kV 1.2 by 50 µs/3 kA, 8 by 20 µs waveform.

Ensure that the ~~suppression device~~*SPD has* ~~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~~ *SPD* shall have a NEMA 4 rating.

Does not define Modes of Protection – can be misinterpreted to detriment of FDOT

Too much Weasel Room for submitters: I would say, SPD shall be UL Listed to UL 1449-3 with 20kA I-nominal rating and posted as such at UL.com.

Verify MCOV at UL.com (See Slide A1. Shows that some manufacturers play games with this.)

150kA does not necessarily mean much. SPD could easily have lower I-n. (See Slide A2 to see why)

APT's 50kA SPD has 20kA I-n rating, whereas, ASC's 150kA SPD has only 10kA I-n rating.

UL 96A & NFPA 780 would reject ASC's unit as not meeting their criteria

Clamp testing is Very Open to interpretation (read: Fluffing) See Slide A1 with example where manufacturer claim is directly contradicted by independent UL test data.

Change to UL 1449-3 VPRs which are independently tested to avoid this problem

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785-2.4 ~~Transient Voltage Surge Suppression~~*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.

~~Furnish only TVSS *surge protective* devices that have been approved in writing by the Engineer.~~

785-2.4.2 ~~TVSS Device~~*SPD* at Power Entry Point: Install a *SPD*~~TVSS~~ at the closest termination/disconnection point where the 120-volt (V) supply circuit enters the ITS device cabinet. Locate the ~~TVSS~~ *SPD* on the load side of the ~~service~~ *main* disconnect and ahead of any and all ITS electronic devices. Configure the *SPD*~~TVSS~~ to operate at 120 V single phase (i.e., *line, neutral and ground*~~two wires~~) or 120/240 V single phase (*line 1, line 2, neutral and ground*~~i.e., three wires~~) as required to match the supply circuit configuration. Verify that the *SPD*~~TVSS~~ has been labeled to indicate that the unit is UL listed and meets the requirements of UL 1449, ~~Second~~ *Third* Edition. ~~Install a TVSS *SPD* that complies with the requirements as detailed in Section 2.2.7 of the NEMA LS-1-1992 (R2000) standard.~~

Ensure that the ~~TVSS~~ *SPD* 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~~ *SPD* 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 *Std.* C62.41.2-2002 Category *B*~~C3~~ and ~~B3~~/C~~1~~ 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 *Std.* C62.41.2-2002 Category C~~3~~ 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 B~~3~~/C~~1~~ at 6 kV 1.2 by 50 µs/3 kA, 8 by 20 µs waveform.

Ensure that the ~~suppression device~~*SPD has* ~~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~~ *SPD* shall have a NEMA 4 rating.

What about overcurrent protection? Need this for safety.

What about SCCRs? Need this to protect FDOT & Engineer of Record

No polite way to say this: Asking SPD manufacturers for clamp test data will result in bogus garbage. Virtually every specifier faces this problem, not just FDOT. (FDOT got whizzed on A1 testing on last spec.) We recommend using UL's VPR test data at 3000A because each manufacturer is tested exactly the same way, which reduces fluff and therefore provides legitimacy. See Slide A1 where a manufacturer claims 416V, but UL's testing using the same test impulse is hundreds of volts higher. This is a dead giveaway of testing manipulation.

This Monitoring language is very good, but will be hard to enforce. Existing FDOT SPDs do NOT have this. SPD could be mostly dead and FDOT does not know it. (Solution: Make manufacturer declare that every MOV is monitored & make company officer sign.)

785-2.4.3 ~~TVSS Device~~*SPD* at Point of Use: Install a ~~TVSS~~ *SPD* at the point the ITS devices receive 120 V power. Ensure that the units are rated at 15 or 20 amps ~~(A)~~ *load and a minimum of 20kA of surge current capacity*~~, 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~~ *SPD* has been labeled to indicate that the unit is UL *recognized.*
~~listed and meets the requirements of UL 1449, Second Edition. Install a TVSS *SPD* that complies with the requirements of Section 2.2.7 of the NEMA LS 1-1992 (R2000) standard.~~
Ensure that the ~~TVSS~~ *SPD at* ~~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~~ *SPD* 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 *Std.* C62.41.2-
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2002 Category A~~+~~ 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.~~ *The let-thru voltage must not exceed 240 V* ~~*volts*~~.

The 15 or 20A ratings & UR (Recognized) suggest a series (two port) SPD. Small two-port SPDs highly regulated by UL 1449-3 changes. (See Slide A3)

UL *Recognized* add wrinkles:

Not a Listed device; almost always has Engineering Considerations, which must be followed (i.e., usually upstream OCP to achieve the SCCR)

Recognized products' Ratings are not posted at UL.com. This makes verification & compliance far more difficult.

We suggest UL Listed whenever possible.

Lots of Possible Problems:

I am not convinced that a small SPD at POU is fully sufficient. See Slide Series A4. A POU application could easily be a Power Entry Cat C environment, not Cat A. 20kA not likely to be enough.

Likewise, it might make sense to put the POU SPD at the actual POU. (I understand that the POU SPD could connect further upstream in the electrical system.)

20kA is not enough.

