



*Florida Department of Transportation*

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SECRETARY

August 25, 2022

Khoa Nguyen  
Director, Office of Technical Services  
Federal Highway Administration  
3500 Financial Plaza, Suite 400  
Tallahassee, Florida 32312

Re: State Specifications Office  
Section: **995**  
Proposed Specification: **9951400 Traffic Control Signal and Device Materials.**

Dear Mr. Nguyen:

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

The changes are proposed by Derek Vollmer and Daniel Strickland, including a team from the State Traffic Operations Office, State Roadway Design Office, and State Program Management Office to move materials/manufacture requirements from Section 700. Separating the manufacturer's requirements from the Contractor's requirement will help with the review of APL product submittals, field installations, inspections, and acceptance criteria.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to [daniel.strickland@dot.state.fl.us](mailto:daniel.strickland@dot.state.fl.us).

If you have any questions relating to this specification change, please call me at 850-414-4130.

Sincerely,

Signature on file

Daniel Strickland, P.E.  
State Specifications Engineer

DS/dh

Attachment

cc: Florida Transportation Builders' Assoc.  
State Construction Engineer

## TRAFFIC CONTROL SIGNAL AND DEVICE MATERIALS.

(REV ~~78-1811~~-22)

SECTION 995 is expanded by the following new Articles:

### **995-14 Internally Illuminated Signs.**

**995-14.1 General:** Marking must be accomplished by permanently affixing an indelible label, identification plate, dot peen type stamp, casting, or metal-marking. Signs must not exceed 9 feet in length or be larger than 18.0 square feet or less in area, and must not weigh more than 144 pounds Internally illuminated sign assemblies must be listed to the requirements of UL48 listed. Light emitting diode (LED) retrofit kits must be listed on the APL.

**995-14.2 Housing:** The sign housing must be constructed of continuous 5052 or 6063-T5 aluminum. All housing, corners, and door seams must be continuously welded. All exterior surfaces of the assembly must be powder-coat painted in accordance with Military Standard MIL-PRF-24712A or AAMA-2603-02. Finish must meet the requirements of ASTM D3359, ASTM D3363, and ASTM D522. Sign housings with any interior airspace must consist of a box type enclosure and separate hinged door assembly. The sign housing must include provisions to prevent water from entering the sign housing. Drain holes in the sign larger than 0.125 inch must be covered by a screen.

Signs must have removable sign faces. The sign face must be secured by a method that holds the sign face securely in place. Slide-in grooves are allowed to secure the sign face if the sign is edge lit.

The sign face must be a translucent lens constructed of 0.125-inch thick high impact strength polycarbonate or acrylic meeting UL48. Background must be translucent retroreflective sheeting coated with a transparent, pressure-sensitive adhesive film. Color must meet the criteria as detailed in Section 994. Retroreflective sheeting must meet the requirements of Section 994 and be listed on the APL.

If a door opens upward, it must have a bracket on each side to secure the door in the open position during maintenance. Doors must be permanently and continuously sealed with a foam gasket listed to UL157 to prevent the entry of water into the sign housing. Each door must be secured from opening by stainless steel rotary action draw latches as follows:

Signs of 5 feet up to 7 feet in length must have a minimum of three latches for each sign door.

Signs over 7 feet up to 9 feet in length must have a minimum of four latches for each door.

The rotary action draw latch must be captive and will not become detached or allow the door to open when the sign housing is torqued or twisted

The sign assembly must be designed and constructed to withstand 150 mph wind loads meeting the requirements of the Department's Structures Manual.

**995-14.3 Luminance:** The sign face must be illuminated evenly across the entire surface. Contrast ratio between the background and legend must be established by the lowest and the highest color retroreflective measurement and shall be at least 4:1. Measure the retroreflectivity in accordance with ASTM D4956.

**995-14.3.1 Background Luminance:** Minimum luminance for the legend portion of the street sign face must be no less than 87.5 lux. The luminance must be determined by averaging a minimum of seven readings. Four of the readings must be taken near the midpoint of

a line that would span between the outside corners of the background and the outside corners of the legend. One reading must be taken near the midpoint of a line that would connect the top corner readings. One reading must be taken near the midpoint of a line that would connect the bottom corner readings. One reading must be taken near the vertical and horizontal midpoint of the sign.

**995-14.3.2 Border and Lettering Luminance:** Minimum luminance of the legend and border must be 350 lux. The luminance must be determined by averaging a minimum of 17 readings. There must be a minimum of one reading from each letter in the legend. Readings within the legend must alternate between the top, middle and bottom portion of each letter. Readings within top and bottom of the border must be perpendicular to the top and bottom readings in the background. Readings within the sides of the border must be taken parallel to the readings taken within each letter.

**995-14.4 Mechanical Requirements:** All assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8-inch in diameter must be Type 304 or 316 passivated stainless steel. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized. Bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-14.5 Electrical Requirements:** Electrical wiring must meet NEC requirements for the light source provided. All wiring must be copper wire. All internal electrical wiring must be tight and secure. The sign must include an accessible electrical power service entrance compartment (internal or external) for connection of field wiring. External compartments must be weather-tight. All power supplies and ballasts must be Federal Communications Commission (FCC) approved.

Electrical connections must be protected against corrosion. All signs must have provisions for an integrated photocell.

**995-14.6 Environmental Requirements:** The illuminated sign assembly must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2.

**995-14.7 Warranty:** Internally illuminated signs must have a manufacturer's warranty covering defects for five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

## **995-15 Highlighted Signs.**

**995-15.1 General:** Highlighted signs must meet the design and functional requirements specified in this Section and Section 2A of the MUTCD. Use LEDs to highlight the sign's shape, color, or message.

Stop, Do Not Enter, Yield, and Wrong Way signs that are highlighted with LEDs must use red LEDs. All other signs must use LEDs which resemble the color of the sign background color.

**995-15.2 Performance Requirements:** Highlighted signs are capable of automatically dimming to reduce brightness of the LEDs at nighttime.

Highlighted signs that rely upon solar power or batteries must be capable of at least 10 days of continuous operation without the need for charging.

**995-15.3 Cabinets:** If the highlighted sign includes a cabinet, the cabinet must be currently listed on the APL or meet the requirements of Section 676.

**995-15.4 Mechanical Requirements:** All assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8-inch in diameter must be Type 304 or 316

passivated stainless steel. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized. Bolts, studs, and threaded rod shall meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-15.5 Electrical Requirements:** Electrical wiring must meet NEC requirements for the light source provided. All wiring must be copper wire. All internal electrical wiring must be tight and secure. The sign must include an accessible electrical power service entrance compartment (internal or external) for connection of field wiring. External compartments must be weather-tight. All power supplies and ballasts must be Federal Communications Commission (FCC) approved.

Electrical connections must be protected against corrosion. All signs must have provisions for an integrated photocell.

**995-15.6 Environmental Requirements:** The highlighted must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2.

**995-15.7 Warranty:** Highlighted signs must have a manufacturer's warranty covering defects for three years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

### **995-16 Dynamic Message Signs.**

**995-16.1 General:** Dynamic message signs (DMS) must meet the requirements of NEMA TS4-2016. DMS are classified by the type of sign display and the type of mechanical construction. Use only equipment and components that meet the requirements of these minimum specifications and are listed on the APL. DMS LED retrofit kits must be listed on the APL.

**995-16.1.1 Front Access DMS:** Front access signs must meet the requirements of NEMA TS 4-2016, Section 3.2.6.

**995-16.1.2 Walk-In DMS:** Walk-in signs must meet the requirements of NEMA TS 4-2016, Section 3.2.8.

**995-16.1.3 Embedded DMS:** Embedded DMSs must be mounted to ground traffic signs, overhead traffic signs, or overhead cantilever traffic signs.

