Attachment 3.16a
TMS Special Provisions

TMS SPECIAL PROVISIONS

TABLE OF CONTENTS

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 238—ELECTRICAL AND SIGNAL COMPONENTS
(PROJECT NEXT TMS)

July 15, 2020

Section 238 – Electrical and Signal Components is amended as follows:

238.02 (a) is amended to include the following:

Liquid-tight flexible metallic conduit shall meet the requirements of UL 360.

238.02 (f) is amended to include the following:

In bridge parapets, barriers, and similar structures, bolts and machine screws used to secure the lid to the box must have hexagonal heads.

Boxes for power cables shall meet the requirements for Type R junction boxes except that they need not have bottoms.

238.02 (g) 2 is amended to include the following:

e. **Copper communication cable between Traffic Management System cabinets** shall comply with IMSA specification 59-2 or 60-2 and shall use 19 gauge wire unless otherwise noted on the plans.

238.02 (h) is amended to add the following:

30. **Cable end caps** used on electrical and communication cables shall meet the requirements of 238.02(h)27.

238.02 is amended to add the following:

(i) **Innerduct** shall be three-inch, three-cell textile innerduct composed of nylon and polyester. It shall have a factory-installed pull tape in each duct and shall meet the following requirements:

1. Breaking strength (ASTM D2256): 2,530 pounds.
2. Coefficient of friction using HDPE cable and no additional lubricant (ASTM D4518): 0.12 maximum.
3. Hydrocarbon resistance (Bellcore 356 4.3.2): 7.5% maximum tensile loss.
4. Print durability: Meets Bellcore 356 5.3.5.

(j) **Duct Plugs** shall be removable and reusable. They shall incorporate compression gaskets to form a watertight and gastight seal. They shall have an eye for attaching a pull tape to the plug on the face that is inside the conduit. Identical duct plugs may be used for conduit ends underground in junction boxes and exposed conduit stubs at sign structures.

(k) **Labels**.

1. Labels for cables. Use self-laminating vinyl labels at least 1.5 inches wide and long enough that the translucent portion of the label completely covers the white area bearing the legend. The vinyl shall be 0.004 inches thick with a 0.00059-inch layer of pressure sensitive acrylic adhesive. The labels shall resist oil, water, and solvents and shall be self-extinguishing. The legend shall be machine printed in letters at least 0.08 inches high. Prior to labeling any cables, submit a sample of the proposed material to the Engineer for approval. The samples shall be imprinted with a typical cable ID.

2. Labels for pigtails. Use white, self-adhesive polypropylene labels applied as flags near the connector. The area available for the text shall be at least 1" by ¾" and the area in adhered to the jumper shall be at least 0.25 square inches.
3. Labels for jumpers shall be self-adhesive vinyl wire markers preprinted with letters.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 510—RELOCATING OR MODIFYING EXISTING MISCELLANEOUS ITEMS
(PROJECT NEXT TMS)

July 15, 2020

Section 510 – Relocating or Modifying Existing Miscellaneous Items is amended as follows:

510.03 – Procedures is amended to include the following:

All work related to relocating or modifying existing miscellaneous items shall be in compliance with the requirements of the Technical Requirements and related addenda and the provisions set forth in this Section.

Modification of existing cables includes labeling the cables and sealing the ducts in accordance with Section 700.05. It also includes distributing the cable slack equally among the junction boxes and manholes through which the installed cable passes and storing the slack neatly on the hooks in the boxes and manholes. At no additional cost, replace cables that are damaged during removal and reinstallation. Proper operation and visual inspection of the cable will be adequate proof that the cable is undamaged. If a cable appears to be damaged prior to removal, do not remove it until the Engineer has inspected the cable and decided whether it should be reused. Similarly, if an existing cable appears damaged prior to installation, do not install it until the Engineer has determined that it is fit for installation.

Prior to relocating or modifying a cabinet, prepare a table or diagram of the existing fiber splices and connections in that cabinet. Replicate those splices and connections in the new location if the connection diagrams in the plans do not indicate otherwise.

Before relocating a cabinet, inspect it for damage. Bring any defects to the attention of the Engineer. The Engineer will then determine how to proceed. After relocation, repair or replace any damage occurring during the relocation. At the new location, provide lifetime silicone sealant on the bottom surface of the base adapter to seal the gap between the adapter and the foundation.

Foundation removal, which is part of cabinet and generator relocation, entails complete demolition of the existing concrete foundation to a depth of at least 2 ft. below grade and proper disposal of the resulting debris. Cap the conduits to prevent entry of water and rodents. Unless the foundation area is to be paved, it also entails provision of clean fill, compaction, application of 2 in. of Class B topsoil, and seeding with a grass seed mix appropriate for the location.

Relocation of electrical equipment entails testing the equipment prior to relocation to confirm that the equipment is working. If it is not working, demonstrate that fact to the Engineer's representative. The Engineer will then determine how to proceed. It also entails testing the relocated equipment using the same procedures developed for new equipment. For detectors and cameras, the work includes the same setup activities as for new installations. For dynamic message signs, the work includes all setup and testing recommended by the manufacturer of that equipment. For all relocated equipment, confirm proper communication from the HOT-OC.

Detector stations and Dynamic Message Signs, as identified on the plans, will be relocated or removed by the Design Builder. Coordinate work in the area of this equipment with the Department or the Department's contractors before any work is performed.

Relocation or modification to reversible roadway gates and gate controller cabinets shall follow the provisions of Section 818.

Transitioning cabinets and service panels from VDOT operation to Express Lanes operation includes:

- Replacing the identification plaque on the cabinet with the type used for Express Lanes cabinets and modifying or replacing the lock so it uses the same keys as the other Express Lane equipment cabinets or service panels. Coordinate with the Concessionaire, to obtain information on existing locks.

- Where a new splice pedestal cabinet is provided for VDOT fiber that is removed from a cabinet transitioned to 495 Express Lanes, provide a new cabinet ID plaque as required in Section 810. Adjust the size of the plaque as needed to accommodate the size of the splice pedestal cabinet provided. Cabinet ID shall be as directed by the Engineer.

- Where an existing VDOT equipment cabinet is being converted to a splice through point only, provide a new cabinet ID plaque as required in Section 823. Cabinet ID shall be as directed by the Engineer.

- Salvaged VDOT equipment shall be returned to NRO ITS Maintenance at the NROIC Facility at 8010 Mason King Court, Manassas, VA 20109.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 700—GENERAL
(PROJECT NEXT TMS)

July 15, 2020

Section 700 – General is amended as follows:

700.05 (a) is amended to replace the fourth sentence with the following:

Ground rods shall include a No. 6 bare, solid copper conductor connected to the ground rod by a clamp or exothermic weld. If that connection is not inside a cabinet or building, exothermic welding must be used. If the Plans show a larger ground wire, use the size on the Plans.

700.05 (e) is amended to add the following:

If there is a gap between the base plate and a foundation containing conduits, then wrap a strip of stainless steel hardware cloth around the gap to keep rodents out. The hardware cloth shall extend from the top of the concrete to the top of the base plate, but shall not protrude above the base plate. The hardware cloth shall have ¼" mesh and shall be held in place by a stainless steel band around the base plate. The ends of the strip shall overlap by at least six inches.

700.05 (h), seventh paragraph is replaced by the following:

Use the same type of sealant for conduits containing communication cables. At the top of occupied conduits in cabinets and pole bases, use a wad of copper wool or mesh stuffed several inches into the conduit, blocking the path of rodents. During conduit installation, plug ducts as soon as they are installed and only remove the plug to join sections together or to pull cable through the duct. Plug the duct immediately after completing the pull. When installing conduit or cable to or through any cabinet, junction box, or manhole, ensure that all ducts are plugged, not just the ones in which work was performed.

Install stainless steel toggle bolts with washers and wing nuts (large enough to completely cover the openings) in communications junction boxes manhole hook openings, blocking the path of rodents.

700.05 (h), tenth paragraph, is replaced by the following:

Non-metallic VDOT conduits with non-metallic cable (fiber optic) within shall be equipped with a No. 8 locator wire.

Non-metallic Express Lanes conduits with non-metallic cable (fiber optic) shall be locatable at all times. Where Express Lanes fiber optic cable is installed in a common trench and where VDOT locator wire is already installed in the same trench, a locator wire shall not be required in the Express Lanes conduits. Where Express Lanes non-metallic cables are installed and conduit system diverges from the common trench, a locator wire shall be installed.

Where a locator wire is required to make the conduit run locatable, the wire shall be an insulated #8
AWG stranded copper wire. The insulation shall not be green in color.

700.05 (h) 2 is amended to include the following:

When boring, provide a means of collecting and containing drilling fluid/slurry that returns to the surface, such as vacuum truck or slurry pit, or a method approved by the Engineer. Provide measures to prevent drilling fluids from entering storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways, or streets. Immediately remove any

slurry that is inadvertently deposited on pedestrian walkways. Transport waste drilling slurry from the site and dispose of it. Do not allow slurry to enter wetlands or waterways. Protect wetlands and waterways using appropriate soil erosion control measures approved by the Engineer.

700.05 is amended to add the following:

(l) **Blocked or Damaged Conduits:** If cable is to be installed into an existing conduit and the conduit is found to be blocked or damaged, clear the obstructions or repair the damage prior to installing cabling in existing conduits.

Conduit requiring cleaning shall be identified in writing by the Design-Builder. Once the Engineer provides approval for the cleaning, the Design-Builder shall clean the conduit. This cleaning shall be conducted in the presence of the Engineer's representative. Blockages shall be cleared by first rodding the conduit. Then, a mandrel having a diameter of at least 80 percent of the inside diameter of the conduit shall be pulled back through the conduit run. Finally, install a pull tape and plug the ends if cable will not be installed immediately.

If the blockage cannot be cleared or the conduit is crushed, propose a solution for the Engineer's approval.

(m) **Cable Labeling:** Label every new or reinstalled cable or wire immediately upon installation. Label the cables at every point of access, including manholes, junction boxes, and termination points.