785-2.4.3 ~~TVSS Device~~*SPD* at Point of Use: Install a ~~TVSS~~ *SPD* at the point the ITS devices receive 120 V power. Ensure that the units are rated at 15 or 20 amps ~~(A)~~ *load and a minimum of 20kA of surge current capacity*~~, 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~~ *SPD* has been labeled to indicate that the unit is UL *recognized.*
~~listed and meets the requirements of UL 1449, Second Edition. Install a TVSS *SPD* that complies with the requirements of Section 2.2.7 of the NEMA LS 1 1992 (R2000) standard.~~
Ensure that the ~~TVSS~~ *SPD at* ~~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~~ *SPD* 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 *Std.* C62.41.2-
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2002 Category A~~+~~ 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.~~ *The let-thru voltage must not exceed 240 V* ~~*volts*~~.

There are two (2) Cat A wave shapes: Combo Wave and Ring Wave. This spec does not say which one.

Another problem: UL 1449 formerly used the Cat A 6kV, 500A Combo Wave test and their best rating was 330V. About half of the industry's products could achieve 330V. Most were 400V.

Asking for compliance at 240V is fantasy and begging for whoppers & story telling.

Does not define Modes of Protection – can be interpreted to detriment of FDOT

Need L-N, L-G (ideally N-G too)

20kA is not enough. I would say, SPD shall be UL Listed to UL 1449-3 with 20kA I-nominal rating and posted as such at UL.com.

Verify MCOV at UL.com See Slide A1 as example of manufacturer rating problem

What about monitoring? We suggest duplicating Monitoring wording.

What about overcurrent protection?

What about SCCRs?

785-6.3 ~~Transient Voltage Surge Suppressors~~*Surge Protective Devices*: Provide a ~~TVSS~~ *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 ~~TVSS~~ *SPD* device manufacturer's standard warranty period, whichever is greater.

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

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

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

FYI: Better SPDs included internal overcurrent protection. These would never trip an external breaker, making "reset" a moot point.

The Monitoring issue noted earlier needs addressed. As-is, FDOT is not fully protected and FDOT does not know which SPDs are truly good or partially failed.

This warranty has lots of unexpected problems:
FDOT's wording of "electrical events" presumes ANY electrical related problem. The reality is that SPDs usually fail from sustained overvoltages, usually caused by 'reference to ground' problems. This usually 'kills' L-G suppression modes. These are usually due to faulty installation of grounding & bonding, system level problems – Not a defect in the SPD's workmanship or material. (Dead L-G usually is trying to tell someone about bigger problems!)
We caution FDOT to not overly penalize the SPD manufacturer. Ten years is a long time – especially for a device purposely put in harm's way. Repeat: SPD failures are rarely the SPD's fault.

FDOT needs to be aware that too many SPDs have inadequate diagnostic indicators. For example, the long time incumbent SPD monitors very few internal suppression elements. More than half of that SPD can be dead, yet the LEDs indicate A-OK. (Take one apart and examine the diagnostic circuitry!)
As it stands now:
- The SPD manufacturer is knowingly and purposely avoiding warranty exposure by having chintzy diagnostics
- FDOT's expensive equipment is not fully protected
- FDOT falsely believes that their equipment is protected

This is just plain wrong.

The way the spec is worded, FDOT is practically inviting an unscrupulous SPD manufacturer to blindly illuminate an LED forever, which would eliminate warranty and associated costs. Is that the type of surge protection that FDOT wants?

785-2.4.4 ~~TVSS Device~~*SPD* for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized ~~TVSS~~ *SPD* 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~~*N*, ~~L~~*N*-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

Table 785-1

~~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*kA*~~,000 amps~~ per mode (8x20 µs)	<100 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA)
Power and Control Up to 12 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5*kA*~~,000 amps~~ per mode (8x20 µs)	<150 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA) <50 Vpk (IEEE Cat A~~1~~ Ringwave 2 kV)
Power and Control Up to 24 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5*kA* ~~,000 amps~~ per mode (8x20 µs)	<175 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA) <50 Vpk (IEEE Cat A~~1~~ Ringwave 2 kV)
Power and Control Up to 48 V	Up to 30 A	Up to 60 Hz (sensitive loads)	5*kA*~~,000 amps~~ per mode (8x20 µs)	<200 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA) <50 Vpk (IEEE Cat A~~1~~ Ringwave 2 kV)
Power and Control Up to 120 V~~AC~~	Up to 30 A	Up to 60 Hz (sensitive loads)	20*kA*~~,000 amps~~ per mode (8x20 µs)	<550 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA) <50 Vpk (IEEE Cat A~~1~~ Ringwave 2 kV)
RS422 Up to 12 V	Up to 500 mA	Up to 100 MHz Up to 10 Mbps	10*kA*~~,000 amps~~ per mode (8x20 µs)	<30 Vpk (IEEE Cat B~~3~~/C~~1~~ 6 kV/3 kA)

Thus far, we are focusing on AC voltage SPDs. But some of these clamp voltage numbers do not look right. Even a large hardwired Service Entry SPD with large & plenty of MOVs cannot reach this

Absolutely Nada Zero chance without fibbing & fluffing

Suggestion:

Utilize UL 96A certifications requirements to save time & headaches

Slide A1 - Manufacturer vs. UL 1449-3 online

Manufacturer Cutsheet

Atlantic Scientific
MTL Surge Technologies

Engineering Specification Submittal

Model: **ZoneMaster PRO** **Order Code: 15101**

Applicable Standards	NEMA LSI - 1992 UL 1449 UL 1283	ANSI/IEEE C62.41 ANSI/IEEE C62.45
General Electrical	SPD Category Nominal service voltage Maximum continuous operating voltage Remote indication	Service Entrance 120/208V 150V Isolated, NO/NC contacts 60W DC, 120VA AC, 3A rated
	Module diagnostics — Protection present Fault warning High voltage neutral to ground On board monitoring	Green LED Red LED Green & Red LED Surge counter, fault monitor, audible alarm
	Optional Fused Disconnect	600VAC 200,000A RMS Symmetrical Rating 200,000 AIC Fusing