**995-16.2 Sign Housing Requirements for all DMS:** The external skin of the sign housing must be constructed of aluminum alloy 5052 H32. The interior structure must be constructed of aluminum. Internal frame connections or external skin attachments must not solely rely upon adhesive bonding or rivets.

The sign enclosure must meet the requirements of NEMA TS 4-2016, Section 3.1.1. All drain holes and other openings in the sign housing must be screened to prevent the entrance of insects and small animals.

The sign housing must comply with the fatigue resistance requirements of the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. Design and construct the DMS unit for continuous usage of at least 20 years. The sign assembly must be designed in accordance with the Department's Structures Manual, including a wind load of 150 miles per hour.

The top of the housing shall include multiple steel lifting eyebolts or equivalent hoisting points. Hoist points are positioned such that the sign remains level when lifted. The hoist points and sign frame allow the sign to be shipped, handled, and installed without damage.

All assembly hardware, including nuts, bolts, screws, and locking washers less than 5/8-inch in diameter, must be Type 304 or 316 passivated stainless steel and meet the

requirements of ASTM F593 and ASTM F594. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized and meet the requirements of ASTM A307.

All exterior, excluding the sign face, and all interior housing surfaces must be a natural aluminum mill finish. Signs must be fabricated, welded, and inspected in accordance with the requirements of the current ANSI/AWS Structural Welding Code-Aluminum.

The sign housing must meet the requirements of NEMA TS 4-2016, Section 3.2.9 for convenience outlets.

**995-16.2.1 Sign Housing for Walk-In DMS:** Exterior seams and joints, except the finish coated face pieces, must be continuously welded using an inert gas welding method. Limit the number of seams on the top of the housing to a maximum of three. Stitch weld the exterior housing panel material to the internal structural members to form a unitized structure.

The exterior mounting assemblies must be fabricated from aluminum alloy 6061-T6 extrusions a minimum of 0.1875 inch thick. Include a minimum of three 6061-T6 structural aluminum Z members on the rear of the sign housing in accordance with the Standard Plans. The structural aluminum Z members must run parallel to the top and bottom of the sign housing and are each a single piece of material that spans the full length of the sign. The structural aluminum Z members must be attached to the internal framework of the sign.

The hoist points must be attached directly to structural frame members by the sign manufacturer.

Housing access must be provided through an access door that meets the requirements of NEMA TS 4-2016, Section 3.2.8.1. The access door must include a keyed tumbler lock and a door handle with a hasp for a padlock. The door must include a closed-cell neoprene gasket and stainless steel hinges.

The sign housing must meet the requirements of NEMA TS 4-2016, Section 3.2.8.3 for service lighting. If incandescent lamps are provided, they must be fully enclosed in heavy-duty shatterproof, protective fixtures. The incandescent fixtures must include aluminum housing and base, a porcelain socket, and clear glass inner cover. All removable components must be secured with set screws. If fluorescent lamps are provided, they must be fitted with shatter proof protective guards.

The sign housing must include emergency lighting that automatically illuminates the interior in the event of a power outage. Emergency lighting must be capable of operation without power for at least 90 minutes.

**995-16.2.1.1 Walk-In DMS Work Area:** The walk-in DMS must have a work area that meets the requirements of NEMA TS 4-2016, Section 3.2.8.2. All edges of the walkway are finished to eliminate sharp edges or protrusions.

**995-16.2.2 Sign Housing for Front Access and Embedded DMS:** Front access and embedded signs must meet the requirements of NEMA TS 4-2016, Section 3.2.5 and Section 3.2.6. Accessing the sign housing must not require specialized tools or excessive force to open.

**995-16.2.3 Housing Face Requirements for all DMS:** The sign face must meet the requirements of NEMA TS 4-2016, Section 3.1.3. All sign face surfaces are finished with a matte black coating system that meets or exceeds American Architectural Manufacturers Association (AAMA) Specification No. 2605. Submit certification that the sign face parts are coated with the prescribed thickness. Except for embedded DMS, the sign face must include a contrast border that meets the requirements of NEMA TS 4-2016, Section 3.1.6.

**995-16.2.3.1 Housing Face for Walk-In DMS:** No exposed fasteners are allowed on the housing face. The display modules shall be easily and rapidly removed from within the sign without disturbing adjacent display modules.

**995-16.2.3.2 Housing Face for Front Access and Embedded DMS:** Any exposed fasteners on the housing face must be the same color and finish as the housing face. Only captive fasteners may be used on the housing face.

**995-16.2.3.3 External Fascia Panels:** If the sign includes external fascia panels, they must be constructed using aluminum. Each fascia panel is finished with a matte black coating system that meets or exceeds AAMA Specification No. 2605.

**995-16.2.3.4 Lens Panel Assembly:** If the sign includes lens panel assemblies, they must be modular in design, removable, and interchangeable without misalignment of the lens panel and the LED pixels. The lens panel assembly must consist of an environmental shielding layer coating to protect and seal the LED and internal electronics. The coating must be a minimum 90% UV opaque. Lens panels must have a matte black coating that meets or exceeds AAMA Specification No. 2605. Lens panels must include a mask constructed of 0.080 inch minimum thickness aluminum. The mask must be perforated to provide an aperture for each pixel on the display module. The apertures must not block the LED output at the required viewing angle.

**995-16.2.4 Sign Housing Ventilation System:** The ventilation systems for walk-in, front-access, and embedded DMS must meet the requirements of NEMA TS 4-2016, Section 3.1.2.

Air drawn into the sign is filtered upon entry. The ventilation system must be automatically tested once each day and is able to be tested on command from remote and local control access locations. The sign must include a sensor or a sensor assembly to monitor airflow volume to predict the need for a filter change. The ventilation system fans must possess a 100,000 hour, L10 life rating.

**995-16.2.4.1 Ventilation System for Walk-In DMS:** The sign includes a fail-safe ventilation subsystem that includes a snap disk thermostat that is independent of the sign controller. The thermostat is preset at 130°F. If the sign housing's interior reaches 130°F, the thermostat must override the normal ventilation system, bypassing the sign controller and turning on all fans. The fans must remain on until the internal sign housing temperature falls to 115°F.

**995-16.2.5 Sign Housing Temperature Sensor:** The sign controller must continuously measure and monitor the temperature sensors. The sign must blank when a critical temperature is exceeded and reports this event when polled. Ensure that remote and local computers can read all temperature measurements from the sign controller.

**995-16.2.6 Sign Housing Humidity Sensor:** Humidity sensors must detect from 0 to 100% relative humidity in 1% or smaller increments. Sensors must operate and survive in 0 to 100% relative humidity, and have an accuracy that is better than plus or minus 5% relative humidity. Use of a humidistat is not acceptable.

**995-16.2.7 Sign Housing Photosensors:** The sign must meet the requirements of NEMA TS 4-2016, Section 9.1.3. The sensors must provide accurate ambient light condition information to the sign controller for automatic light intensity adjustment. The automatic adjustment of the LED driving waveform duty cycle must occur in small enough increments that the sign's brightness changes smoothly, with no perceivable brightness change between adjacent levels. Stray headlights shining on the photoelectric sensor at night must not cause LED brightness changes.

The brightness and color of each pixel must be uniform over the sign's entire face within a 30 degree viewing angle in all lighting conditions.

**995-16.3 Display Modules:** Display modules manufactured by one source and fully interchangeable throughout the manufacturer's sign system shall be provided. The removal or replacement of a complete display module or LED board must be accomplished without the use of special tools.

Display modules must contain solid-state electronics needed to control pixel data and read pixel status.

The sign must have a full matrix display area as defined in NEMA TS 4-2016, Section 1.6.

**995-16.3.1 LED and Pixel Specifications:** LED lamps must have a minimum viewing angle of 30 degrees.

All pixels in all signs in a project, including operational support supplies, must have equal color and on-axis intensity. The sign display must meet the luminance requirements of NEMA TS 4-2016, Section 5.4, for light emitting signs connected at full power. Amber displays must produce an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. Provide the LED brightness and color bins that are used in each pixel to the Engineer for approval. The LED manufacturer must demonstrate testing and binning according to the International Commission on Illumination (CIE) 127-1997 Standard.