Cables for ITS Communications and Power

Cables and wires shall be labeled using the three-part ID system used for existing cables. The cable ID shall be the same at every point where the cable is labeled, from one termination or splice point to the other. The first part of the ID identifies the type of cable. The second part of the ID is the ID of a cabinet or other location where the cable is terminated or spliced. For example, 48SMF-B078 denotes a fiber optic cable with 48 single mode fiber strands that enters cabinet B078. The third part of the ID is a number assigned sequentially to differentiate between cables that have the first two parts of the ID the same. For example, 24SMF-B097-1 and 24SMF-B097-2 would be two different fiber optic cables, each made up of 24 single mode fiber strands that originate (or terminate) in Cabinet B097. Every communication cable should have a different ID. Power conductors in the same circuit, running together between the same two points, should have the same ID. Ensure that the labels accurately reflect as-built conditions.

Cables for Roadway Lighting

Cable label material and procedures shall be identical to that for ITS cables. Cable IDs shall identify the service panel, circuit number, and phase conductor.

(n) **Textile Innerduct:** Innerduct shall be installed in all 4" Express Lanes and VDOT communications conduits that have cables installed as part of the project unless noted on the plans. Spare conduits and 2" communications conduits shall not have innerduct installed. In conduits between equipment cabinets and the nearest junction box or manhole, innerducts shall be omitted.

Arrange for the manufacturer of the innerduct to provide on-site training in the installation of this product. Only personnel who have been trained by the manufacturer are allowed to supervise the installation.

Use the swivels and grips recommended by the manufacturer.

Unless this project installs three strips of textile innerduct in a conduit, install a pull tape into the conduit on top of the innerduct, so that another innerduct can be pulled into the conduit if needed in the future.

Anchor the innerduct at the feed end before pulling cables into it, so the cables don't drag the innerduct into the conduit. To anchor, make a slit near the seam, pass a length of pull tape through the slit and tie it to the innerduct. Then tie the other end of the tape to a fixed object.

(o) **Wall Penetrations:** To install conduit into junction boxes and manholes with reinforced concrete walls, enter through the bottom if the bottom is open. Otherwise, use existing knockouts or conduit stubs. If none of those options are available, drill, cut, or chisel a hole through the wall without cracking the concrete. Use a rebar detector to mark the location of reinforcing steel prior to making the hole. If the spacing of the rebar permits, make the holes without damaging the reinforcing steel. After the conduit has been installed, scrub the perimeter of the hole with water, apply an approved bonding agent to concrete, and grout the gap between the

conduit and the wall. Use non-shrink grout.

(p) Cleaning Junction Boxes: Pump out standing water, clear all silt, debris, and foreign matter to the satisfaction of the Engineer. Remove and dispose of debris. Should additional silt, debris, or water accumulate in the box between the original cleaning and final inspection, remove them at no additional cost to the Concessionaire.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 703—TRAFFIC SIGNALS
(PROJECT NEXT TMS)

July 15, 2020

Section 703 – Traffic Signals is amended as follows:

703.02(f) Detectors is amended to include the following:

6. **Microwave Vehicle Detector:** For both permanent and temporary detection, provide a Wavetronix SmartSensor HD. The detector shall include mounting hardware, device server, sealant, cable, Category 5E jumpers, power supply, and a surge protection module in the main cabinet. If the detector cable passes through a Type 1 cabinet, provide a second surge protection module in that Type 1 cabinet. All these items shall be recommended by, and supplied by, the detector manufacturer. If multiple detectors are connected to a single cabinet, each must be installed with separate communications cables, device servers, and surge protectors. Multiple detectors may share a single power supply.

   Type 1 cabinets house a surge protection module at the structure supporting the detector. These cabinets also provide a place where a technician can plug in a laptop computer and calibrate the detector while observing traffic. The cabinets shall be small aluminum NEMA 3R enclosures with a DIN rail and, mounted to the DIN rail, a surge protector supplied by the detector manufacturer. The protector shall have an EIA-232 connector for the technician's laptop. Equip the cabinet with a lock that uses the same key as the other Express Lanes cabinets in this project. Provide a cabinet ID plaque per the requirements of Section 810. Cabinet IDs shall be as shown on the plans or as provided by the Engineer.

   Detector cables shall be labeled in each equipment cabinet with the detector it servers and the destination cabinet ID. For cabinets serving multiple detectors, clear identification of the detector shall be provided. For example, identify detectors for ramps versus detectors for mainline express lanes.

703.03(g) Installing Detectors is amended to include the following:

6. Microwave Vehicle Detectors for both temporary and permanent installations must be installed in accordance with the manufacturer's recommended procedure for side-fired installation. Note that the recommended mounting height is relative to the road surface, not the base of the pole. Installation may be done by the Design-Builder's forces, but must be checked by the manufacturer's representative and adjusted as recommended by the manufacturer's representative.

   Installation includes connecting the detector to surge protection, power, and communication, aiming it, and setting operating parameters. Use EIA-485 communication and set the communication rate to 9.6kbps unless otherwise directed by the manufacturer and the Integrator.

   If mounted on a metal pole or post, the Type 1 cabinets must be grounded to the pole or post that must, in turn be grounded. Use #6 AWG wire or an equivalent bonding strap between the cabinet and post.

   Set up shall include speed calibration using measured reference speeds. Present evidence satisfactory to the Engineer that the speed measuring device used for detector calibration has been proven accurate. Provide all equipment, such as a radar gun, software, laptop computer, tools, and cables, needed for the set up work.

Develop test procedures in accordance with manufacturer recommended procedures and satisfactory to the Engineer. The tests shall include confirmation of the accuracy of counts and average speed in each lane. Both results shall be within ten percent of independently measured values during a continuous period in which at least 100 vehicles are counted unless a lower count is approved by the Engineer or

System Integrator representative on-site. Conduct the test in the presence of the Engineer's representative. When the detector passes the test, deliver the values of all parameters to the Engineer in printed or computer-readable form, along with the test report. For detectors monitoring a reversible lane, this test procedure shall be applied separately for each direction of traffic flow. Provide a table in the plans illustrating microwave detector lane coverage for Express Lanes and General Purpose Lanes where applicable.

7. **Microwave Vehicle Detector Reconfiguration:** At the temporary and permanent locations installed by the Design-Builder as part of the project, microwave vehicle detectors shall be set up as if they were new when shifts in traffic lanes warrant reconfiguration. Active detectors shall monitor traffic lanes as defined by the current maintenance of traffic lane arrangement or the permanent lanes as defined by the plans or construction operations. After all lanes are in their final configuration and carrying traffic, check the detector's operation and adjust the setup parameters as necessary to match existing conditions. Then test the detector using the same acceptance test as for those provided in this project. After it passes the test, give the Engineer a written or computer-readable copy of all the setup parameters along with the test report.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 800—SUMMARY OF WORK
(PROJECT NEXT TMS)

July 15, 2020

800.01— General.

The purpose of these Special Provisions is to set forth the Traffic Management System (TMS) communications infrastructure, power, equipment, and testing requirements for the Design-Builder to install the infrastructure, communication, and hardware as specified in the Contract Documents and as shown on the Plans. In addition to these Supplemental Specifications where applicable, the Contractor shall adhere to the 2020 Edition of the VDOT Road and Bridge Specifications.

The applicable sections of the VDOT Road and Bridge Specifications, 2020 Edition, including all construction supplements thereto, shall govern all construction items that are not specifically covered in these Supplemental Specifications. In the event of conflict between the Supplemental Specifications and VDOT Road and Bridge Specifications, the Special Provisions will govern for work on the Express Lanes, while the VDOT Road and Bridge Specifications, 2020 Edition will govern work on the General Purpose Lanes. Also in the event of conflict between these Supplemental Specifications and the Plans, these Supplemental Specifications (Project NEXT TMS Special Provisions) are the controlling document.

Field equipment, vendor software, communications and power as specified in the Contract Documents, are to be furnished and installed as a complete Traffic Management System.

These Special Provisions and Plans are for materials and equipment to construct the proposed Project NEXT TMS; however, every fitting, minor detail or feature is not shown or described. The Design-Builder is assumed to be an expert in the trade, capable of understanding the intent of the Plans and Special Provisions, and capable of constructing the project in accordance with the best practices of the trade.

The intent of the Contract is to provide for the construction, execution and completion of every detail and element of the Work in accordance with the Contract Documents. The Design-Builder shall perform all items of work covered and stipulated in the Contract Documents, perform altered and miscellaneous work, and furnish all labor, materials, equipment, tools, transportation and supplies required to complete the Work in accordance with the Contract Documents. Should any dispute or misunderstanding arise as to the intent or meaning of any of the Contract Documents, or any discrepancy therein, the decision of the Engineer shall be final and conclusive as to the requirements for performance of the Work; provided, however, if the Design-Builder disagrees with such decision, it may dispute the decision in accordance with the dispute resolution process.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 813—UNINTERRUPTIBLE POWER SUPPLY
(PROJECT NEXT TMS)

July 15, 2020

813.01 – General.

All work related to the installation and testing of Project NEXT UPS shall be in compliance with the requirements of the provisions set forth in this section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of Section 802 of the 2020 Edition of the VDOT Road and Bridge Specifications.

Provide Uninterruptible Power Supplies (UPS) at locations as shown on plans. The UPS assembly shall provide complete non-interruptible power protection, voltage regulation, and surge and spike protection for all ITS devices and communications equipment powered by it. The UPS shall instantly transfer the cabinet to the battery back-up mode in the event the main AC power source goes offline.

(a) Express Lanes Configuration: UPS shall be installed at the last DMS cabinet location before entering the Express Lanes. The UPS shall have an uninterruptible power supply (UPS) that supports the equipment in the event of a power outage for at least 1 hour. For Hub Sites install one UPS as shown on the plans and supports the equipment in the event of a power outage for at least 1 hour.

813.02 – Materials.

(a) The Inverter/UPS shall be ZincFive UPStealth 170 Inverter/Controller with Simple Network Management Protocol. The 170 UPStealth Inverter/Controller shall be configured to match the power requirements of the traffic cabinet. Provide one USB port and one Ethernet RJ-45 connector for Category 5/6 copper wire connections. The Battery Panels shall be the Living-Hinge Battery type Panels which are designed for easy installation by sliding between the cabinet rack and the outside shell of the cabinet. Provide one 500W Battery Panel for each UPS installed.