Maximum Surge Current

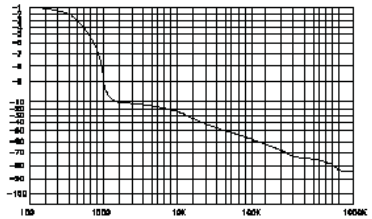
Maximum Surge Current in per Protection Mode				Maximum Surge Current
L-N	L-G	L-L	N-G	Per Phase
100,00A	100,000A	200,000A	200,000A	200,000A

Clamping Voltage

ANSI/IEEE C62.41 ANSI/IEEE C62.45 Clamping Voltage	B (3,000A)	C High (10,000A)
	416V	528V

EMI - RFI Noise Reduction

75dB Max
100kHz to 100MHz



Agency Approvals

UL 1449
UL 1283
C-UL-US

Independent UL 1449 Suppressed Voltage Ratings				UL 1449 Listed 3rd Edition VPR			
L-N	L-G	L-L	N-G	L-N	L-G	L-L	N-G
400V	400V	700V	400V	900V	800V	1200V	700V

UL.com excerpt

See General Information for Surge-protective Devices

ATLANTIC SCIENTIFIC CORP
SUITE A
4300 FORTUNE PL
WEST MELBOURNE, FL 32904 USA

E315539

Model	Product Type	V (V ac)	Phase*	Mode(s)@	VPR (V pk)	In	MCOV
15100, 15000, 15000X, 15100X	Type 2 SPD	120/240	S	L-N	700	10 kA	127
				L-G	700		
				N-G	600		
				L-L	1000		254
15101, 15101X, 15001, 15001X	Type 2 SPD	120/208	3Y	L-N	700	10 kA	127
				L-G	700		
				N-G	600		
				L-L	1000		220
15102, 15102X	Type 2	120/240	3H	L-N	700+(1200)	10	127

MCOV:

- Manufacturer: 150V
- UL: 127V

Clamping Voltages at 3000A:

- Manufacturer: 416V
- UL: 700V & 600V (If manufacturer was accurate, UL would have assigned 500V VPR, not 700's & 600's)

(Manufacturer cheating itself out of better VPR)

Slide A2 - MOVs, Safety & Affect on I-n

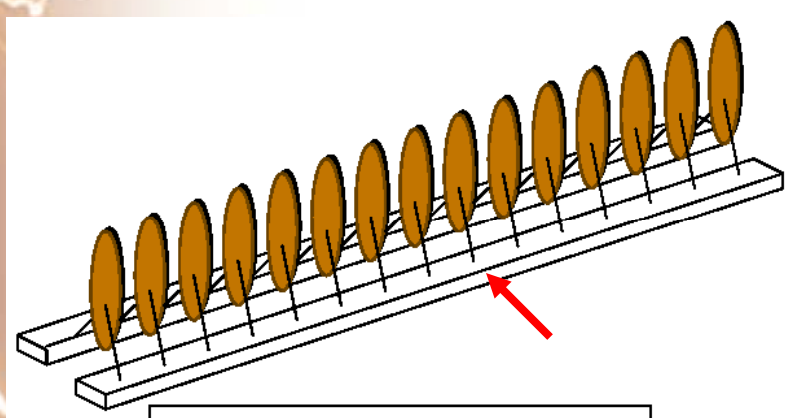


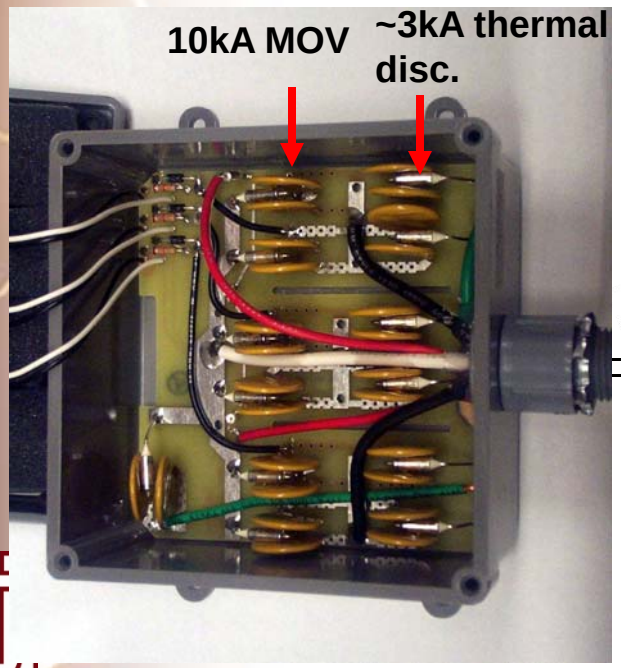
Figure 1 – Paralleled MOVs provide a theoretical maximum surge current rating.

These are 10kA MOVs. In theory, 15 10kA MOVs equals 150kA.

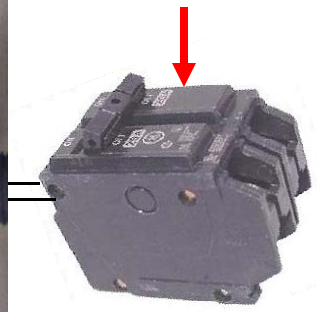
Problem is that small MOVs do Not share equally. One will dominate, one will slack, others will be in between.