All LEDs must operate within the LED manufacturer's recommendations for typical forward voltage, peak pulsed forward current, and other ratings. Component ratings must not be exceeded under any operating condition.

Ensure that the operational status of each pixel in the sign can be automatically tested once a day. Ensure that the pixel status test determines the functional status of the pixel as defined by the pixel Failure Status object in National Transportation Communications for ITS Protocol (NTCIP) 1203 v02.39 and does not affect the displayed message for more than half a second.

LEDs must be individually mounted directly on a printed circuit board (PCB).

**995-16.3.2 Optical, Electrical, and Mechanical Specifications for Display Modules:** The display modules must be rectangular and have an identical vertical and horizontal pitch between adjacent pixels. The separation between the last column of one display module and the first column of the next module must be equal to the horizontal distance between the columns of a single display module. Full matrix DMS must have the ability to display messages with 20mm pixel pitch (resolution).

The LED circuit board must be a NEMA FR4-rated, single 0.062 inch, black PCB. No PCB shall have more than two PCB jumper wires present. All PCBs shall be finished with a solder mask and a component-identifying silk screen.

PCBs with conformal coating meeting the material requirements of IPC-CC-830 or MIL-I-46058C Military Standard, United States Department of Defense (USDOD) must be provided.

Any devices used to secure LEDs must not block air flow to the LED leads or block the LED light output at the required viewing angle. All components on the LED side of a PCB must be black.

There must be a minimum of two power supplies that are wired in a parallel configuration for redundancy. If one, or 25% of the supplies in a group, whichever is

greater, completely fails, the sign shall still be supplied with enough power to run 40% of all pixels at a 100% duty cycle with an ambient operating temperature of 165°F.

The sign controller must continuously measure and monitor all LED module power supply voltages and provide the voltage readings to the TMC or a laptop computer on command.

LEDs must be protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Epoxy must not be used to encapsulate the LEDs.

**995-16.3.3 Display Area for Walk-In DMS:** The display area must be capable of displaying three lines with a minimum of 15 characters per line, using an 18 inch font that meets the height to width ratio and character spacing in the MUTCD, Section 2L.04, paragraphs 05, 06, and 08.

**995-16.4 Characters, Fonts, and Color:** The signs must be capable of displaying American Standard Code for Information Interchange (ASCII) characters 32 through 126, including all uppercase and lowercase letters, and digits 0 through 9, at any location in the message line. Submit a list of the character fonts to the Engineer for approval.

All signs must be loaded (as a factory default) with a font in accordance with or that resembles the standard font set described in NEMA TS 4-2016, Section 5.6. For signs with a pixel pitch of 35 mm or less, the sign must be loaded (as a factory default) with a font set that resembles the FHWA Series E2000 standard font.

DMS fonts must have character dimensions that meet the MUTCD, Section 2L.04, paragraph 08.

Full-color signs must display the colors prescribed in the MUTCD, Section 1A.12.

**995-16.5 Main Power Supply and Energy Distribution Specifications:** A nominal single-phase power line voltage of 120/240 V<sub>AC</sub> must be provided. The DMS must meet the requirements of NEMA TS 4-2016, Section 10.2.

All 120 V<sub>AC</sub> wiring must have an overall nonmetallic jacket or be placed in metal conduit, pull boxes, raceways, or control cabinets and installed as required by the NEC. Do not use the sign housing as a wiring raceway or control cabinet.

Surge protective devices (SPD) must be installed or incorporated in the sign system by the manufacturer to guard against lightning, transient voltage surges, and induced current. SPDs must meet or exceed the requirements of Section 996. SPDs must protect all electric power and data communication connections.

**995-16.6 Uninterruptible Power Supply (UPS):** Walk-in DMS must include a UPS that can be installed within the sign housing or within the ground mounted control cabinet. Front access and embedded signs must include a UPS that can be installed within the ground mounted control cabinet. The UPS system must be capable of displaying the current messages on a sign when a power outage occurs. Signs with an UPS must be able to operate on battery power and display text messages for a minimum of two hours. The system must use sealed absorbed glass mat (AGM) batteries.

**995-16.7 Operational Support Supplies:** Furnish the operational support supplies listed in Table 995-8. Promptly replace any of the supplies used to perform a warranty repair.

For every group of 10 or fewer DMSs provided or required, provide one set of supplies as follows:



<u>Table 995-9</u> <u>Operational Support Supplies</u>	
<u>1 each</u>	<u>Sign controller and I/O board(s)</u>
<u>1 per DMS</u>	<u>LED display modules</u>
<u>1 each</u>	<u>Display power supply</u>
<u>1 each</u>	<u>Uninterruptible power supply</u>
<u>2 each</u>	<u>Surge suppression sets</u>
<u>1 each</u>	<u>Fan assembly</u>

**995-16.8 Components:** All components must meet the requirements of NEMA TS 4-2016, Section 8.

**995-16.8.1 Mechanical Components:** All fasteners, including bolts, nuts, and washers less than 5/8 inch in diameter, must be passivated stainless steel, Type 316 or 304 and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. All bolts and nuts 5/8 inch and over in diameter must be galvanized and meet the requirements of ASTM A307. Self-tapping screws must not be used. All parts must be fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass. Construction materials must be resistant to fungus growth and moisture deterioration. All dissimilar metals must be separated with an inert, dielectric material.

**995-16.8.2 Sign Controller:** The sign controller must monitor the sign in accordance with NEMA TS 4-2016, Section 9. The sign must monitor the status of any photocells, LED power supplies, humidity, and airflow sensors. Sign controllers must use fiber optic cables for data connections between the sign housing and ground-level cabinet.

The sign controller must meet the requirements of NEMA TS 4-2016, Sections 8.3 and 8.4. The sign controller must be capable of displaying a self-updating time and date message on the sign. Sign controllers within ground cabinets must be rack-mountable, designed for a standard Electronic Industries Alliance (EIA) EIA-310 19 inch rack, and includes a keypad and display.

**995-16.8.3 Display System Hardware:** The sign must utilize a system data interface circuit for communications between the sign controller and display modules. Except for embedded DMS, the following components must reside inside the sign housing: sign controller (master or slave), display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, EIA-232 null modem cables (minimum of four feet long for connecting laptop computer to sign controller), and surge protective devices.

**995-16.8.4 Control Cabinet:** A control cabinet that meets the requirements of Section 676 shall be provided. The minimum height of the cabinet must be 46 inches.

A ground control cabinet that includes the following assemblies and components: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, a four foot long cable to connect laptop computers, a workspace for a laptop computer, and duplex outlets shall be provided.

All telephone, data, control, power, and confirmation connections between the sign and ground control box, and for any required wiring harnesses and connectors shall be provided.

**995-16.8.5 Sign Controller Communication Interfaces:** The sign controller must have communication interfaces in accordance with NEMA TS 4-2016, Section 8.3.2. Ensure that EIA-232 serial interfaces support the following:

<u>Table 995-10</u>	
<u>Communication Interface Requirements</u>	
<u>Data Bits</u>	<u>7 or 8 bits</u>
<u>Parity</u>	<u>Even, Odd, or None</u>
<u>Number Stop Bits</u>	<u>1 or 2 bit</u>

The sign controller must have a 10/100 Base TX 8P8C port or a 100 Base FX port Ethernet interface.

The TMC or a laptop computer must be able to remotely reset the sign controller.

**995-16.9 Message and Status Monitoring:** The DMS must provide two modes of operation: (1) remote operation, where the TMC commands and controls the sign and determines the appropriate message or test pattern; and (2) local operation, where the sign controller or a laptop computer commands and controls the sign and determines the appropriate message or test pattern.