813.03 – Construction.

(a) The UPS shall be a commercially available package containing all wiring connectors, software, mounting brackets, and cables. The UPS assembly shall consist of a UPS with batteries, surge suppression, LED status indicators for “On-line,” “Battery On,” “Replace Battery,” and “Overload,” customizable output relays and input contacts, and network management cards (IP addressable).

813.04 -Procedures

(a) Installation:

1. Install the UPS, power and wiring in accordance with the manufacturer’s recommendations. The UPS shall be rack mounted below the controller in the DMS Cabinet.
2. Ground the UPS in accordance with the manufacturer’s recommendations.
3. Label all cables at both ends, indicating the particular device it serves.
4. Set the operating parameters as directed by the System Integrator, including IP address, and location.

(b) **Testing:**

Acceptance Testing: Develop a test plan and procedures that demonstrate proper operation of the UPS under full load conditions and demonstrate the expected operating performance and uptime. The plan shall include all tests recommended by the manufacturer. When the plan is satisfactory to the Engineer, conduct the testing in accordance with the plan and prepare a test report. Provide any software and equipment needed to conduct the tests.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 814—CAMERA SYSTEM
(PROJECT NEXT TMS)

July 15, 2020

814.01 – General.

All work related to the installation and testing of Project NEXT closed circuit television (CCTV) shall be in compliance with the requirements of the provisions set forth in this section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of Section 803 of the 2020 Edition of the VDOT Road and Bridge Specifications.

Provide CCTV cameras, poles, mounting hardware, cables, and surge protection for surveillance and automatic incident detection (AID) as indicated in the plans.

814.02 – Materials.

(a) **Express Lanes surveillance camera Assembly:** shall be COHU Costar Electronics Model 4260HD-Rise Series Positioner with cables, power supplies, and mounting hardware recommended by the manufacturer. It shall use NTCIP communication.

(b) **Express Lanes AID camera assembly** shall be COHU Electronics Model 3430 Series Fixed Barrel AID camera with cables, power supplies, and mounting hardware recommended by the manufacturer. It shall use NTCIP communication.

(c) **Camera Pole**

1. **General:** Pole shall be a galvanized steel pole and shall comply with Section 226 of VDOT Standard Specifications and the Plans. Some camera pole foundations shall be built in accordance with designs in the Plans and others shall be designed by the Design-Builder. Regardless of who designs the foundation, poles of the same length shall be interchangeable unless the Engineer approves an exception. If the design requires a pole height greater than 50 feet, the Design-Builder shall provide a camera-lowering device.

2. **Design:** Design the pole and, if indicated on the Plans, the foundation. Submit the design to the Engineer for approval, including a structural analysis and calculations sealed by a professional engineer registered in Virginia. The structural calculations shall be based on soil samples from each proposed pole location. The design shall be adequate for a pole with two surveillance cameras, two AID cameras, and two detectors. The structural analysis shall use the procedures and parameters in the 1994 AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* to demonstrate that:

   - The foundation meets all the requirements of the AASHTO *Standard Specifications*.
   - The horizontal deflection of the top of the pole does not exceed 1/2 inch in a 30 mph wind.

   The anchor bolts shall be designed in accordance with the 2001 AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.* Do not construct or order the pole and foundation until the drawings and calculations are approved.

3. **Hand-holes** shall have steel frames with gasketed galvanized steel covers and captive stainless steel attachment screws. Finish handholes smoothly and neatly without rough edges. Handhole covers shall be connected to the pole with rustproof chain that connects the inside of the cover to an attachment point inside the pole, just below the handhole. The chain shall be long enough to permit the cover to dangle 6 inches below the handhole opening.

4. **Cable access holes** at the elevation of the AID cameras and Detectors shall be embedded two-inch galvanized steel couplings. Each shall be fitted with a weatherhead or a raintight removable

plug, depending on whether the hole is used.

5. **Identification tag:** The pole shall have an identification tag permanently attached in accordance with the requirements for identification tags set forth in Section 700.04(e). The tag shall state the length of the pole.

6. **Cable support:** Provide hooks securely fastened to the inside of the pole wall for cable grips. See the Plans.

7. **Air Terminal:** Provide a solid copper rod, 0.75 inches in diameter. The length of the rod shall be such that it projects 5 feet above the top of the camera. At the points where the rod bolts to the pole, use a conductive joint compound to minimize galvanic corrosion of the dissimilar metals.

814.03 – Procedures.

(a) **Installation**.

1. All conductors shall run continuously from the camera to the cabinet, with no splicing or connections along the way.

2. Camera cables shall be installed in junction boxes with a nominal slack length of 15 feet.

3. Inside the pole, support every cable with a cable grip hung from a hook inside the pole.

4. Install the surveillance camera such that when the camera is commanded to the factory default home position, the camera is pointed approximately north.

5. Pressurize the cameras with dry nitrogen to the pressure recommended by the manufacturer.

(b) **Setup**:

1. Set the camera operating parameters as directed by the Integrator. This includes the IP addresses. Video from the surveillance and AID cameras shall be sent using multicast.

2. Aim the AID cameras in accordance with the initial layouts provided in the plans. Then, verify them in the field with the support of the AID vendor. Adjust the cameras as recommended by the AID system vendor.

(c) **Acceptance Testing:** Develop a test plan and procedures that tests every camera function. Test plans shall include all tests recommended by the camera manufacturer. When the plan is satisfactory to the Engineer, conduct the testing in accordance with the plan and prepare a test report. The tests shall be conducted at the field equipment cabinets and shall include the following:

- All diagnostic tests recommended by the manufacturer and all self-tests of which the equipment is capable.
- Visual inspection for manufacturing and installation defects.
- Local operation of all CCTV equipment, exercising the iris and focus controls while observing the video picture on a laptop. For surveillance cameras, also check pan, tilt, and zoom.
- Verification that the camera enclosure is at proper pressure and maintains that pressure over time.
- Demonstration of camera sensitivity at low light levels.
- Demonstration of pan/tilt speed and extent of movement.
- Demonstration that the Preset test to ensure camera consistently goes to the proper preset position and that the presets have been properly titled.
- Demonstration that the sectors have been properly titled.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 815—DYNAMIC MESSAGE SIGNS
(PROJECT NEXT TMS)

July 15, 2020

815.01 – General.

All work related to the installation and testing of Project NEXT DMS shall be in compliance with the requirements of the provisions set forth in this Section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of Section 804 of the 2020 Edition of the VDOT Road and Bridge Specifications.

Provide dynamic message signs (DMS) as shown on plans.

815.02 – Materials.

(a) **Signs:** Provide two models of DMS:

1. **TYPE 2:** Provide Daktronics Model VF-2420-64x192-20-RGB complete with a Daktronics Model VFC controller (or successor model recommended by the sign vendor) and any other accessories needed for safe, effective operation.

2. **TYPE 2A:** Provide Daktronics Model VF-2420-96x288-20-RGB complete with a Daktronics Model VFC controller (or successor model recommended by the sign vendor) and any other accessories needed for safe, effective operation

Cables: Provide cables between the DMS and the controller cabinet as recommended by the manufacturer, except that fiber optic cables must be listed as round drop cable on the last edition of the Rural Utility Service List of Materials Acceptable for Use on Systems of USDA Rural Development Telecommunications Borrowers. It shall be round, dielectric cable with a single core and shall contain at least two spare fibers. All cables including patch cables and pigtails shall meet EIA/TIA telecommunications standards. Fiber Optic cable between the DMS and controller cabinet shall be terminated in a wall mounted patch panel in both the DMS and controller cabinet.

815.03 – Procedures.

(a) **Installation:**

1. Install the sign and controller in accordance with the manufacturer's recommendations. The controller goes in the equipment cabinet on or near the sign support structure.

2. After installing the cables running from the controller cabinet to the sign, terminate copper cables on terminal blocks and provide surge protection meeting the requirements of Section 801. In the equipment cabinet, terminate fiber optic cables in small, DIN rail-mounted interconnect centers that provide no openings through which a mouse can pass. Use jumpers to connect the interconnect center to the equipment. Terminate fibers in the sign in an interconnect center recommended by the sign manufacturer and connect fibers to the sign communication panel using jumpers. Fan-out kits and field termination of fibers in the cabinet and the sign are prohibited.

3. Configure the controller with a network address and other parameters in accordance with a plan provided by the system integrator.

(b) **Brightness Adjustments:** Adjust the sign and controller to achieve 16 or more brightness levels appropriate for the particular sign, and set up the lighting conditions for which each brightness level will be used. The Engineer's representative will observe the operation of the sign under a variety of lighting conditions. Make changes requested by the Engineer until the brightness adjustments are approved by the Engineer.

(c) **Acceptance Testing:** For Express Lanes signs, develop a test plan and procedures that demonstrates

proper operation of the sign. The plan shall include all tests recommended by the manufacturer. When the plan is satisfactory to the Engineer, conduct the testing in accordance with the plan and prepare a test report. Provide any software and equipment needed to conduct the tests. Testing must include the following:

1. **At the DMS site**:

   - Visual inspection for manufacturing and installation defects.
   - All tests recommended by the manufacturer and all self-tests of which the equipment is capable.
   - DMS housing ventilation system.
   - Restart of DMS controller following loss of power.
   - Verification of contents of non-volatile, changeable memory following loss of power.
   - Operation of stored messages and schedule.
   - Functionality of each pixel.
   - Automatic dimming.
   - For gate signs, proper response to control signals from the gate controller.

2. **At the HOT-OC:** Demonstrate that the sign operates properly under the control of the HOT-OC's central software. Confirm proper operation in the field during the testing.

   - Acceptance of properly addressed messages.
   - Message selection command and response.
   - Immediate message command and response.
   - Parameter download command and response.
   - Parameter upload command and response.
   - Time broadcast command.
   - Reporting of high temperature.
   - Detection and reporting of errors.
   - After final acceptance of the installation and operation of each DMS, capture the sign configuration files and provide them to the System Integrator.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 816—FIBER OPTIC COMMUNICATION
(PROJECT NEXT TMS)

July 15, 2020

816.01 – General.