Another problem is that safety disconnectors tend to reduce the MOV's surge current capability

Actual surge current capacity is usually the rating & effectiveness of safety disconnectors – not capacity of MOVs



20A breaker – passes about 10-15kA surge current (once)



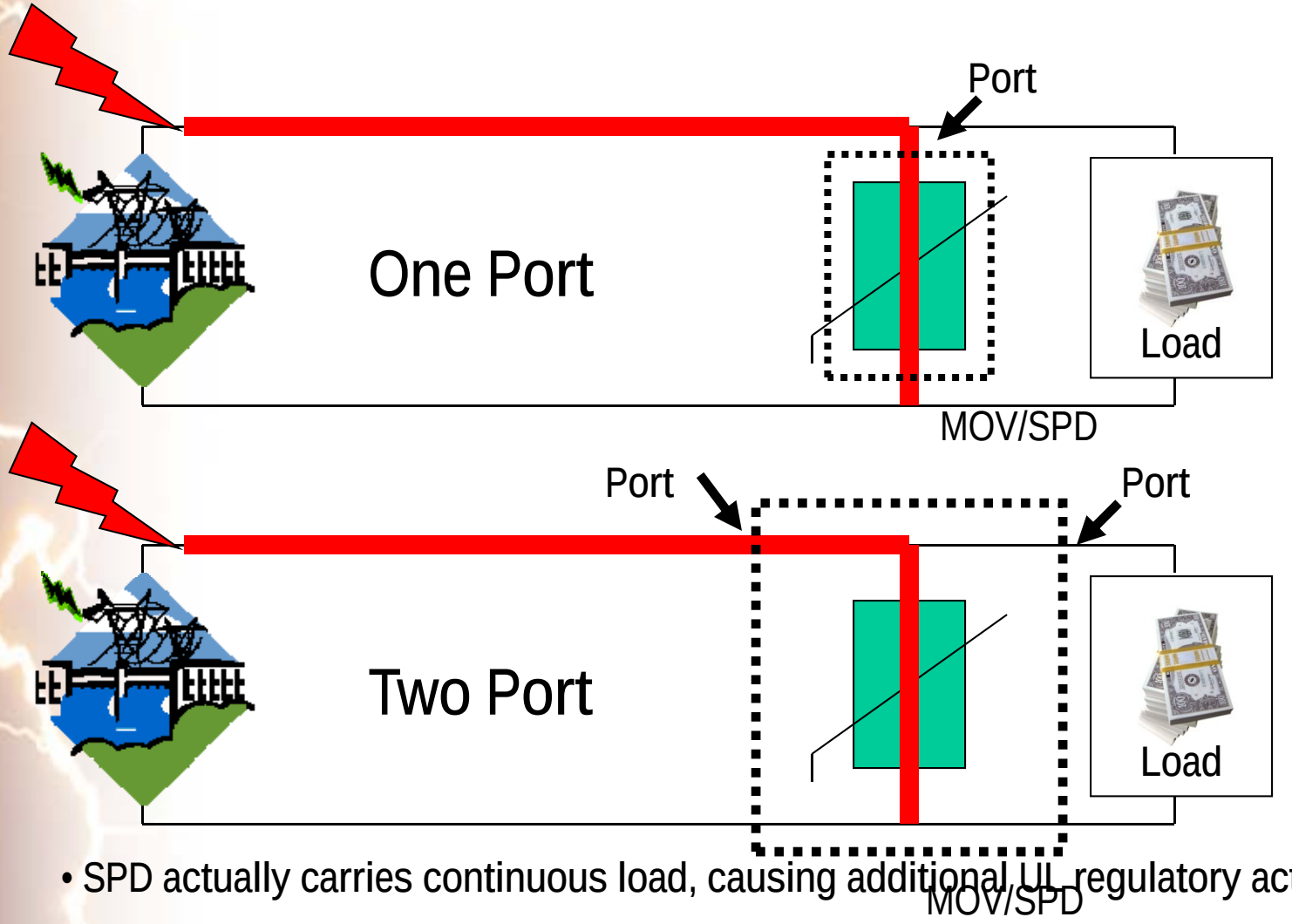
10kA MOV (mustard)

Thermal disconnector (white) Passes about 3kA – limits surge current

'Small' 20A circuit breaker required as overcurrent protection – also limits surge current

Reality – A 150kA SPD might only pass 10kA during UL's testing. This is why UL's 20kA I-n test is required for UL 96A. FDOT should require this too.

Slide A3 - One Port vs. Two Port SPD



- SPD actually carries continuous load, causing additional UL regulatory action
- Almost always require upstream OCP, which can cause inadvertent load outage
- Often are UL Recognized (not Listed) – Not intended for field installation