The sign must perform the following functions:

1. Control Selection – Ensure that local or remote sign control can be selected. Ensure that there is a visual indicator on the controller that identifies whether the sign is under local or remote control.

2. Message Selection – Ensure that the sign controller can select a blank message or any one of the messages stored in the sign controller’s nonvolatile memory when the control mode is set to local.

3. Message Implementation – Ensure that the sign controller can activate the selected message.

Ensure that the sign can be programmed to display a user-defined message, including a blank page, in the event of power loss.

Ensure that message additions, deletions, and sign controller changes may be made from either the remote TMC or a local laptop computer. Ensure that each font may be customized, and modifications to a font may be downloaded to the sign controller from the TMC or a laptop computer at any time without any software or hardware modifications.

Ensure that there is no perceivable flicker or ghosting of the pixels during sign erasure and writing periods.

**995-16.10 TMC Communication Specification for all DMS:** The sign controller must be addressable by the TMC through the Ethernet communications network using software that complies with the NTCIP 1101 base standard (formerly the NEMA TS 3.2-1996 Standard), including all amendments as published at the time of Contract letting, the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. The software must implement all mandatory objects in the supplemental requirement SR-700-4.1.1, Dynamic Message Sign NTCIP Requirements, as published on the Department’s State Traffic Engineering and Operations Office web site at the following URL: <https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm>.

The sign must comply with the NTCIP 1102v01.15, 2101v01.19, 2201v01.15, 2202v01.05, and 2301v02.19 Standards. The sign must comply with NTCIP 1103v02.17, Section 3.

Ensure that the controller's internal time clock can be configured to synchronize to a time server using the network time protocol (NTP). NTP synchronization frequency must be user-configurable and permit polling intervals from once per minute to once per week in one-minute increments. The controller must allow the user to define the NTP server by IP address.

**995-16.11 Sign Control Software:** The sign must be provided with computer software from its manufacturer that allows an operator to program, operate, exercise, diagnose, and read current status of all sign features and functions using a laptop computer. The sign control software must provide a graphical representation that visibly depicts the sign face and the current ON/OFF state of all pixels as well as allows messages to be created and displayed on the sign.

**995-16.12 Environmental Requirements:** The DMS must meet the requirements of NEMA TS 4-2016, Section 2.

**995-16.13 Warranty:** The DMS system and equipment must have a manufacturer's warranty covering defects for a minimum of five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

### **995-17 Electronic Display Sign.**

**995-17.1 General:** All electronic display signs (EDS) must meet the physical display and operational requirements for warning, guide, or regulatory signs described in the MUTCD and the SHS.

The term EDS refers to a general category of electronically enhanced signs that includes electronic road signs (ERS) with warning, regulatory, or guide legends; electronic speed feedback signs (ESFS); and blank-out signs (BOS).

EDS must allow attachment to vertical and horizontal support structures as part of a single or double sign post configuration. Bolts must be used for load bearing attachments.

**995-17.2 Requirements Common to all EDS:** All EDS must be designed to withstand the loads defined in the Department's Structures Manual without deformation or damage. EDS, other than BOS, must provide an option to include flashing beacons. Printed circuit boards must be protected with conformal coating. Housings that contain electronics must be constructed of aluminum alloy sheet a minimum of .090 inch thick. Welding used during the construction of EDS must be accordance with Section 965.

Signs included on the APL will be designated with a size and type category and may be listed with restrictions, such as "requires District Traffic Operations Engineer approval", "school zones only", or "low speed only".

**995-17.2.1 Electronic Display Sign with Static Sign Panel:** EDS that include both a static sign panel and dynamic display may be a modular system comprised of a static sign panel with an attached electronic display. Static sign panels must meet the Department's requirements for highway signing found in this Section.

**995-17.2.2 Electronic Display:** Electronic displays must appear completely blank (dark) when not energized. No phantom characters or graphics will be allowed under any ambient light conditions.

**995-17.2.3 Housing:** The housing must protect and seal the dynamic display and other internal electronics. Any polycarbonate material used on the sign face must be a minimum 90% UV opaque and resistant to fading and yellowing. The housing must be NEMA 3R rated

and prevent unauthorized access. The housing must include weather tight cable entry or connection points for any required power or data connections.

**995-17.2.4 Cabinet:** Any equipment cabinets provided with the EDS must be listed on the APL.

**995-17.2.5 Optical, Electrical, and Mechanical Specifications for Display Modules:** All LEDs must operate within the LED manufacturer's recommendations for typical forward voltage, peak pulsed forward current, and other ratings. Component ratings must not be exceeded under any operating conditions.

**995-17.2.6 LED and Pixel Specifications:** All LEDs used in the display must have a wavelength output that varies no more than plus or minus two nanometers from the specified peak wavelength. The display and LED pixel cone of vision must be a minimum of 15 degrees (centered around the optical axis, or zero point, of the pixel). The cone perimeter is defined by the point where light output intensity is 50% of the intensity measured at the zero point of the pixel. For all colors other than white, the sign display must produce an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. For white or full color matrix displays, the sign display must produce white with an overall luminous intensity of at least 12,400 candelas per square meter when operating at 100% intensity. Submit documentation that indicates the LED brightness and color bins that are used in each pixel. LEDs must be individually mounted on a PCB and must be able to be removed and replaced using conventional electronic repair methods. Encapsulated LEDs within a pixel are not allowed. ERS LEDs must be arranged and powered in a manner that maintains a discernible message in the event of a single LED or pixel failure.

**995-17.2.7 Character Size, Fonts, and Graphics:** The minimum numeral and letter size of the electronic display must meet or exceed the numeral and letter sizes prescribed in the MUTCD and the SHS. Fonts and graphics must mimic the characteristics of fonts and graphics defined in the MUTCD and SHS.

**995-17.2.8 Electronic Display Controller:** Any electronic display controller required for the operation of the EDS shall be housed within the sign and be equipped with a security lockout feature to prevent unauthorized use. The controller shall have the capability to provide a stipulated default message upon loss of controller function. A blank message is acceptable.

**995-17.2.9 Communication:** The electronic display controller shall possess a minimum of one serial, Ethernet, USB, or Bluetooth interface with the ability to connect to a laptop computer. The serial data interface shall support multiple data rates from 9,600 bps to 115,200 bps.

**995-17.2.10 Configuration and Management:** Ensure that the sign is provided with computer software from its manufacturer that allows a user to program, operate, exercise, diagnose, and read current status of all sign features and functions using a laptop. Configuration and management functions must be password protected.

**995-17.2.11 Operation and Performance:** Ensure that the EDS is visible from a distance of at least 1/4 mile and legible from a distance of 400 feet for applications on roads with a speed limit less than 45 mph and visible from a distance of at least 1/2 mile and legible from a distance of at least 650 feet for roads with speed limits 45 mph or higher. In both cases, the requirements must be met under both day and night conditions.

The electronic display shall automatically adjust brightness for day and night operation. The EDS must be equipped with a light sensor that accurately measures ambient

light level conditions at the sign location. The EDS must automatically adjust LED intensity based on the ambient light conditions in small enough increments that the sign's brightness changes smoothly, with no perceivable brightness change between adjacent levels. Stray headlights shining on the photoelectric sensor at night must not cause LED brightness changes.

Flashing messages must not exceed 150 flashes per minute.

**995-17.2.12 Mechanical Specifications:** EDS mounting provisions and mounting hardware must accommodate sign weight and wind loading requirements of the Department's Structures Manual. BOS must be designed to accommodate overhead attachment using a tri-stud signal hanger. Multiple tri-stud attachment points may be used to meet weight and wind loading requirements. Tri-stud attachment points must be weather-tight and structurally reinforced.