All work related to the installation and testing of Project NEXT Fiber Optic Communication shall be in compliance with the requirements of the provisions set forth in this Section. In addition to these Supplemental Specifications, the Contractor shall adhere to the applicable requirements of Section 808 of the 2020 Edition of the VDOT Road and Bridge Specifications.

816.02 – Materials.

a) **Fiber optic cable** shall be loose tube, single mode, metallic single-armored cable. The cable shall meet the requirements of ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-2006 and GR-20-CORE and have a tensile rating of at least 600 lbs. The cable sheath shall have length markings in feet, and shall indicate that the unit of measure is feet. The cable shall have an operating temperature range of -40º F to 157º F.

All fibers shall be suitable for transmission using both 1310 nm and 1550 nm wavelengths. Attenuation shall not exceed 0.35 dB/km and 0.25 dB/km for 1310 nm and 1550 nm signals, respectively. Cables shall be constructed with twelve fibers per tube.

Armored cables without an inner jacket shall have an armor layer applied directly over the water swellable tape and cable core. The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall have an overlapping seam. The outer jacket shall be applied over the corrugated steel armor tape.

(b) **Number of Fibers:**
Fiber optic cables shall be provided as shown on the plans with the number of fibers as follows:

XPL Trunk – 36 fibers: Install trunk and distribution cables in separate conduits. (Trunk shall be installed in primary 4” conduit)

XPL Distribution – 36 fibers (except where noted on the plans: Install trunk and distribution cables in separate conduits. (Distribution shall be installed in spare 4” conduit)

VDOT Trunk – New installations – 48 fibers

VDOT Trunk – Replace/Relocate – Replace in kind, to be verified in the field

VDOT Distribution – New installations – 36 fibers

VDOT Distribution – Replace/Relocate – Replace in kind, to be verified in the field

(c) **Connectors** shall be LC compatible, with ceramic ferrules unless otherwise approved for specific manufacturer device connections. They shall be suitable for use in traffic cabinets and shall be designed for single mode fibers. The connector loss at terminal equipment shall not exceed 1 dB. All connectors in VDOT and new Express Lanes cabinets shall be Ultra Polished Connectors (UPC).

(d) **Rack-Mounted Interconnect Center:** Provide a Corning Cable Systems Model CCS-03U interconnect center or approved equal, with enough connector panels and splice trays to accommodate all the terminations and splices made at its location. Splice trays shall be 0.2 inches high, made of aluminum with clear plastic covers, designed for outdoor use. Each shall accommodate 24 or more fusion splices

in heat- shrink sleeves. All trays shall have a black powder coat finish. The trays shall have both perforations for cable ties and crimpable metal tabs for buffer tube strain relief.

(e) **Pigtails** shall be factory-made, buffered, and strengthened with aramid yarn to reduce the possibility that accidental mishandling will damage the fiber or connection. Pigtails shall be yellow. They must use LC type of connectors unless otherwise specified. Each must contain one fiber. Length shall suffice to provide two feet of slack after installation.

(f) **Jumpers** shall meet the requirements for pigtails, but shall have a connector on each end. The second connector shall be as specified in Sections 808,809 and 810 except where a different connector is required for compatibility with the equipment to which the jumper connects. Length shall suffice to provide approximately three feet of slack after installation.

(g) **Splice Enclosures (where approved by the Engineer)** shall be suitable for underground installation in manholes and junction boxes. Splice enclosures shall meet the standards of Telcordia GR-771. The splice closure shall allow for splicing of fibers within uncut cables. The splice closure shall be installed with all necessary splice trays and accessories to support up to 72 splices. The splice closure shall be wall mountable inside a junction box or manhole.

(h) **Ground Kits** shall be provided for the bonding and grounding of armored cable, splice enclosures, and interconnect centers (i.e., patch panels). The kits at a minimum shall include armor ground clamps, bonding jumpers, and connectors; and shall be in accordance with the cable manufacturers' recommendations, NEC, and industry standards.

816.03 – Procedures.

(a) **Fiber Optic Cable Installation:** Use installation techniques that do not degrade the optical and mechanical characteristics of the fiber. Do not violate the minimum bend radius or maximum tension during installation or afterwards.

When pulling cable, use a clutch device or breakaway swivel to ensure the allowable pulling tension is not exceeded.

Use a lubricant recommended by the cable manufacturer to facilitate pulling the cable. After the cable has been installed, wipe the exposed cable in each junction box, manhole, or cabinet clean of cable lubricant with a cloth.

For proposed cables, store 20 feet of slack in every intermediate manhole or junction box. If multiple fiber cables pass through the junction box or manhole, store 20 feet of slack for each. At cabinet locations, where cable runs from the junction box directly to an equipment cabinet, store 30 feet of slack cable in the junction box. Additionally, treat the cable returning from the cabinet to the junction box as a separate cable, and store 30 feet of slack for it. Store slack cable neatly on the walls of the junction box or manhole using racking hardware acceptable to the Engineer. Store one loop of cable in the base adapter of ground mounted cabinets. Ensure the cable is supported and neatly organized in the cabinet base.

Seal the fiber optic cable ends to prevent the entry of water.

(b) **Splicing:** Before splicing, use an optical loss test set to collect the data needed to demonstrate that the splice is acceptable. See the section on testing, below.

All fibers, including spares, shall be spliced to provide continuous runs. Splices shall be allowed only in equipment or splice cabinets unless otherwise shown on the plans or approved by the Engineer. If the connection diagrams in the plans indicate that the splices are to be housed in existing splice enclosures or interconnect centers, provide additional splice trays or other hardware as required to make the splices.

All splices shall be made using a Sumitomo FastCat Type-39 or Quantum Q101 fusion splicer or approved equivalent. Average splice loss for both 1310 and 1550 nm wavelengths shall not exceed 0.1 dB, and no single splice may have a loss above 0.2 dB. Any splice with a loss exceeding 0.2 dB shall be remade until its loss falls below 0.2 dB. Provide all equipment and consumable supplies.

Use a separate splice tray for each buffer tube color, unless that would require more trays than the existing

splice enclosure can hold. If there are too few existing trays in the enclosure, provide additional trays. Provide the same type of trays as the existing ones.

Protect each splice in a heat-shrink sleeve.

(c) **Termination:** Terminate fibers by splicing them to pigtails. For each pigtail, label the corresponding position on the patch panel with the cable ID and fiber number. Label the pigtail with the fiber number. All labeling must legible and done with indelible markings.

(d) **Jumper management:** Use latching cable rings to guide and protect bundles of jumpers between the interconnect center and equipment. Affix the rings to wall of the cabinet or a vertical member of the equipment rack. Label the jumpers at each end, assigning each jumper a unique letter of the alphabet.

(e) **Bonding and Grounding:** Bond and ground the fiber optic cable armor and other metallic components of splice enclosures and interconnect centers (i.e., patch panels) at each cable splice and cable termination location. In addition, bond and ground the cable armor at intermediate pull box locations (i.e., boxes used as cable pull points between cable splices and terminations) where required. Perform the work in accordance with the cable manufacturers' recommendations, NEC, and industry standards.

(f) **Testing:** Test the fiber after installation, including all splicing and terminations, is complete. Note, however, that this test procedure involves measuring the optical loss of existing fiber before splicing to it. For each fiber optic link, including spare fibers, determine whether the optical loss is within the limits permitted by these specifications. A link is a continuous segment of fiber between one connector (or unterminated end) and another connector (or unterminated end). When testing links that do not have connectors on both ends, use a mechanical splice to attach a pigtail to the unterminated fiber for the duration of the test.

(g) **System Cutover:** The existing 495 Express Lanes Trunk and Distribution fiber shall remain in place during construction and after the new NEXT trunk and distribution becomes active. The Design-Builder shall coordinate with the Concessionaire's Engineer for transitioning the existing new communications infrastructure and the proposed Traffic Management System devices to the existing 495 Express Lanes communications network segment. All work authorizations shall be coordinated and approved by the Concessionaire.

Before taking the measurements, provide evidence satisfactory to the Engineer that a power meter and light source test set produces accurate results at both 1310 nm and 1550 nm wavelengths. This can be a demonstration that the set correctly measures the loss of a test fiber whose loss is known.

For each fiber link, follow this procedure:

1. If the link includes existing fiber cable, use an optical loss test set (power meter/light source) to measure and record the optical loss over that portion of the link before it is spliced to new fiber.

2. Calculate the maximum allowable loss for the completed link, both at 1310 nm and at 1550 nm. Use the following formula:

   Maximum link loss =
   Measured loss over existing cable portion +
   (New fiber length in km) x (0.35 for 1310 nm and 0.25 for 1550 nm) +
   (Number of fusion splices) x (0.1) +
   (Number of mechanical splices [for temp. connection]) x (0.3) +
   (Number of connections) x (1.0)

   Provide this calculation to the Engineer along with the test results.

3. Use the test set (power source/light meter) whose calibration has been approved by the Engineer to measure the loss of the link under test. Record the result at both 1310 nm and 1550 nm. Arrange for the Engineer or his representative to witness these tests.

4. If the measured loss exceeds the calculated maximum, use an optical time domain reflectometer and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum. Such corrective actions shall be

at no additional cost.

5. Prepare a diagram showing all of the links tested in this project. For the portions installed in this project, show the equipment cabinets, splices, and pigtails. On each line representing a link, show the maximum allowable loss and the actual loss. The actual loss shall be the one measured after all corrective actions have been taken. Submit 10 copies of this diagram to the Engineer, along with the calculations for the maximum allowable losses.

At each bonding and grounding location test the installation to demonstrate that the installation is in accordance with cable manufacturer recommendations, NEC, and industry standards. Prior to performing the tests, submit a test procedure to the Concessionaire's Engineer for approval.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 817—ETHERNET SWITCHES
(PROJECT NEXT TMS)

July 15, 2020

.

817.01 – General.