Slide Series A4 –

- Why POU Downstream SPDs should be larger

- Why Cat A isn't enough

- Why L-G protection is required downstream

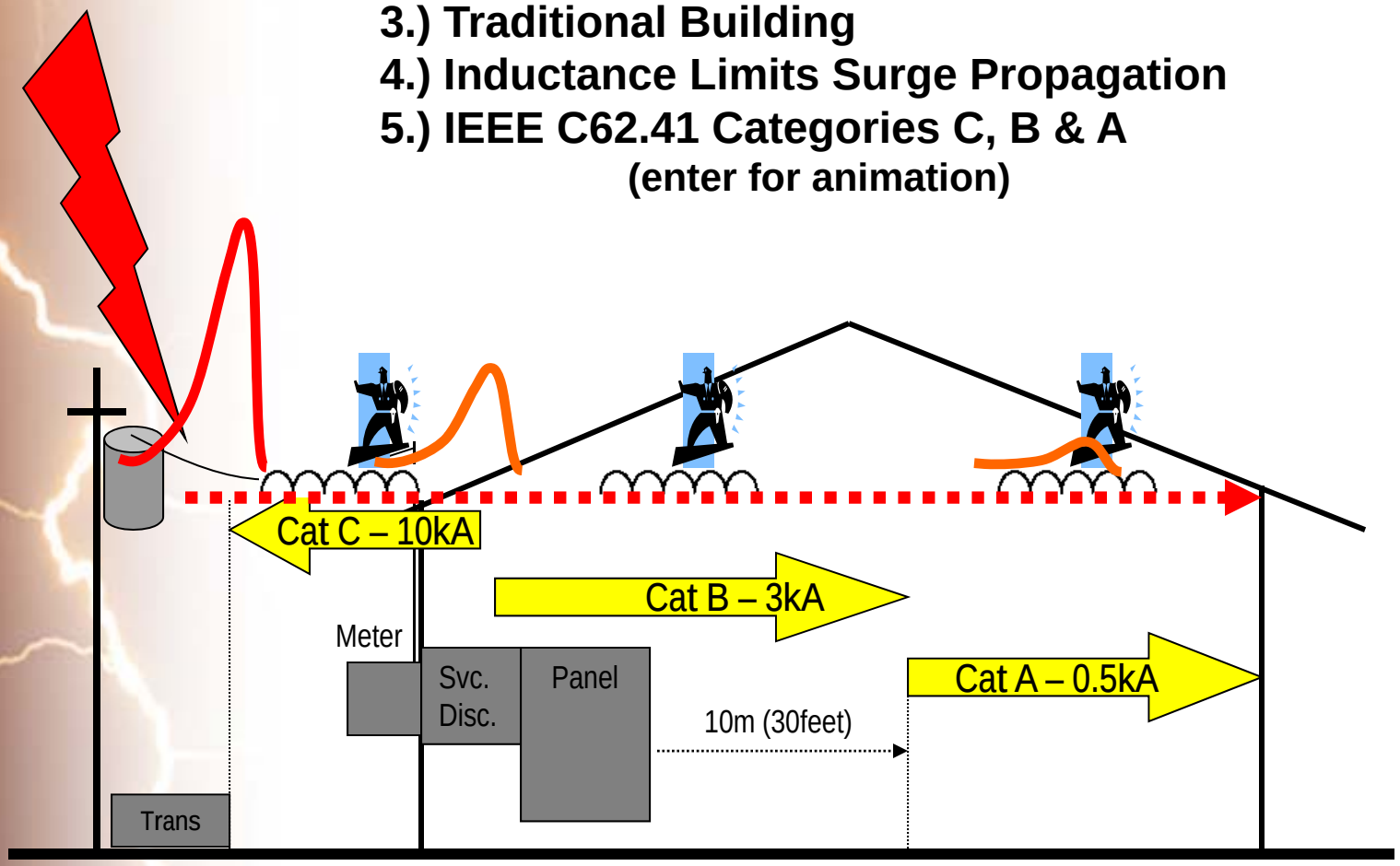
1.) Cat A is Least Case – Not Severe Case
(Cat A is least of worries compared to Cat C)

2.) Note that there are two (2) Cat A waveshapes
- Combo Wave
- Ringwave

3.) The electrical system's Ground Reference is at the Service Entrance, not downstream. Recommend L-G protection (can make solid argument for N-G protection too)

A4-1 Classical IEEE-style Surge Protection Assumes:

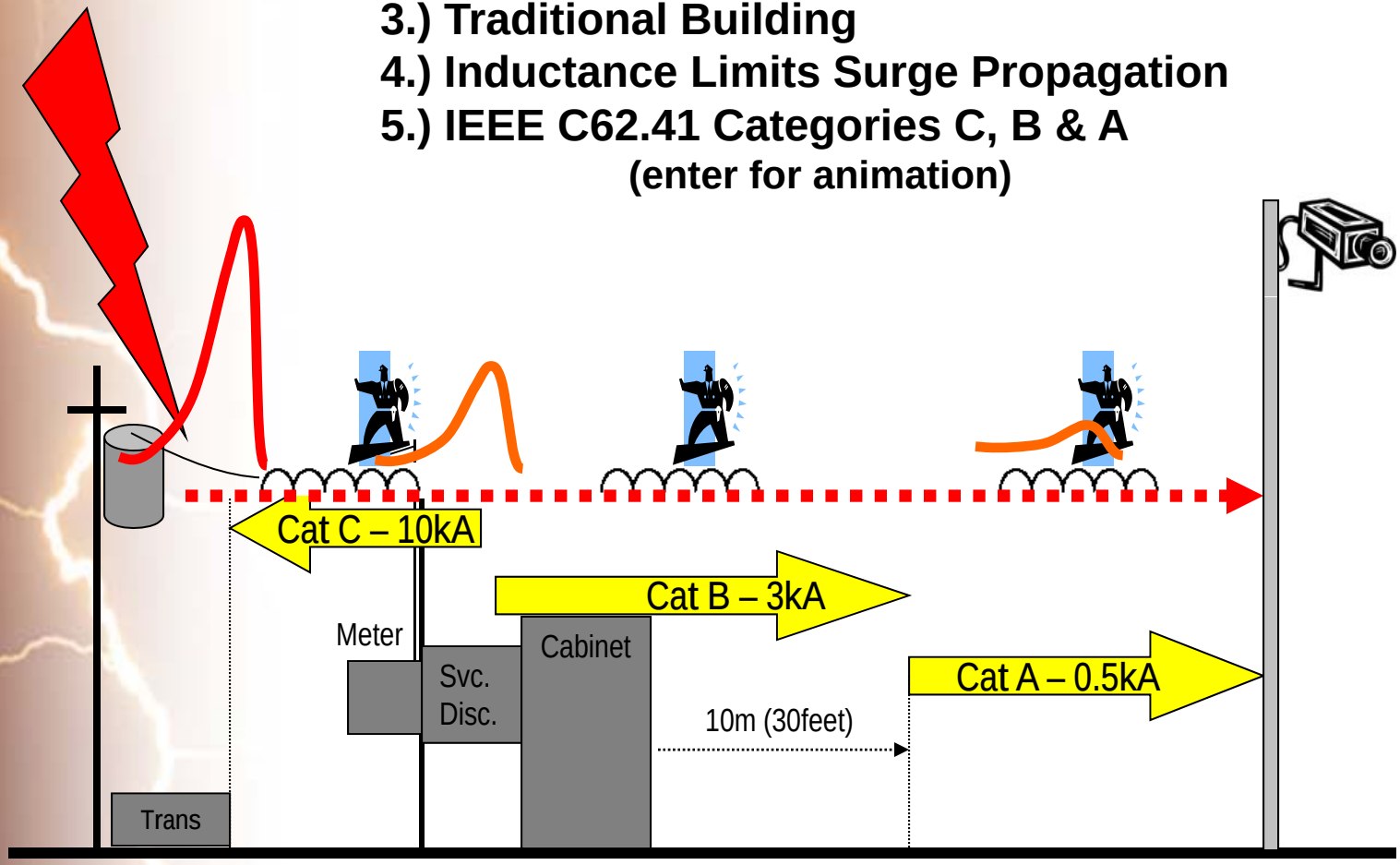
1.) Surge Is From Service Entrance
2.) Surge Hits Line
3.) Traditional Building
4.) Inductance Limits Surge Propagation
5.) IEEE C62.41 Categories C, B & A
(enter for animation)