**995-17.2.13 Fasteners and Attachment Hardware:** Ensure that all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, are Type 304 or 316 passivated stainless steel. Stainless steel bolts, screws and studs must meet ASTM F593. Nuts must meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized. Bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-17.2.14 Electrical Specifications:** All power inputs must be fuse and reverse polarity protected. All EDS must be able to recover from power loss and return to their operational state without user intervention.

**995-17.2.14.1 Solar Power:** Solar powered signs must be capable of fully autonomous operation 24 hours per day, 365 days per year. Batteries must be a standard 12 volt deep cycle battery suitable for the application and operating environment. Flooded lead-acid batteries are prohibited.

Batteries must be capable of providing 10 days of continuous operation without sunlight. Charging system must use a solar charge controller with temperature compensation. The system must provide for automatic battery charging, overcharge protection, and have indications that display current status and faults.

**995-17.2.14.2 AC Power:** Fluctuations in line voltage must have no visible effect on the appearance of the display.

**995-17.2.15 Environmental Requirements:** The EDS assembly must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2. Fog, frost, or condensation must not form within the dynamic portion of the sign. Electronics must meet FCC Title 47, Subpart B Section 15.

**995-17.2.16 Warranty:** The EDS systems and equipment furnished must have a manufacturer's warranty covering defects in assembly, fabrication, and materials for a minimum of three years.

**995-17.3 Electronic Warning Signs:** EWS must include a secure wireless connection to communicate with a nearby laptop.

**995-17.3.1 EWS Foreground/Background Colors:** If a black background is used on the changeable electronic display, the color used for the legend must match the background color that would be used on a standard sign for that type of legend, in accordance with the MUTCD. Black EWS display backgrounds must be flat black (FED-STD-595-37038) with a reflectance value not exceeding 25%. EWS must utilize yellow LEDs with a peak wavelength of either 585 or 590 nanometers. EWS must have a minimum one-inch contrasting margin around illuminated characters or graphics.

**995-17.3.2 Speed Detector:** EWS that detect or display the speed of approaching vehicles must be programmable for the posted speed limit and the maximum speed to display. When the detected speed exceeds the maximum programmed speed (high speed cut-off) threshold, the display must automatically blank. Alternately, the display may show an alert message such as “SLOW DOWN” when speeds above the maximum programmed speed threshold are detected.

The EWS must detect when the posted speed is exceeded by one mph and then activate the alert. When the alert is activated, the display shall be able to flash. When no advancing traffic is detected, the display must be blank. The speed detector must not activate alerts for vehicles outside the display cone of vision.

The speed detector must meet the requirements of FCC Title 47, Part 90 and not require an FCC operating license. The speed detector must operate on 10.8 to 16.6 V<sub>DC</sub> and draw less than three amperes. The EWS must monitor and display the speed of approaching traffic only. The EWS detector must be able to accurately detect and determine the speed of approaching vehicles. The EWS must be capable of measuring and displaying speeds of approaching traffic only between 10 and 99 mph with an accuracy of plus or minus one mph, 1,000 feet in advance of the sign.

**995-17.4 Electronic Regulatory Signs:** Display modules for ERS must have a minimum two-inch contrasting margin around digits, text, or graphics. ERS must utilize LED technology for the dynamic display.

**995-17.4.1 ERS Battery Backup System:** AC powered signs must include a battery backup system that maintains full operation of the sign for a minimum of two hours in the event of utility power loss. Operation on battery backup can have no visible effect on the appearance of the display.

**995-17.4.2 Variable Speed Limit Signs:** Variable speed limit signs (VSLS) must be able to display speed limits from 5-70 mph in five mph increments and mimic the physical appearance of a static regulatory speed limit sign as shown in the MUTCD and SHS. VSLS must use black characters on a white background. VSLS must log the time and date of any speed limit change to internal non-volatile memory. The log must be able to record a minimum of 1,000 events in a first-in, first-out fashion.

**995-17.4.2.1 VSLS Controller Communications:** VSLS must be equipped with a sign controller that includes a minimum of one Ethernet 10/100 Base TX 8P8C port.

**995-17.4.2.2 Configuration and Management Requirements for VSLS:** VSLS must support remote management from a TMC and local management using a laptop computer. Remote and local computers must be able to reset VSLS sign controller. VSLS must log and report status, errors, and failures, including data transmission errors, receipt of invalid data, communication failure recoveries, power failures, power recoveries, display errors, fan and airflow status, temperature status, power supply status, and information on the operational status of the temperature, photocell, airflow, humidity, and LED power supply sensors.

The sign controller must be addressable through an Ethernet communication network using software that complies with the NTCIP requirements published online by the Department’s Transportation Traffic Engineering Research Laboratory (TERL) at: <https://www.fdot.gov/traffic/>. The sign must implement any NTCIP standards required to achieve interoperability and interchangeability. Any additional objects implemented by the

software must not interfere with the standard operation of any mandatory objects. VLS must be compatible with the Department's SunGuide<sup>®</sup> software.

**995-17.5 Blank-Out Signs:** BOS must have a black exterior finish (FED-STD-595-37038) with a reflectance value not exceeding 25%. Overhead BOS must include a visor.

**995-17.6 Electronic Speed Feedback Signs:** The ESFS display background must be flat black (FED-STD-595-37038) with a reflectance value not exceeding 25%. ESFS must utilize amber LEDs with a peak wavelength of 590 nanometers. ESFS shall have a minimum one-inch contrasting margin around illuminated characters or graphics.

**995-17.6.1 Speed Detector:** The ESFS must be programmable for the posted speed limit and the maximum speed to display. When the detected speed exceeds the maximum programmed speed (high speed cut-off) threshold, the display must automatically blank. Alternately, the display may show an alert message such as "SLOW DOWN" when speeds above the maximum programmed speed threshold are detected. The ESFS must detect when the posted speed is exceeded by one mph and then activate the alert. When the alert is activated, the display must flash at a rate of 50 to 60 cycles per minute. When no advancing traffic is detected, the display must be blank. The speed detector must not activate alerts or display speeds for vehicles outside the display's cone of vision. The ESFS must meet the requirements of FCC Part 90 and not require an FCC operating license. The speed detector must operate on 10.8 to 16.6 V<sub>DC</sub>. The ESFS must be capable of measuring speeds of approaching traffic between 10 and 99 mph with an accuracy of plus or minus one mph, 1,000 feet in advance of the sign.

## **995-18 Sign Beacon.**

**995-18.1 General:** Flashing beacon assemblies incorporating a circular traffic signal must meet the design and functional requirements set forth in MUTCD Chapter 4L. All circular beacons must have a minimum nominal diameter of 12 inches and meet the requirements of Section 650. All beacons must use a LED light source.

**995-18.1.1 School Zone Beacon:** Beacons designed for use with school zone signing must include a means of calendar scheduling to program days and times of operation.

**995-18.1.2 Vehicle Activated Beacon:** Vehicle activated beacons must utilize a vehicle detection system listed on the APL.

**995-18.1.3 Pedestrian Activated Beacon:** Pedestrian activated beacons must utilize a pedestrian detector listed on the APL.

**995-18.2 Cabinets, Housings, and Hardware:** Flashing beacon cabinets must be currently listed on the APL or meet the requirements of Section 676.

All housings, other than pole-mounted cabinets, must be powder coated dull black (FED-STD-595-37038) with a reflectance value not exceeding 25% as measured by ASTM E1347. Cabinets and housings must prevent unauthorized access.

Flashing beacon assemblies must allow installation on 4-1/2 inch outer diameter posts.

Ensure all exposed assembly hardware including nuts, bolts, screws, and locking washers less than 5/8 inch in diameter, is Type 304 or 316 passivated stainless steel and meets the requirements of ASTM F593 and ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized and meet the requirements of ASTM A307.

**995-18.3 Electrical Specifications:** Provide equipment that operates on solar power or a nominal voltage of 120 V<sub>AC</sub>. If the device requires operating voltages of less than 120 V<sub>AC</sub>, supply the appropriate voltage converter. Solar powered beacon systems must be designed to provide 10 days of continuous operation without sunlight and must automatically charge

batteries and prevent overcharging and over-discharging. Solar powered systems must include a charge indicator.