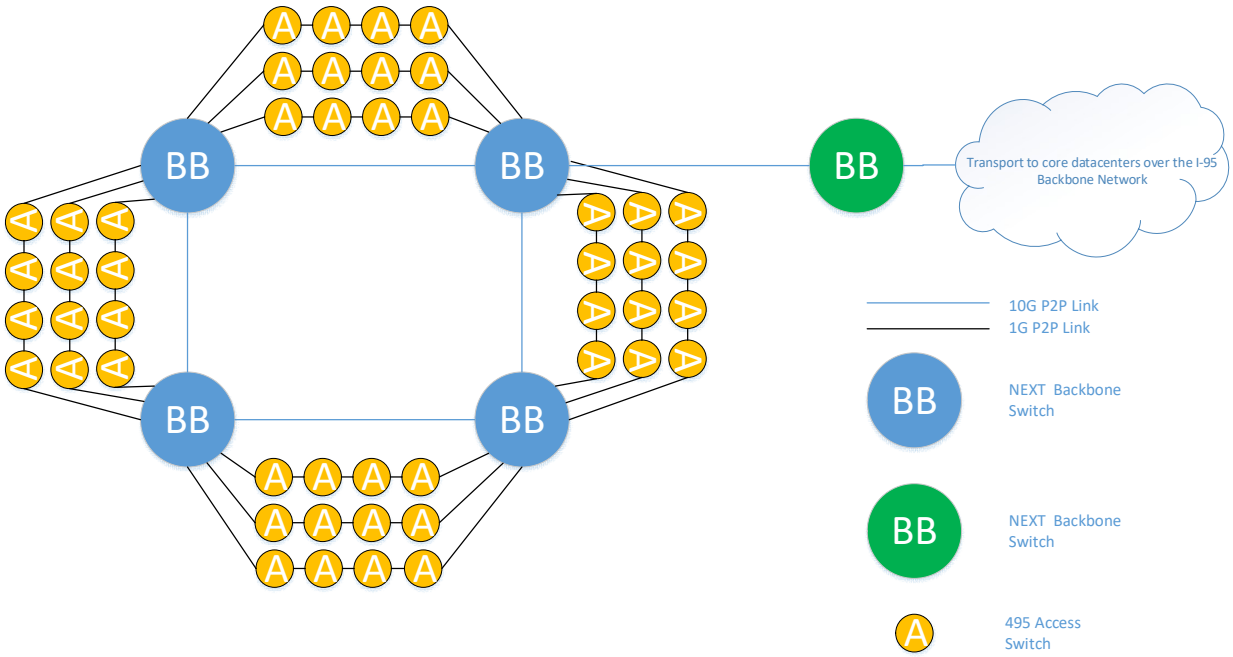
All work related to relocating or modifying existing networks or the installation of new networks shall be in compliance with the requirements of the provisions set forth in this section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of section 809 (Access) and 810 (Layer 3) of the 2020 Edition of the VDOT Road and Bridge Specifications.

This work entails expansion of a wide area network connecting proposed roadside equipment to the HOT-OC. It also entails modifying the Concessionaire's existing network by adding proposed cabinets and transferring some cabinets from the existing Express Lanes Southern Terminus network. The connection diagrams in the plans show the communication equipment to be provided in each cabinet and how the equipment connects to the fiber optic cables.

(a) **Express Lanes Network Topology:** The Express Lanes network is built over two cables, a trunk cable and a distribution cable. The trunk (backbone) cable runs directly from one toll location or hub site to the next. It is used for backbone network control data as well as transport of endpoint traffic. Endpoint traffic originates from distribution and backbone connected devices, onto and off of the network. The backbone uses 10 Gigabit Ethernet communications and is built over a single fiber pair between each backbone switch.

The distribution cable generally runs parallel to the backbone cable in the same duct bank. Instead of running directly between tolling points or hub sites, it is run into and out of each roadside cabinet and tolling point that it passes. A distribution link built over this cabling infrastructure connects the equipment in the roadside cabinets to the 10 Gbps backbone. Where possible, distribution links connect to separate tolling points on either side of a given link. The distribution links operate at 1 Gbps. The roadside cabinets are not all connected to the same pair of fibers in the distribution cable; multiple pairs are used so that no more than seven (7) access switches are on any pair running between adjacent tolling points. Access switches shall be connected as shown on the plans. Also, cabinets at generators are on a separate pair of fibers from other cabinets so that communication to the generators is maintained even when neither the generator nor the power company is supplying power. (If the generator cabinets, which have battery backup power, were on the same fibers as cabinets without battery backup, then the cabinets without power would interrupt communication between the generator cabinet and the HOT-OC.) Similarly, cabinets connected to generator power are always on separate fibers from cabinets that do not have generator power.

The diagram below illustrates the topology to be used, it is representative and does not reflect the actual number of toll points. Each line represents a pair of fibers. The circles containing A are roadside cabinets containing access switches. The circles containing BB are tolling points (or the EOC) containing Backbone switches. The network shall be configured as a 'IP to the edge' solution. Each access switch will have a set of local virtual local area networks (VLANs), and associated switched virtual interface (SVI), to be assigned per-port depending on the connected endpoint service. Each endpoint will use the local SVI as their designated IP gateway which will be advertised into the network via Open Shortest Path First (OSPF). Inter-access switch, backbone to backbone, and access to backbone switch, communication will be established via point-to-point (P2P) routed links.



(b) **Express Lanes Network Operation:** The operation of the network shall be as follows. When a packet is sent from the operations center computer, it travels around the backbone ring until it reaches a tolling point or hub site that connects to the pair of distribution fibers serving the destination equipment. Then the switch in the Technical Shelter or Hub Site transfers the packet from the backbone to the distribution cable, where it continues on to its ultimate destination. If a cable cut or switch failure interrupts the usual path between the operations center and the destination equipment, the switches use the OSPF protocol to route data packets around the break.

817.02 – Materials.

(a) **General:** Along with each switch, provide all required licenses, mounting hardware, power supplies, SFP transceivers, cables, jumpers, and connectors needed to connect the switch to power, communication cables, and neighboring devices. Access switches installed in roadside cabinets shall use LC optical connectors and be mounted on DIN rail. Backbone switches shall use LC optical connectors and be rack-mountable.

(b) **Backbone switches for the Express Lanes communication network** shall be Cisco C9500-16X-A with the C9500-NM-8X expansion module at the tolling points. These switches shall include two (2) hot-swappable 350W AC power supplies and Network Advantage feature set. The Design-Builder shall provide the switch model at each toll point to accommodate the connections shown on the plans and as described herein. Provide enough SFP optical transceivers to accommodate all the fiber connections shown on the plans. Ensure that the

transceivers are recommended by the switch manufacturer and have sufficient optical power to communicate reliably with the adjacent switches on the ring. Transceivers shall use two fibers. Provide three SFP transceivers with RJ-45 connectors for Category 5/6 copper wire connections. Any remaining SFP ports shall be blank.

(c) **Backbone switches for the HOT-OC** will not be required by the Design-Builder. The Express Lanes existing Layer 3 core switch stack will integrate the proposed network segments.

(d) **Access switches for the Express Lanes communication network** shall be Cisco Model IE-4000-8T4G-E and will include the IP Services feature set. Provide enough SFP optical transceivers to accommodate all the fiber connections shown on the plans. Ensure that the transceivers are recommended by the switch manufacturer and have sufficient optical power to communicate reliably with the adjacent switches on the ring. Transceivers shall use two fibers. All available ports on the IE-4000-8T4G-E model not utilized for fiber optic connections shall be populated with SFP transceivers with RJ-45 connectors for Category 5/6 copper wire connections.

(e) **Device servers for Express Lanes communication network** shall meet the following requirements:

1. The number of serial ports shall be sufficient to provide a separate port for each serial device in the cabinet, except where the connection diagrams show multiple devices sharing the same serial port.

2. The device server and its power supply shall have an operating temperature range of -31 degrees to +165 degrees F and an operating humidity range of 5 % to 90 %.

3. The device server shall be managed via SNMP and also a web browser in addition to any specific applicable vendor software.

4. The device server must automatically resume normal operation after a power outage or irregularity.

5. Every serial port shall be switchable among EIA-485, EIA-422, and EIA-232 communication.

6. Provide DIN rail mounting.

Device servers for microwave vehicle detectors are not applicable to this section. See Section 703.

817.03 – Construction.

(a) Obtain the IP addresses, VLAN setup, and multicast route information from the System Integrator for all devices to be added to the Express Lanes network. Obtain the same information from the Engineer for any proposed or relocated VDOT devices.

(b) Configure equipment for initial installation such as setting IP addresses, IGMP snooping for switches, multicast routes for cameras, and VLAN setup in switches. Configure the switches to support multicasting of the surveillance and AID video and to direct multicast video to the HOT-OC, not to devices in roadside cabinets. If the switches are capable of filtering out video that is not being used at the operations center, implement that feature.

(c) Connect the switches to the equipment and fibers as shown on the connection diagrams in the plans.

(d) Configure the network to operate in accordance with the description in Section 809 and 810 respectively. Configure the 10 Gigabit ports between Backbone switches as trunk ports, carrying the trunked VLANs between the Backbone switches.

(e) Update the configuration of the Backbone switches in the I-495 Express Lanes network so that they properly participate in the VLANs created in this project. The Design-Builder shall provide the Backbone switches to the Concessionaire for configuration and the Concessionaire will return the Backbone switches to the Design-Builder for system integration and testing.

(f) After the acceptance testing described in Section 816 is complete and all communication equipment is operational, capture the configuration files from each Access switch, backbone switch, and device

server in a computer readable file. Store this data on two identical CDs or DVDs pertaining to VDOT equipment and two other identical CDs or DVDs pertaining to Express Lanes equipment. Organize the data to facilitate quick access when needed for maintenance. Deliver the discs to the Engineer's representative.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 818
(PROJECT NEXT TMS)

[NOT USED]

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 819—GENERATOR ASSEMBLIES
(PROJECT NEXT TMS)

July 15, 2020

819.01 – Description.