A4-2 Does This Transfer to FDOT Application??

1.) Surge Is From Service Entrance
2.) Surge Hits Line
3.) Traditional Building
4.) Inductance Limits Surge Propagation
5.) IEEE C62.41 Categories C, B & A

(enter for animation)



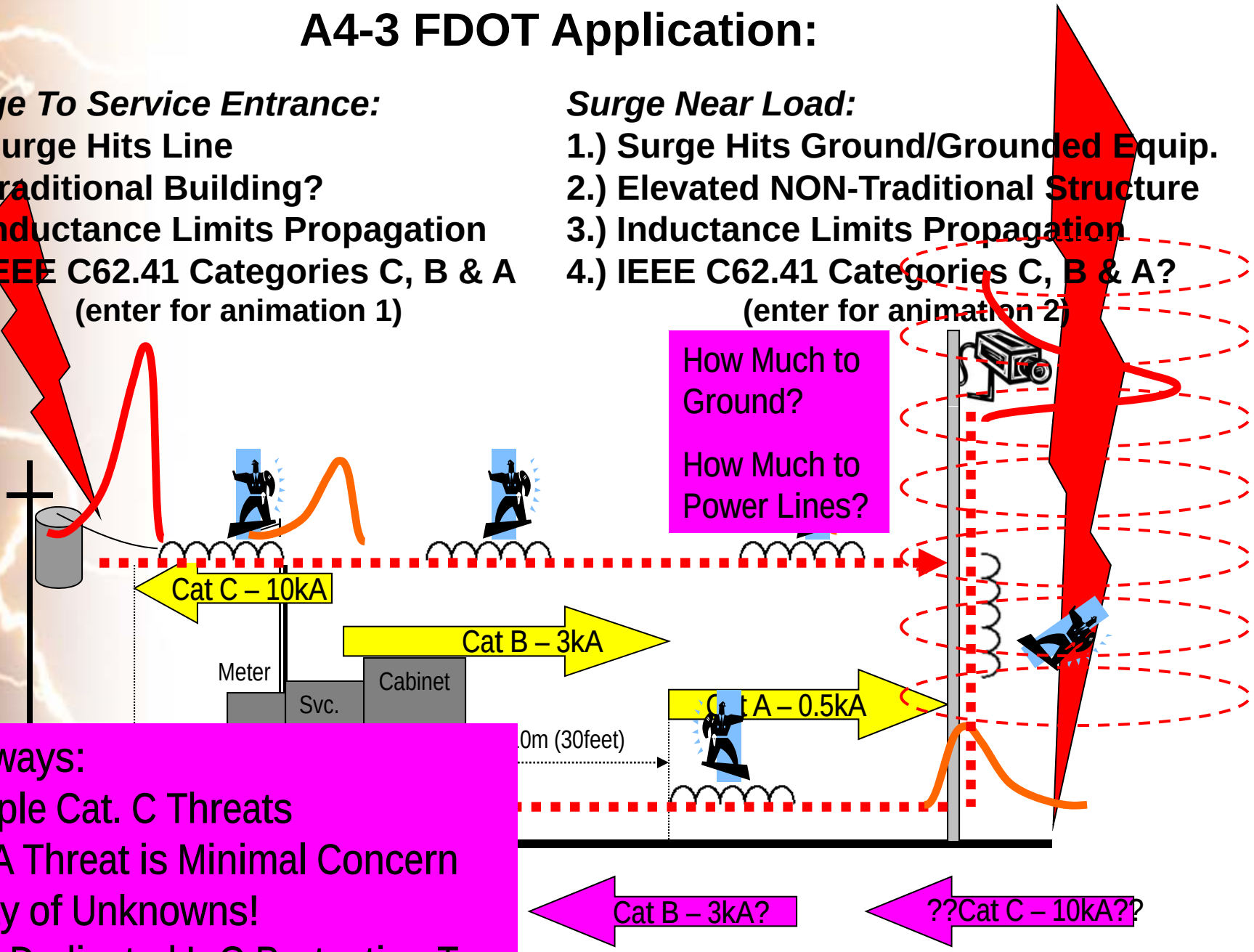
A4-3 FDOT Application:

Surge To Service Entrance:

1.) Surge Hits Line
2.) Traditional Building?
3.) Inductance Limits Propagation
4.) IEEE C62.41 Categories C, B & A
(enter for animation 1)

Surge Near Load:

1.) Surge Hits Ground/Grounded Equip.
2.) Elevated NON-Traditional Structure
3.) Inductance Limits Propagation
4.) IEEE C62.41 Categories C, B & A?
(enter for animation 2)



Takeaways:
- Multiple Cat. C Threats
- Cat. A Threat is Minimal Concern
- Plenty of Unknowns!
- Need Dedicated L-G Protection Too

A4-5 Based on This Demonstration:

Suggest:

- Reconsider robustness of Point of Use SPD,
  Change to Service Entrance Class SPD?
- Clarify where POU SPD is located
- Defined Modes of Protection
  Directly Connected L-N and L-G
  (Could easily argue for Direct N-G too)
  (If I were king, I would spec N-G, but I can understand FDOT cost & size constraints)

Sample Draft – Short with Far Better Surge Protection & Easier Verification

785-2.4 Surge Protective Devices:

785-2.4.1 General: Provide all ITS field installation sites with cascade surge protection on the AC power.

785-2.4.2 SPDs for 120V or 120/240V Power: Install an SPD on the load side of the service entrance or main disconnect. Install an SPD on the power distribution to the equipment. Install an SPD at the ITS equipment' power connection terminals, closest to ITS equipment; top-of-pole included. Leads shall be as short and straight as possible. Wire nuts shall not be permitted.

SPDs shall be UL Listed and labeled to UL 1449 Third Edition. SPDs shall be posted on VZCA at UL.com with 20kA I-nominal rating and the following ratings:

	L-N	L-G
Voltage Protection Rating (VPR):	700V	700V
Maximum Continuous Operating Voltage (MCOV):	150V	150V

SPD's surge current rating shall equal or exceed 50kA per mode. Per phase rating shall equal or exceed 100kA per phase (sum of L-N plus L-G). SPDs shall include directly connected MOVs exceeding 32mm in diameter from L-N and L-G. Each MOV shall include thermal safety disconnector(s). SPD SCCR shall equal or exceed 50kA or the available short circuit current, whichever is higher. Type 1 SPDs are preferred because of integral overcurrent protection (OCP). Type 2 or Two-Port SPDs shall declare and make provisions for any UL required overcurrent protection and Engineering Considerations. Gas Tubes or Spark Gaps not permitted due to high initial clamp overshoot.

Every MOV's operational status shall be monitored via visual indicator. SPD shall include one set of Normally Open (NO) Normally Closed (NC) Form C contacts for remote monitoring. SPD shall be outdoor rated as NEMA 4.

785-2.4.4 SPD for Low-Voltage Power, Control, Data and Signal Systems…

Thank you for your time

APT actively participates in IEEE, UL and NEMA surge activities. Should FDOT wish to know & understand current & upcoming surge standards issues, we volunteer to assist.

We started the draft spec from scratch using a coordinated approach with up-to-date terminology & standards. It will provide excellent, low cost, competitive surge protection, for a long time, and be much easier for FDOT to administer. However, if someone unfamiliar with latest standards picks & chooses wording, there is good chance that some 'teeth' will be cut out.

We volunteer to train, update, discuss, debate, arm-wrestle, etc.

Please contact Lou Farquhar at APT at (800) 237-4567 or lfarquhar@apttvss.com

TRANSCORE

July 20, 2010

Mr. Chester H. Chandler, P.E.
District ITS Program Manager
Florida Department of Transportation – District 7
11201 North McKinley Drive
MS Sunguide Center
Tampa, Florida 33612

RE: ITS Districtwide Consultant Services Project
FDOT Contract Number: C-8T08
FDOT Project Number: 258372-1-32-03
Review Comments for FDOT Supplemental Specification 785
TransCore Project No. 2309002

Dear Mr. Chandler:

Per your request, I have reviewed the FDOT Specification 785 and have the following comments:

Section 785-1: Description

1. Recommend that the last paragraph read as follows: "All materials furnished, assembled, fabricated, or installed under this specification shall be *brand*-new products *only. Materials which have been refurbished or previously used shall not be used.*"

Section 785-2.1: Grounding and Surge Protective Devices, Description

1. Recommend that the first sentence begin with "Furnish and install" instead of "Provide". "Provide" would seem to indicate furnish only.
2. What is the difference between devices which are "installed in the field" vs. devices which are installed at "remote locations"? Suggest that the phrase "for all ITS devices installed in the field or in remote locations" be removed and replace with "with all ITS devices".