**995-18.4 Environmental Specifications:** All electronic assemblies must operate as specified during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS 4-2016, Section 2. All electronic equipment must comply with FCC Title 47 Subpart B Section 15.

**995-18.5 Warranty:** Ensure all flashing beacons have a manufacturer's warranty covering defects for a minimum of three years from the date of final acceptance in accordance with 5-11 and Section 608. Ensure the manufacturer will furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department or maintaining agency within 30 calendar days of notification.

### **995-19 In-Street Signs.**

**995-19.1 General:** In-Street signs consist of the R1 6a or R1 6c In Street Pedestrian Crossing Sign assemblies including the sign base.

**995-19.2 Materials:** The sign assembly includes the vertical panel, retroreflective sign sheeting, a rebounding boot support, and a base. The vertical panel is bolted to a flexible boot which is fastened to a plastic, recycled PVC, or rubber base. The sign assembly shall contain no upright metal parts.

The vertical panel shall yield (bend) fully upon vehicle impact, then return to vertical position plus or minus 10 degrees with no delaminating. The face of the vertical panel shall resist twisting and remain oriented to the installed direction after vehicle impact. The vertical panel shall not split, crack, break, or separate from base. Use only UV stabilized, ozone and hydrocarbon resistant outdoor-grade thermoplastic polymer, polycarbonate, recycled PVC, or HDPE materials. UV stabilization testing shall be in accordance with ASTM D1435.

Use Type XI fluorescent yellow-green retroreflective sign sheeting meeting the requirements of Section 994 on both sides of the vertical panel. The surface of the panel shall be smooth and free of defects, suitable for adherence of appropriate retroreflective sheeting.

#### **995-19.2.3 Base:**

**995-19.2.3.1 Sign Base (Fixed):** The base shall be constructed with high-impact materials using ozone and hydrocarbon resistant outdoor grade thermoplastic polymer, polycarbonate, or HDPE materials meeting the general provisions for all In-Street sign bases.

**995-19.2.3.2 Sign Base (Portable):** Portable base assemblies shall consist of a lightweight plastic, recycled PVC, or rubber material that may be easily moved or relocated by a single person.

**995-19.2.3.3 Color:** Sign bases shall be either black, or the same color as the adjacent pavement marking.

**995-19.2.4 Approved Product List (APL):** In addition to the APL requirements of 995-1.2, provide the following:

1. Product Drawings, which at a minimum includes:

a. Model Number

b. Allowable sign panel size and substrate

c. Dimensions of sign base and mounting heights

2. Crash Test Reports demonstrating MASH compliance

3. All FHWA Eligibility Letters

4. When requested, submit product sample



**995-19.3 Vertical Panel Messages:** Fabricate vertical panel messages in accordance with Section 994. Vertical panels of 8 inches wide x 28 inches tall or 12 inches x 36 inches are acceptable. See Standard Plans Section 700-102.

**995-19.4 Connection Method:** Products will be categorized as either Fixed Base or Portable. Fixed base will be installed in accordance with the manufacturer's instructions. Portable base will be limited to temporary applications at school crossings where a crossing guard is present during school arrival and departure times or when children are present.

**TRAFFIC CONTROL SIGNAL AND DEVICE MATERIALS.****(REV 8-11-22)**

SECTION 995 is expanded by the following new Articles:

**995-14 Internally Illuminated Signs.**

**995-14.1 General:** Marking must be accomplished by permanently affixing an indelible label, identification plate, dot peen type stamp, casting, or metal-marking. Signs must not exceed 9 feet in length or be larger than 18.0 square feet or less in area, and must not weigh more than 144 pounds. Internally illuminated sign assemblies must be listed to the requirements of UL48 listed. Light emitting diode (LED) retrofit kits must be listed on the APL.

**995-14.2 Housing:** The sign housing must be constructed of continuous 5052 or 6063-T5 aluminum. All housing, corners, and door seams must be continuously welded. All exterior surfaces of the assembly must be powder-coat painted in accordance with Military Standard MIL-PRF-24712A or AAMA-2603-02. Finish must meet the requirements of ASTM D3359, ASTM D3363, and ASTM D522. Sign housings with any interior airspace must consist of a box type enclosure and separate hinged door assembly. The sign housing must include provisions to prevent water from entering the sign housing. Drain holes in the sign larger than 0.125 inch must be covered by a screen.

Signs must have removable sign faces. The sign face must be secured by a method that holds the sign face securely in place. Slide-in grooves are allowed to secure the sign face if the sign is edge lit.

The sign face must be a translucent lens constructed of 0.125-inch thick high impact strength polycarbonate or acrylic meeting UL48. Background must be translucent retroreflective sheeting coated with a transparent, pressure-sensitive adhesive film. Color must meet the criteria as detailed in Section 994. Retroreflective sheeting must meet the requirements of Section 994 and be listed on the APL.

If a door opens upward, it must have a bracket on each side to secure the door in the open position during maintenance. Doors must be permanently and continuously sealed with a foam gasket listed to UL157 to prevent the entry of water into the sign housing. Each door must be secured from opening by stainless steel rotary action draw latches as follows:

Signs of 5 feet up to 7 feet in length must have a minimum of three latches for each sign door.

Signs over 7 feet up to 9 feet in length must have a minimum of four latches for each door.

The rotary action draw latch must be captive and will not become detached or allow the door to open when the sign housing is torqued or twisted.

The sign assembly must be designed and constructed to withstand 150 mph wind loads meeting the requirements of the Department's Structures Manual.

**995-14.3 Luminance:** The sign face must be illuminated evenly across the entire surface. Contrast ratio between the background and legend must be established by the lowest and the highest color retroreflective measurement and shall be at least 4:1. Measure the retroreflectivity in accordance with ASTM D4956.

**995-14.3.1 Background Luminance:** Minimum luminance for the legend portion of the street sign face must be no less than 87.5 lux. The luminance must be determined by averaging a minimum of seven readings. Four of the readings must be taken near the midpoint of a line that would span between the outside corners of the background and the outside corners of

the legend. One reading must be taken near the midpoint of a line that would connect the top corner readings. One reading must be taken near the midpoint of a line that would connect the bottom corner readings. One reading must be taken near the vertical and horizontal midpoint of the sign.

**995-14.3.2 Border and Lettering Luminance:** Minimum luminance of the legend and border must be 350 lux. The luminance must be determined by averaging a minimum of 17 readings. There must be a minimum of one reading from each letter in the legend. Readings within the legend must alternate between the top, middle and bottom portion of each letter. Readings within top and bottom of the border must be perpendicular to the top and bottom readings in the background. Readings within the sides of the border must be taken parallel to the readings taken within each letter.

**995-14.4 Mechanical Requirements:** All assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8-inch in diameter must be Type 304 or 316 passivated stainless steel. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized. Bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-14.5 Electrical Requirements:** Electrical wiring must meet NEC requirements for the light source provided. All wiring must be copper wire. All internal electrical wiring must be tight and secure. The sign must include an accessible electrical power service entrance compartment (internal or external) for connection of field wiring. External compartments must be weather-tight. All power supplies and ballasts must be Federal Communications Commission (FCC) approved.

Electrical connections must be protected against corrosion. All signs must have provisions for an integrated photocell.

**995-14.6 Environmental Requirements:** The illuminated sign assembly must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2.

**995-14.7 Warranty:** Internally illuminated signs must have a manufacturer's warranty covering defects for five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

## **995-15 Highlighted Signs.**

**995-15.1 General:** Highlighted signs must meet the design and functional requirements specified in this Section and Section 2A of the MUTCD. Use LEDs to highlight the sign's shape, color, or message.