All work related to the installation and testing of Generator Assemblies shall be in compliance with the requirements of the provisions set forth in this Section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of Section 801.03(f) of the 2020 Edition of the VDOT Road and Bridge Specifications.

Provide and test backup power generator assemblies at the electrical service panels shown on the plans. Generator sites shall include service panel telemetry stations that include a cabinet, remote terminal unit, and DC power system that shall be used for generator assembly monitoring and control.

819.02 – Materials.

(a) **Generator** shall be a Cummins Power Generation spark-ignited set fueled by liquid propane. It shall produce three-phase, four-wire, 277/480 volt AC power and have at least the capacity shown on the plans. Each generator shall be equipped with:

- A vaporizer for the fuel.
- A battery, battery charger, and battery heater to ensure cold weather starts. The battery charger shall have status outputs (including low battery alarm) compatible with the PowerCommand PCC500 system.
- A coolant heater to ensure cold weather starts.
- A Level II (F173-2) sound-attenuating, weather protective enclosure.
- Heavy duty air cleaner.
- A full set of sensors, status outputs, and control inputs compatible with the PowerCommand PCC500 system.

(b) **Automatic transfer switch** shall be a Cummins Power Generation Model OTPC with programmed open transition and Level 2 PowerCommand control. The capacity shall be as recommended by the manufacturer for the associated generator. The switch shall have a locking interface panel for monitoring and setting up the switch and also a full set of sensors, status outputs, and control inputs compatible with the PowerCommand PCC500 system.

(c) **Remote monitor** shall be a Cummins Power Generation PowerCommand PCC500 (SNMP) PowerCommand PCC500 or successor product. The device shall permit remote monitoring and control, including starting and stopping the generator and switching the transfer switch. It shall include mounting hardware and all cables, modules and accessories needed to perform all remote monitoring and controlling functions that the generator, transfer switch, and battery charger allow. The device shall incorporate a web server and all remote functions shall be performed via a web browser.

(d) **Generator communication cabinet** shall be suitable for mounting on the rails of the service panel. It shall be a locking aluminum NEMA 3R cabinet large enough to hold the uninterruptible power supply battery (see below) and the following DIN rail-mounted equipment: uninterruptible power supply; remote monitor (PowerCommand PCC500 PowerCommand PCC500); Ethernet switch, fuse block, and

remote terminal unit. The cabinet shall have screened, filtered intake vents in the rear floor and screened, downward-facing exhaust vents in the overhang above the door. It shall have one or more thermostat-controlled fans capable of moving a total of 100 cubic feet per minute. It shall have a light bar consisting of at least 12 white LEDs positioned to illuminate the equipment. Both the fan and light bar shall be at the top of the cabinet and both shall be powered by 24 VDC. The lights shall be on when the door is open and off when it is closed.

(e) **Telemetry power system** for the PowerCommand PCC500, the Ethernet Switch, cabinet light, cabinet fan, and the remote terminal unit shall consist of the following:

- A power supply with a three-phase 480 VAC input and a 20 amp, 24 VDC output. The power supply shall mount on DIN rail or other suitable mounting bracket for the cabinet and have an operating temperature range of at least -25° C to +70° C. The power supply shall be mounted inside the service panel breaker cabinet.

- A DC uninterruptible power supply (UPS) that is able to produce at least 10 amps at 24 VDC. The UPS shall store power in two batteries rated at 12 volts, 14 ampere-hours. The UPS shall have an operating temperature range of -25° C to +60° C. The UPS shall have alarm contacts for loss of input power and low battery. The batteries shall be sealed, maintenance-free, and have a built-in lifting strap. The operating temperature range of the batteries shall be -40° C to +70° C.

- A fuse block that distributes the power from the UPS to five appropriately fused 24 VDC circuits, one for the Ethernet switch, one for the remote terminal unit, one for the fan, one for the light, and one for the PowerCommand PCC500. The fuse block shall be modular with the modules on DIN rail. Each module shall have a label and each shall have a fuse carrier that can be rotated out of its normal position to interrupt the circuit without interrupting other circuits.

- An inverter to power the PowerCommand PCC500. The input shall be 24 VDC and the output shall be 120 VAC, pure sine wave. The operating temperature range shall be -15° C to +55°C.

(f) **Remote terminal unit** shall be Moxa ioLogik E4200 that shall be configured as directed by the System Integrator to send status information to the HOT-OC. The RTU shall include input modules to monitor the status of the DC UPS and issue an SNMP trap to the central computer when alarm conditions begin or end. It shall also include input modules to monitor the fuel level in the tank and issue traps when the level drops below set levels.

The RTU shall be as used for the 495 HOV/HOT lanes project for propane tank monitoring. Coordinate with the System Integrator for specific model information. Otherwise, the RTU shall accommodate the necessary number of input and output modules that could monitor up to 200 inputs. Provide one module to monitor all the contact closures from the UPS and another to monitor the 4-20 milliamp signal from the fuel level sensor. The RTU shall have modules available (but not provided) for analog voltage inputs (0-10 V), and analog and digital outputs.

The device shall include a web server that permits setup and troubleshooting using only a web browser.

(g) **Fuel tank** shall be a 500 gallon horizontal ASME tank. Equip it with all features and fittings needed for safe operation and compliance with codes and the requirements of the propane delivery service. It shall have supports for mounting the tank on a concrete pad and a belly valve for feeding liquid propane to the generator. Equip the tank with two devices that measure the amount of liquid propane in the tank. One shall indicate the level visually on an indicator on the tank. It shall not require power and shall be calibrated in gallons or percent full. The other device shall produce a 4-20 mA signal and shall require no other power than that provided by the input module of the remote terminal unit. Both devices shall resist impact, temperature extremes, corrosion, moisture, and bright sunlight. A single sensor with both a visible indicator and a 4-20 mA output is acceptable.

(h) **Fuel line** carrying the liquid propane to the generator shall be installed underground and shall be in compliance with pertinent codes and the recommendations of the generator manufacturer. Include fittings.

(i) **Vaporizer** kit for conversion of an existing Cummins generator from propane vapor to liquid propone

fuel. This must be recommended by Cummins and installed by a contractor approved by Cummins.

819.03 – Procedures.

(a) **Generator assembly installation.** Ensure that all aspects of the site, equipment, and installation comply with NFPA 58 and pertinent state and local codes. Coat the threads of all fittings with a compound suitable for propane.

1. **Generator**. Design and construct a reinforced concrete pad and mount the generator and transfer switch in accordance with the generator manufacturer's recommendations. Prior to construction, submit the proposed pad design, including concrete strength, to the Engineer for approval. Provide fuel, power, and control connections in accordance with the manufacturer's recommendations. For existing generators to be reused, equip the generator with a vaporizer and fuel lines so that it uses a liquid propane fuel supply.

2. **Fuel tank**. Design and construct a reinforced concrete pad for the propane tank and the fuel line from the tank to the generator. Ensure that the bottom of the tank is at least as high as the vaporizer at the generator. Prior to construction, submit the proposed pad and fuel line designs to the Engineer for approval. Include the raceway for the connection between the fuel sensor and the remote terminal unit. Install the tank level on the pad and make the connections to the fuel line, electrical ground, and remote terminal unit. Do not put propane into the tank yet.

3. **Telemetry system.** Install all elements of the PowerCommand and fuel level monitoring systems, including connections to power and the fiber optic communication network. At locations that already have service panel telemetry cabinets, use those cabinets and equipment. In those locations, connect the PowerCommand and inverter to the existing DC UPS and Ethernet switch. At those locations, also connect the fuel sensor to the existing RTU, providing an additional 4-20 mA module if needed. At all locations, set up the generator for automatic tests at a frequency provided by the Concessionaire. Set up SNMP traps in the remote terminal unit to notify the HOT-OC when alarm conditions involving the DC UPS begin and end. Set up traps to notify the operations center when the fuel tank is 25 % full and 10 % full. Configure the Telemetry System to provide the following data via SNMP: generator status (run/stop), ATS status (utility/generator), and utility power (on/off).

4. **Code Inspection**. Inform the Engineer when all site work, propane work, and electrical work has been completed, so that the Engineer can arrange for inspection by the authority having jurisdiction. Be present at the inspection, providing information and assisting in the inspection as requested by the inspector. Correct all deficiencies found by the inspector.

5. **First Fill.** When the site passes the inspection, vacuum purge the tank and fill it to the regulatory limit. However, use the filling of the tank as an opportunity to test the accuracy of the visual and electronic indications of the fuel level. If the two fuel level sensors are not within 10% or if they don't correspond to the amount of propane that has been dispensed, stop the filling process, empty the tank, and fix the fuel level sensing devices.

(b) **Acceptance testing.** Develop a test plan for the generator assembly and submit it to the Engineer for approval. Incorporate every test recommended by the manufacturer of each component including the generator, propane tank, remote terminal unit, and telemetry system. Include a visual inspection. Demonstrate proper operation in response to a power outage and to a power restoration. Demonstrate remote monitoring of the generator, fuel tank, and DC UPS over the fiber optic communication network. Demonstrate remote control of generator operation. Demonstrate that the light and fan in the generator communication cabinet work, and that the cabinet shows no evidence of leaks. Revise the test plan until it is satisfactory to the Engineer. Then conduct the tests in the presence of the Engineer's representative.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 820
(PROJECT NEXT TMS)

[NOT USED]

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 821—VARIABLE SPEED LIMIT SIGNS
(PROJECT NEXT TMS)

July 15, 2020

821.01 – General.

This work includes providing Variable Speed Limit (VSL) signs, associated equipment and software.

821.02 – Materials.

(a) **VSL Sign:**

1. Sign shall meet the requirement set forth in the MUTCD regarding, but not limited to, size, shape, color, font, borders, text height, legibility, illumination and retro-reflectivity and details shown in the Signing and Pavement Marking plans and details.

2. Sign shall comply with Section 701 – Traffic Signs of VDOT's 2020 Road and Bridge Specifications and any revisions that may apply to this section.