Section 785-2.2: Grounding and Surge Protective Devices, Materials

1. Recommend that this section have a table referencing various components and the standard(s) associated with their manufacture as a consolidation point for all materials standard references – see associated standards comments, below.
2. I believe that FDOT would want the SPDs provided to be appropriately rated for the use as designed by the manufacturer. Depending on the SPD in question (AC power, CCTV, RS232/422/485, Ethernet, etc.), the operating voltage and frequency may not apply. Recommend that the last sentence of the first paragraph be revised to read: "Ensure that all SPDs are used for the use as designed by the manufacturer, and comply with environmental requirements of section A615 as shown in the table below.

Table 785-2.2a	
All SPDs	A615-4. A615-5, A615-6
AC Power SPDs	A615-2, A615-7.1, A615-7.3

"

Section 785-2.3: Grounding and Surge Protective Devices, Installation Requirements

1. Recommend that this section have a table referencing various components and the standard(s) associated with their installation as a consolidation point for all installation standard references- see associated standards comments, below.
2. General comment: The specification as described in subsections 785-2.3.1, 785-2.3.2, and 785-2.3.3 seem to make an assumption that there is plenty of land area around the site in question. However, in some cases, the use of the multiple ground rod electrode assembly may not be practical or feasible – one example is inside an urban area outside of the limited access rights-of-way. Suggest allowing the grounding designs in the most recent edition of the FDOT Design Standards Index (ITS and Traffic Signal sections) as a baseline reference, as applicable, or a signed and sealed design plan provided by a Florida-registered electrical P.E.

   For reference, here are some example Index references from the FDOT Design Standards: 1) FDOT Design Standards Index 18102 for CCTV Pole Grounding; 2) FDOT Design Standards Index 18305 for DMS Grounding Details; 3) FDOT Design Standards Index 17900 for a Traffic Monitoring Site; and 4) FDOT Design Standards Index 17736 for AC Electric Power Service.

3. Recommend that the 5 ohm resistance measurement requirement is taken as a stand-alone ground system measurement (i.e., not connected to utility ground).
4. Recommend that all ground system components shall be bonded together to a "single point ground".
5. It should be verified whether UL467 should be in the installation section of the specification. It appears that the scope of this document may refer to the standard that the grounding materials must meet for use in the NEC, which would be more appropriate in subsection 785-2.2. Testing in this document seems to be performed by manufacturers of grounding materials in independent testing labs.
6. It should be mentioned that UL497A applies to communications data circuits, voice, and video cabling.
7. Recommend that UL1449 is also referenced for AC power SPDs.
8. Section 785-2.3.2, Grounding Specifications, second paragraph, first sentence, is modified to: "Connect all grounding electrodes related to the ITS device and any *associated* grounded electrical system....."
9. Section 785-2.3.4, Ground Resistance Testing and Certification: Recommend using the four-point Fall of Potential method as a baseline certification vs. the three-point fall-of-potential where practical and feasible. The four-point method is the "gold standard" of ground testing. In addition, for ongoing test purposes, a "clamp-on" style of test can be performed at the same time to provide a baseline for comparison to the four-point Fall of Potential results. These readings would be used for ongoing inspections to find out if there is an issue with the ground system. In the case of a system that is to be custom engineered by a Florida-registered P.E., recommend that FDOT provide site geotechnical soil boring and soil conductivity tests on a per-site basis to be used in P.E. design calculations and the final grounding readings compared to baseline design projections.
10. Section 785-2.3.5, Air Terminals, last sentence: UL96 appears to provide the standard for the air terminal itself, while UL96A provides a standard for installation requirements. Recommend that UL96A is referenced along with NFPA 780 in this section, while the materials section references air terminals manufactured according to UL96.

Section 785-2.4: Surge Protective Devices

1. General comment: There seems to be a lot of text to describe what kind of tests that an SPD must meet in a lab environment, not as criteria that must be met as the selected device. Recommend moving this type of text into either another specification section labeled "ITS Testing Standards" or some similar title, and this document could refer to that set of standards. Alternatively, have a separate subsection in 785 that discusses testing standards for the QPL/APL for ITS SPDs.
2. Section 785-2.4.3, SPD at Point of Use: There are devices that are "UL Listed" and "UL Recognized". A "UL Listed" product is complete and can be used as is by the purchaser. A "UL recognized" component is a component to be used in the construction of some other product. Recommend that a "UL Listed" product is used as opposed to "UL Recognized", since a "UL Recognized" component is not a component designed to be installed in the field. In addition, the use of a "UL Recognized" component does not mean that the entire

assembly meets the "UL Listing" certification. A list of manufacturers that have met the "UL Listed" certification are on the following URL (use VZCA in the UL category code):

http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html

Section 785-5.2.13.1, Primary AC-Powered Surge Protective Device:

1. Recommend modification of the first sentence to read: "Provide the equipment shelter with a primary AC SPD (UL 1449 Type 1) that meets...."

Section 785-5.2.13.2, Secondary AC-Powered Surge Protective Devices:

1. Recommend modification of the first sentence to read: "Provide the equipment shelter with a secondary AC SPD (UL 1449 Type 2) that meets...."

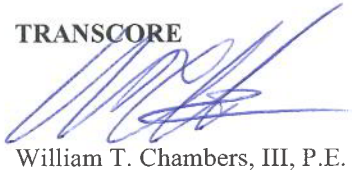
Section 785-5.3.2, Electrical Installation:

1. Second paragraph, second sentence: Recommend electrical power wiring to be sized according to NEC standard, or minimum of 12 AWG, whichever is larger.

If you have any questions, please feel free to contact me at my office (407-382-1301) or via email (bill.chambers@transcore.com).

Sincerely yours,

TRANSCORE



William T. Chambers, III, P.E.
Manager, Florida Communications

cc: Vaughn Cooper
Elizabeth Bitting
Andrew Young