Stop, Do Not Enter, Yield, and Wrong Way signs that are highlighted with LEDs must use red LEDs. All other signs must use LEDs which resemble the color of the sign background color.

**995-15.2 Performance Requirements:** Highlighted signs are capable of automatically dimming to reduce brightness of the LEDs at nighttime.

Highlighted signs that rely upon solar power or batteries must be capable of at least 10 days of continuous operation without the need for charging.

**995-15.3 Cabinets:** If the highlighted sign includes a cabinet, the cabinet must be currently listed on the APL or meet the requirements of Section 676.

**995-15.4 Mechanical Requirements:** All assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8-inch in diameter must be Type 304 or 316 passivated stainless steel. All assembly hardware greater than or equal to 5/8-inch in diameter

must be galvanized. Bolts, studs, and threaded rod shall meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-15.5 Electrical Requirements:** Electrical wiring must meet NEC requirements for the light source provided. All wiring must be copper wire. All internal electrical wiring must be tight and secure. The sign must include an accessible electrical power service entrance compartment (internal or external) for connection of field wiring. External compartments must be weather-tight. All power supplies and ballasts must be Federal Communications Commission (FCC) approved.

Electrical connections must be protected against corrosion. All signs must have provisions for an integrated photocell.

**995-15.6 Environmental Requirements:** The highlighted must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2.

**995-15.7 Warranty:** Highlighted signs must have a manufacturer's warranty covering defects for three years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

## **995-16 Dynamic Message Signs.**

**995-16.1 General:** Dynamic message signs (DMS) must meet the requirements of NEMA TS4-2016. DMS are classified by the type of sign display and the type of mechanical construction. Use only equipment and components that meet the requirements of these minimum specifications and are listed on the APL. DMS LED retrofit kits must be listed on the APL.

**995-16.1.1 Front Access DMS:** Front access signs must meet the requirements of NEMA TS 4-2016, Section 3.2.6.

**995-16.1.2 Walk-In DMS:** Walk-in signs must meet the requirements of NEMA TS 4-2016, Section 3.2.8.

**995-16.1.3 Embedded DMS:** Embedded DMSs must be mounted to ground traffic signs, overhead traffic signs, or overhead cantilever traffic signs.

**995-16.2 Sign Housing Requirements for all DMS:** The external skin of the sign housing must be constructed of aluminum alloy 5052 H32. The interior structure must be constructed of aluminum. Internal frame connections or external skin attachments must not solely rely upon adhesive bonding or rivets.

The sign enclosure must meet the requirements of NEMA TS 4-2016, Section 3.1.1. All drain holes and other openings in the sign housing must be screened to prevent the entrance of insects and small animals.

The sign housing must comply with the fatigue resistance requirements of the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. Design and construct the DMS unit for continuous usage of at least 20 years. The sign assembly must be designed in accordance with the Department's Structures Manual, including a wind load of 150 miles per hour.

The top of the housing shall include multiple steel lifting eyebolts or equivalent hoisting points. Hoist points are positioned such that the sign remains level when lifted. The hoist points and sign frame allow the sign to be shipped, handled, and installed without damage.

All assembly hardware, including nuts, bolts, screws, and locking washers less than 5/8-inch in diameter, must be Type 304 or 316 passivated stainless steel and meet the requirements of ASTM F593 and ASTM F594. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized and meet the requirements of ASTM A307.

All exterior, excluding the sign face, and all interior housing surfaces must be a natural aluminum mill finish. Signs must be fabricated, welded, and inspected in accordance with the requirements of the current ANSI/AWS Structural Welding Code-Aluminum.

The sign housing must meet the requirements of NEMA TS 4-2016, Section 3.2.9 for convenience outlets.

**995-16.2.1 Sign Housing for Walk-In DMS:** Exterior seams and joints, except the finish coated face pieces, must be continuously welded using an inert gas welding method. Limit the number of seams on the top of the housing to a maximum of three. Stitch weld the exterior housing panel material to the internal structural members to form a unitized structure.

The exterior mounting assemblies must be fabricated from aluminum alloy 6061-T6 extrusions a minimum of 0.1875 inch thick. Include a minimum of three 6061-T6 structural aluminum Z members on the rear of the sign housing in accordance with the Standard Plans. The structural aluminum Z members must run parallel to the top and bottom of the sign housing and are each a single piece of material that spans the full length of the sign. The structural aluminum Z members must be attached to the internal framework of the sign.

The hoist points must be attached directly to structural frame members by the sign manufacturer.

Housing access must be provided through an access door that meets the requirements of NEMA TS 4-2016, Section 3.2.8.1. The access door must include a keyed tumbler lock and a door handle with a hasp for a padlock. The door must include a closed-cell neoprene gasket and stainless steel hinges.

The sign housing must meet the requirements of NEMA TS 4-2016, Section 3.2.8.3 for service lighting. If incandescent lamps are provided, they must be fully enclosed in heavy-duty shatterproof, protective fixtures. The incandescent fixtures must include aluminum housing and base, a porcelain socket, and clear glass inner cover. All removable components must be secured with set screws. If fluorescent lamps are provided, they must be fitted with shatter proof protective guards.

The sign housing must include emergency lighting that automatically illuminates the interior in the event of a power outage. Emergency lighting must be capable of operation without power for at least 90 minutes.

**995-16.2.1.1 Walk-In DMS Work Area:** The walk-in DMS must have a work area that meets the requirements of NEMA TS 4-2016, Section 3.2.8.2. All edges of the walkway are finished to eliminate sharp edges or protrusions.

**995-16.2.2 Sign Housing for Front Access and Embedded DMS:** Front access and embedded signs must meet the requirements of NEMA TS 4-2016, Section 3.2.5 and Section 3.2.6. Accessing the sign housing must not require specialized tools or excessive force to open.

**995-16.2.3 Housing Face Requirements for all DMS:** The sign face must meet the requirements of NEMA TS 4-2016, Section 3.1.3. All sign face surfaces are finished with a matte black coating system that meets or exceeds American Architectural Manufacturers Association (AAMA) Specification No. 2605. Submit certification that the sign face parts are coated with the prescribed thickness. Except for embedded DMS, the sign face must include a contrast border that meets the requirements of NEMA TS 4-2016, Section 3.1.6.

**995-16.2.3.1 Housing Face for Walk-In DMS:** No exposed fasteners are allowed on the housing face. The display modules shall be easily and rapidly removed from within the sign without disturbing adjacent display modules.

**995-16.2.3.2 Housing Face for Front Access and Embedded DMS:** Any exposed fasteners on the housing face must be the same color and finish as the housing face. Only captive fasteners may be used on the housing face.

**995-16.2.3.3 External Fascia Panels:** If the sign includes external fascia panels, they must be constructed using aluminum. Each fascia panel is finished with a matte black coating system that meets or exceeds AAMA Specification No. 2605.

**995-16.2.3.4 Lens Panel Assembly:** If the sign includes lens panel assemblies, they must be modular in design, removable, and interchangeable without misalignment of the lens panel and the LED pixels. The lens panel assembly must consist of an environmental shielding layer coating to protect and seal the LED and internal electronics. The coating must be a minimum 90% UV opaque. Lens panels must have a matte black coating that meets or exceeds AAMA Specification No. 2605. Lens panels must include a mask constructed of 0.080 inch minimum thickness aluminum. The mask must be perforated to provide an aperture for each pixel on the display module. The apertures must not block the LED output at the required viewing angle.

**995-16.2.4 Sign Housing Ventilation System:** The ventilation systems for walk-in, front-access, and embedded DMS must meet the requirements of NEMA TS 4-2016, Section 3.1.2.

Air drawn into the sign is filtered upon entry. The ventilation system must be automatically tested once each day and is able to be tested on command from remote and local control access locations. The sign must include a sensor or a sensor assembly to monitor airflow volume to predict the need for a filter change. The ventilation system fans must possess a 100,000 hour, L10 life rating.