3. Speed value shall be displayed using LED display that should allow speed to be displayed in increments of 5 mph in the range of 10 mph to 80 mph. The remaining area of the sign face shall be static panel consistent with the requirements for static highway signing and as shown in the signing and pavement marking plans. The static portion of the sign shall include black legend on white backgrounds consistent with the MUTCD requirements for regulatory signs. Speed values should be displayed using white color LEDs on a black background. The dimensions of the text displayed using LED should match the MUTCD requirements set forth for static signs. The LED panel should be bolted to the static panel. LED panel shall be accessible from front for maintenance. LED housing shall be NEMA 3R rated.

4. Sign shall have an external brightness sensor and automatic brightness control to adjust the brightness level of LEDs depending upon the ambient brightness to improve legibility. Minimum sign intensity shall be 9200 cd/m^2 when operating at 100% intensity.

5. LEDs used in the sign shall be rated for 100,000 hours and protected against degradation due to UV light. The sign shall have a ventilation/heating system, if recommended by the sign manufacturer, to keep the LED temperature within the range for which the LEDs are rated.

(b) **Associated Equipment:**

1. Provide an Ethernet based NTCIP-compliant sign controller. The environmental rating for the controller shall be
   i. Temperature: -40 degree Celsius to 60 degree Celsius.
   ii. Humidity: 0 to 99% non-condensing.

2. Provide 120 VAC power supply for controller and LED driver for sign panel.

3. Provide all communication and power cable for the sign as recommended by the manufacturer.

4. Provide mounting hardware for installing the sign on sign structures as shown on plans.

(c) **Software for laptop computer:** Provide software that enables a technician to control, configure, test a VSL sign by connecting a laptop computer directly to the Ethernet switch in the roadside cabinet. The software shall enable the technician to exercise every feature and function of the sign and to set every configuration parameter. The software shall also enable the technician to control and program the sign from the HOT-OC. The Design-Builder shall install the software on laptop computers

provided by the Engineer.

821.03—Procedures.

(a) **Installation:**

1. Install the sign and controller in accordance with the manufacturer's recommendations. The controller goes in the equipment cabinet on or near the sign support structure as shown on the plans. The sign shall be installed in conjunction with the overhead sign structure to be designed and fabricated by the Design-Builder. Ensure sign mounting allows for access to the LED panel and cable connections for maintenance.

2. Make power and communication connections as recommended by the sign manufacturer between the controller cabinet and the sign.

3. Adjust the sign and controller to achieve 16 or more brightness levels appropriate for the particular sign, and set up the lighting conditions for which each brightness level will be used. The Engineer's representative will observe the operation of the sign under a variety of lighting conditions. Make changes requested by the Engineer until the brightness adjustments are approved by the Engineer.

(b) **Acceptance Testing:** Develop a test plan and procedures that demonstrates proper operation of the sign.

The plan shall include all tests recommended by the manufacturer. When the plan is satisfactory to the Engineer, conduct the testing in accordance with the plan and prepare a test report. Testing must include the following:

At the VSL sign site:

- Visual inspection for manufacturing and installation defects.
- All tests recommended by the manufacturer and all self-tests of which the equipment is capable.
- VSL sign legibility.
- Restart of VSL controller following loss of power.
- Functionality of each pixel.
- Automatic and manual brightness adjustments.
- Local operation using the laptop computer and application software.

At the HOT-OC: Tests at the HOT-OC shall use the communication system and central software furnished by the Concessionaire. Confirm proper operation in the field during the testing.

- Acceptance of properly addressed messages.
- Message selection command and response.
- Immediate message command and response.
- Parameter download command and response.
- Parameter upload command and response;
- Detection and reporting of errors.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 822
(PROJECT NEXT TMS)

[NOT USED]

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 823—CABINET ASSEMBLIES
(PROJECT NEXT TMS)

July 15, 2020

823.01 – General.

All work related to the installation and testing of Cabinet Assemblies shall be in compliance with the requirements of the provisions set forth in this Section. In addition to these Supplemental Specifications, the Contractor shall adhere to applicable requirements of Section 703 and 801.04(a) of the 2020 Edition of the VDOT Road and Bridge Specifications.

This section governs all cabinets furnished in this project except Type 1 cabinets.

823.02 – Materials.

(a) **General Requirements applicable to all cabinets:**

1. All Department cabinets shall have door locks equipped with the Department's standard tumbler lock Number 9R48773. Provide a total of ten (10) keys.

2. All Express Lanes cabinets shall have locks from CCL Security similar to the locks on Department cabinets. They shall be keyed to match cabinet locks provided on the I-495 HOV/HOT Lanes project. Provide a total of 30 keys.

3. Provide an engraved plaque on the front door, displaying the cabinet ID indicated on the plans. Characters shall be at least 4 in. high with a minimum stroke width of 0.4 in unless smaller characters are required to fit the ID on one line. The plaque shall be made of multilayered plastic. Plaques on Express Lanes cabinets shall have a black surface over a white interior.

4. The connection to ground must be bare, solid AWG # 6 copper wire. For multiple cabinets on a single foundation, bond each ground bus bar using a solid AWG #6 copper wire and bond one of the bus bars to the grounding electrode.

5. All cabinets shall have a natural aluminum or stainless steel finish, free from blemishes. All seams shall be continuously welded and ground smooth.

6. Fasteners must be stainless steel.

7. Cabinets shall have sunshields on all four sides and the top, except that no shield is required on the back of Type 3 cabinets. Also, where two or more cabinets are mounted side-by-side, no sun shield is required on facing sides.

8. Shall support a removable standard 19” EIA rack.

9. Provide mounting panels for terminal blocks, surge protectors, and other small items on both sidewalls.

10. Provide terminal blocks for all conductors entering the cabinet. Except for blocks used for coaxial cable, the blocks shall be the barrier type with nickel-plated brass screw terminals and solid backs. Each terminal shall be clearly and permanently labeled on a contiguous surface using silk screening or other approved method. Terminal blocks for conductors carrying more than 60 volts must be covered by a clear acrylic shield.

11. Provide an interior fluorescent light above each door. Each door shall have a door switch controlling the light. In cabinets with two doors, both lights shall light when either door is opened.

12. Provide a duplex ground fault interrupt outlet for use by technicians. If several cabinets are mounted side-by-side, only one must have a convenience outlet.

13. Provide a thermostatically controlled fan that moves 100 CFM through vents at the top of the cabinet.
    The air intake shall be through louvers in the door, and the air shall pass through a replaceable filter as it enters the cabinet.

14. If the cabinet receives 480-volt power, provide a step-down transformer to convert it to 120-volt power.
    All transformers shall be designed for outdoor use. The transformer shall be inside cabinets unless noted on the plans. Transformers at cabinets supplying dynamic message signs shall have center- tapped secondaries, producing 120/240- volt power. Other transformers shall produce only 120-volt power.

15. In each cabinet with a transformer, provide a panel or DIN rail-mounted, two-pole main breaker on the primary side of the transformer. Base the capacity of the breaker on the rating of the transformer. The breaker shall be a UL489 listed.

16. In each cabinet, provide a 120 VAC main breaker and branch circuit breakers, all DIN rail mounted.
    The breakers shall be UL489 listed. The main breaker shall be rated at 25 amps unless the load requires a larger rating. Branch circuits shall have 15 amp breakers unless the load requires a larger breaker. One or more branch circuits shall serve the communication and traffic management equipment in the equipment cabinet. Connect that circuit to the second stage of the surge suppressor and to the equipment. A second branch circuit shall power auxiliary devices in the equipment cabinet, such as the fan, heater, light, and GFI outlet.

17. In cabinets serving dynamic message signs or gates, provide a multi-pole breaker to cut off power to the sign or gates. Power running from the transformer secondary or incoming power terminal block to this breaker shall bypass the 120 VAC breakers in the cabinet.

18. Before buying any cabinets, provide shop drawings, layout drawings, catalog cuts, and schematics for the Department and Concessionaire's approval. The layout drawings shall be dimensioned drawings showing the proposed location of all equipment for each cabinet. The drawings shall demonstrate that all the equipment will fit and that all controls, connections, convenience outlet, and other service points are readily accessible for use and maintenance. They should also demonstrate that incoming conductors reach surge suppressors as soon as they enter the cabinet. Layout all cabinets that have the same equipment in the same way and submit a single drawing for all like cabinets. Revise the layout as instructed by the Engineer and resubmit the drawings until they are accepted.

(b) **Ground-Mounted Cabinets:** The cabinets shall be Model 334C cabinets on the Caltrans Transportation Electrical Equipment Specifications (TEES) Qualified Products List (QPL). Acceptable equivalent products must meet one of the following conditions: 1) previously approved for use on the I-495 HOV/HOT Lanes Project or 2) references provided from agency where cabinet has been used for similar purpose and found suitable by the Department and Concessionaire. No input panel, input file, C1 harness, or power distribution assembly is required, except for gate controller cabinets. Police panels are not required. Provide bolts, nuts, washers, and lock washers to secure the cabinet to the base adapter.

(c) **Base Adapters for Ground-Mounted Cabinets:** The base adapter has two functions. It raises the cabinet 12" above the foundation, making it easier for a technician to work in the lower part of the cabinet. In addition, it provides a raceway between adjacent cabinets on the same foundation. Base adapters shall be as follows:

1. The base adapter shall be a hollow aluminum box 12 inches high, 30 inches wide, and 30.25 inches deep (the same depth as the cabinet). It shall have a cutout opening centered in the top, 15 inches wide and 21 inches deep, matching the opening in the bottom of the cabinet. It shall have a similar cutout on the bottom, directly below the top cutout. Around the top cutout shall be four punched holes that match the anchor bolt holes in the cabinet. Around the bottom cut out shall be four punched holes that match the anchor bolts in the foundation.

2. Construct the adapter so that it does not sag under the weight of the fully loaded cabinet. Any internal members must not obstruct cables going from the cabinet to adjacent cabinets, nor to the conduits below.

3. Construct the adapter of the same material used for the cabinet and give it a matching finish. All seams shall be continuously welded and ground smooth.

4. Provide anchor bolts, nuts, washers, and lock washers to secure the base adapter to the foundation.

(d) **Type 2 Cabinets:** The cabinets shall be Model 336A cabinets on the Caltrans Transportation Electrical Equipment Specifications (TEES) Qualified Products List (QPL). If no vendors for this cabinet are on the QPL, provide a Model 336A from a vendor of Model 332 or Model 334 cabinets on the QPL. Equivalent products will be allowed per the requirements for Ground Mounted cabinets. No input panel, input file, output file, C1 harness, or power distribution assembly is required, except for gate controller cabinets. Police panels are not required.

823.03—Procedures.

(a) **Ground-Mounted Cabinet Installation:** Apply a coat of silicone sealant to the bottom of the cabinet immediately before bolting it to the base adapter. Ensure that the cabinet is plumb, using shims if necessary, and ensure that it is properly aligned with the front edge of the base adapter.

(b) **Type 2 Cabinet Installation:** Securely fasten the cabinets to their supporting structures using mounting brackets. Ensure that conduits enter the cabinet only from the bottom. Bond the cabinets to the support structure, if metal, and the support structure to a ground rod. If the support structure is not metal, run a # 6 solid copper ground wire from the cabinet to a ground rod.

(c) **Testing:** Develop a proposed test procedure for the cabinets and submit it to the Engineer for approval. It shall include visual inspection, testing of lights, fan, and power outlets. It shall also include a test in which each branch circuit is shorted to the ground bus bar to confirm that the breaker trips. Revise the proposed test procedure until it is acceptable to the Engineer.

Provide all equipment and personnel needed to safely conduct the tests. Arrange for the Engineer's representative to witness the tests. Give the Engineer a report documenting the result of every visual inspection and test. Include a summary indicating whether the cabinet passed every test. The cabinet must pass every test to be accepted.

If the cabinet fails, correct the problems and arrange for a new test. If the test of the breakers reveals breakers that do not trip, the resistance to ground is too high; lower the resistance by adding more ground rods and improving the connections in the ground system.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 824—COMMUNICATION SYSTEM TESTING
(PROJECT NEXT TMS)

July 15, 2020

Section 824.01 – Procedures.

(a) **Objectives:** Test the constructed communication system to confirm the following:

1. All 495 Express Lanes roadside equipment to be relocated or modified in this project communicates normally with the HOT-OC.

2. All Department roadside equipment that was provided in this project communicates normally with a test computer at the communication node to which the roadside equipment reports.

3. All Express Lanes equipment communicates normally with the HOT-OC central computer.

4. Tested communication channels operate at the data rates and error rates anticipated, based on the components used in the channel.

5. Communication over the Express Lanes network continues normally despite a single cable cut or switch failure anywhere on the network.

(b) **When to Test:**

1. **Express Lanes network:** Conduct the tests when the entire network is complete and all communication and traffic management equipment is in its final configuration. Test existing Express Lanes fiber at cabinets installed on the 495 Express Lanes project when modifications to the cabinet are made as part of the Project NEXT.

(c) **How to Test Express Lanes Cabinets:**

1. Arrange for the tests to be witnessed by the Engineer's representative.

2. Do the following at each cabinet to be tested, proceeding sequentially around the network from cabinet to cabinet. If testing reveals a problem, such as an improperly configured switch, that can be fixed immediately, fix it and retest. If a distribution ring has an even number of cabinets, only one of the two middle cabinets need be subjected to the communications tests.

   a. Use software on the test computer at the HOT-OC to communicate bi-directionally with the traffic management equipment in the cabinet. If the cabinet is a CCTV cabinet, display the video.

   b. Disconnect the switch at the cabinet under test from one pair of optical fibers and confirm that any interruption in communication lasts only a few seconds. Use switch manufacturer console interface to test the communication channel for throughput, latency, frame loss, and back-to-back frames. Reconnect the pair of fibers and confirm that any communication lapse lasts only a few seconds.

   c. Repeat the previous step with the other pair of fibers connected to the switch.

   d. If the cabinet under test is at the midpoint of a distribution ring, turn off the power to the Layer 3 switch at one of the Layer 3 switches that is on the distribution ring. Confirm that any communication lapse lasts only a few seconds. Repeat communications tests. Power up the Layer 3 switch. Confirm

that any communication lapse lasts only a few seconds. This test will not apply to cabinets south of the last toll point in Segment 1.

e. If the second Layer 3 switch in the distribution ring is also in a IRU (rather than the HOT-OC), repeat the previous step with the second Layer 3 switch.

3. In each IRU, use software on the test computer at the HOT-OC to communicate with the UPS and any tolling equipment that may be present.

(d) **Acceptance and Corrective Action:**

1. Prepare a table containing all the data collected during the testing: whether the equipment performed as expected; duration of communication lapses during faults and restorations, and the communications test results. Display this data in a way that facilitates comparisons among the communication channels. Supplement the table with graphs if that makes the data easier to understand.

2. Highlight test results that are significantly different from the rest. For each such anomaly, identify possible causes. Investigate and correct anomalies caused by defects in materials or workmanship.

3. When all the defects have been fixed, retest the corrected communication channels in the presence of the Engineer's representative. Conduct any additional tests the Engineer's representative requests to demonstrate that the actions taken to correct the anomalies have not impaired the performance of other communication channels.

(e) **Documentation:** Submit the table and graphs described above, but with both the original and final test results. For each anomaly corrected, identify the corrective action taken. Submit proposed fixes and corrective actions of defects for approval prior to commencing work.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 825—WIRING AND SURGE PROTECTION
(PROJECT NEXT TMS)

July 15, 2020

825.01 – General.

All work related to the installation and testing of Wiring and Surge Protection shall be in compliance with the requirements of the provisions set forth in this section. In addition to these Supplemental Specifications, the Contractor shall adhere to the applicable requirements of Section 801 of the 2020 Edition of the VDOT Road and Bridge Specifications.

825.02 – Wiring.

(a) Protect personnel from accidental contact with dangerous voltages.

(b) In equipment cabinets and housings, every conductor, except conductors contained entirely within a single piece of equipment, must terminate either in a connector or on a terminal block. Provide connectors and terminal blocks where needed.

(c) Within equipment cabinets, use wire saddles to keep wiring, including fiber optic pigtails, out of the way of service activities. Ensure that any removable assembly can be removed without disturbing wiring that is not associated with the assembly being removed.

(d) Do not install conductors carrying 120 volt AC power or greater in the same wiring harness as conductors carrying lower voltage control or communication signals.

(e) Equipment and wiring shall be arranged so that the distance between each conductor's point of entry and the surge protector shall be as short as possible, and the protector shall be located as far as possible from electronic equipment. All wiring between the surge protectors and the point of entry shall be free from sharp bends.

(f) At locations where modifications to existing wiring is required, the Design-Builder shall note deficiencies or code violations and bring to the attention of the Engineer.

(g) Phase taping of electrical conductors shall not be permitted. Electrical conductors shall have a continuous phase colored jacket between connection and termination points. Neutral conductors shall have a continuous white or gray colored jacket between connection and termination points. Ground conductors shall have a continuous green colored jacket between connection and termination points.

(h) Cable reducing compression adapters shall be used at circuit breaker locations where oversized cable is used to reduce voltage drop on long runs or where neutral conductors are upsized for power quality. Compression adapters shall contain insulating covers supporting termination of Class B 600 V conductors. Compression reducing terminal adapters shall meet Underwriters Laboratories (UL) standards and listings and additional associated standards.

(i) Provide 2 feet of electrical wiring slack at every junction box. Electrical wiring shortage or excessive amounts of wiring will not be accepted.

825.03 – Surge Protection.

(a) **General:** All ungrounded conductors entering or leaving any equipment cabinet shall be equipped with surge protectors. For purposes of this section, multiple cabinets on a single foundation are considered a single cabinet.

(b) **Microwave vehicle detector cables** shall be protected by surge protectors recommended by, and supplied by, the detector manufacturer. At locations where multiple detectors or sensors are used, a separate surge protector shall be used for each power and communication circuit to the detectors.

(c) **Other low-voltage signal pairs** shall be protected by protectors meeting the following requirements:

1. The protectors shall suppress a peak surge current of up to 10K amps.

2. The protectors shall have a response time less than five nanoseconds.

3. The protector shall clamp the voltage between the two wires at a voltage that is no more than twice the peak signal voltage, and clamp the voltage between each wire and ground at 50 volts or less.

4. It shall be possible to replace the protector using only common hand tools.

(d) **Cables carrying power** from an equipment cabinet to a camera or other external device shall be protected by grounded metal oxide varistors of appropriate voltages. All metal oxide varistors used for surge protection shall be 0.79 in. in diameter or larger. Power-Over-Ethernet (POE) equipment shall be protected by Ethernet Extender's Enable-IT 265LP or approved equal.

(e) **Main AC power** shall be protected by a protector that is UL 1449 listed and bears the UL label. If the main power uses a step down transformer at the cabinet or toll point, then the surge protector shall be on the primary side of the transformer, on the load side of the main breaker. If the voltage on the primary side of the transformer is 480 volts, the surge suppressor shall be designed to protect three phases and the neutral, even though only two phases are used.

The surge protector shall have the following characteristics:

- For each phase, the sum of the line-to-neutral and line-to-ground surge capacities shall be at least 80 kA.
- It shall be a Type 1 surge protective device with a tested normal current (I_n) of 20 kA.
- The short circuit current rating shall be 200 kA.
- Depending on the voltage of the lines being protected, the voltage protection ratings and maximum continuous voltage shall be as follows:

	277/480 V WYE	120/240 V SPLIT
Line-to-neutral voltage protection rating	1200 V	700 V
Line-to-ground voltage protection rating	1200 V	700 V
Neutral-to-ground voltage protection rating	1200 V	600 V
Line-to-line voltage protection rating	2000 V	1000 V
Maximum continuous operating voltage (line-to-neutral)	320 V	150 V

- The protector shall be in the equipment cabinet for the electronics being protected.
- Its operating temperature range shall be -25° C to 60° C
- The protector shall have one or more status LEDs giving a visual indication when any suppression element has failed.
- The protector shall have a ten year warranty.

DESIGN-BUILD PROJECT
SPECIAL PROVISION FOR

SECTION 826
(PROJECT NEXT TMS)

[NOT USED}