**995-16.2.4.1 Ventilation System for Walk-In DMS:** The sign includes a fail-safe ventilation subsystem that includes a snap disk thermostat that is independent of the sign controller. The thermostat is preset at 130°F. If the sign housing's interior reaches 130°F, the thermostat must override the normal ventilation system, bypassing the sign controller and turning on all fans. The fans must remain on until the internal sign housing temperature falls to 115°F.

**995-16.2.5 Sign Housing Temperature Sensor:** The sign controller must continuously measure and monitor the temperature sensors. The sign must blank when a critical temperature is exceeded and reports this event when polled. Ensure that remote and local computers can read all temperature measurements from the sign controller.

**995-16.2.6 Sign Housing Humidity Sensor:** Humidity sensors must detect from 0 to 100% relative humidity in 1% or smaller increments. Sensors must operate and survive in 0 to 100% relative humidity, and have an accuracy that is better than plus or minus 5% relative humidity. Use of a humidistat is not acceptable.

**995-16.2.7 Sign Housing Photosensors:** The sign must meet the requirements of NEMA TS 4-2016, Section 9.1.3. The sensors must provide accurate ambient light condition information to the sign controller for automatic light intensity adjustment. The automatic adjustment of the LED driving waveform duty cycle must occur in small enough increments that the sign's brightness changes smoothly, with no perceivable brightness change between adjacent levels. Stray headlights shining on the photoelectric sensor at night must not cause LED brightness changes.

The brightness and color of each pixel must be uniform over the sign's entire face within a 30 degree viewing angle in all lighting conditions.

**995-16.3 Display Modules:** Display modules manufactured by one source and fully interchangeable throughout the manufacturer's sign system shall be provided. The removal or replacement of a complete display module or LED board must be accomplished without the use of special tools.

Display modules must contain solid-state electronics needed to control pixel data and read pixel status.

The sign must have a full matrix display area as defined in NEMA TS 4-2016, Section 1.6.

**995-16.3.1 LED and Pixel Specifications:** LED lamps must have a minimum viewing angle of 30 degrees.

All pixels in all signs in a project, including operational support supplies, must have equal color and on-axis intensity. The sign display must meet the luminance requirements of NEMA TS 4-2016, Section 5.4, for light emitting signs connected at full power. Amber displays must produce an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. Provide the LED brightness and color bins that are used in each pixel to the Engineer for approval. The LED manufacturer must demonstrate testing and binning according to the International Commission on Illumination (CIE) 127-1997 Standard.

All LEDs must operate within the LED manufacturer's recommendations for typical forward voltage, peak pulsed forward current, and other ratings. Component ratings must not be exceeded under any operating condition.

Ensure that the operational status of each pixel in the sign can be automatically tested once a day. Ensure that the pixel status test determines the functional status of the pixel as defined by the pixel Failure Status object in National Transportation Communications for ITS Protocol (NTCIP) 1203 v02.39 and does not affect the displayed message for more than half a second.

LEDs must be individually mounted directly on a printed circuit board (PCB).

**995-16.3.2 Optical, Electrical, and Mechanical Specifications for Display Modules:** The display modules must be rectangular and have an identical vertical and horizontal pitch between adjacent pixels. The separation between the last column of one display module and the first column of the next module must be equal to the horizontal distance between the columns of a single display module. Full matrix DMS must have the ability to display messages with 20mm pixel pitch (resolution).

The LED circuit board must be a NEMA FR4-rated, single 0.062 inch, black PCB. No PCB shall have more than two PCB jumper wires present. All PCBs shall be finished with a solder mask and a component-identifying silk screen.

PCBs with conformal coating meeting the material requirements of IPC-CC-830 or MIL-I-46058C Military Standard, United States Department of Defense (USDOD) must be provided.

Any devices used to secure LEDs must not block air flow to the LED leads or block the LED light output at the required viewing angle. All components on the LED side of a PCB must be black.

There must be a minimum of two power supplies that are wired in a parallel configuration for redundancy. If one, or 25% of the supplies in a group, whichever is greater, completely fails, the sign shall still be supplied with enough power to run 40% of all pixels at a 100% duty cycle with an ambient operating temperature of 165°F.

The sign controller must continuously measure and monitor all LED module power supply voltages and provide the voltage readings to the TMC or a laptop computer on command.

LEDs must be protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Epoxy must not be used to encapsulate the LEDs.

**995-16.3.3 Display Area for Walk-In DMS:** The display area must be capable of displaying three lines with a minimum of 15 characters per line, using an 18 inch font that meets the height to width ratio and character spacing in the MUTCD, Section 2L.04, paragraphs 05, 06, and 08.

**995-16.4 Characters, Fonts, and Color:** The signs must be capable of displaying American Standard Code for Information Interchange (ASCII) characters 32 through 126, including all uppercase and lowercase letters, and digits 0 through 9, at any location in the message line. Submit a list of the character fonts to the Engineer for approval.

All signs must be loaded (as a factory default) with a font in accordance with or that resembles the standard font set described in NEMA TS 4-2016, Section 5.6. For signs with a pixel pitch of 35 mm or less, the sign must be loaded (as a factory default) with a font set that resembles the FHWA Series E2000 standard font.

DMS fonts must have character dimensions that meet the MUTCD, Section 2L.04, paragraph 08.

Full-color signs must display the colors prescribed in the MUTCD, Section 1A.12.

**995-16.5 Main Power Supply and Energy Distribution Specifications:** A nominal single-phase power line voltage of 120/240 V<sub>AC</sub> must be provided. The DMS must meet the requirements of NEMA TS 4-2016, Section 10.2.

All 120 V<sub>AC</sub> wiring must have an overall nonmetallic jacket or be placed in metal conduit, pull boxes, raceways, or control cabinets and installed as required by the NEC. Do not use the sign housing as a wiring raceway or control cabinet.

Surge protective devices (SPD) must be installed or incorporated in the sign system by the manufacturer to guard against lightning, transient voltage surges, and induced current. SPDs must meet or exceed the requirements of Section 996. SPDs must protect all electric power and data communication connections.

**995-16.6 Uninterruptible Power Supply (UPS):** Walk-in DMS must include a UPS that can be installed within the sign housing or within the ground mounted control cabinet. Front access and embedded signs must include a UPS that can be installed within the ground mounted control cabinet. The UPS system must be capable of displaying the current messages on a sign when a power outage occurs. Signs with an UPS must be able to operate on battery power and display text messages for a minimum of two hours. The system must use sealed absorbed glass mat (AGM) batteries.

**995-16.7 Operational Support Supplies:** Furnish the operational support supplies listed in Table 995-8. Promptly replace any of the supplies used to perform a warranty repair.

For every group of 10 or fewer DMSs provided or required, provide one set of supplies as follows:

<p>Table 995-9 Operational Support Supplies</p>
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1 each	Sign controller and I/O board(s)
1 per DMS	LED display modules
1 each	Display power supply
1 each	Uninterruptible power supply
2 each	Surge suppression sets
1 each	Fan assembly

**995-16.8 Components:** All components must meet the requirements of NEMA TS 4-2016, Section 8.

**995-16.8.1 Mechanical Components:** All fasteners, including bolts, nuts, and washers less than 5/8 inch in diameter, must be passivated stainless steel, Type 316 or 304 and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. All bolts and nuts 5/8 inch and over in diameter must be galvanized and meet the requirements of ASTM A307. Self-tapping screws must not be used. All parts must be fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass. Construction materials must be resistant to fungus growth and moisture deterioration. All dissimilar metals must be separated with an inert, dielectric material.

**995-16.8.2 Sign Controller:** The sign controller must monitor the sign in accordance with NEMA TS 4-2016, Section 9. The sign must monitor the status of any photocells, LED power supplies, humidity, and airflow sensors. Sign controllers must use fiber optic cables for data connections between the sign housing and ground-level cabinet.

The sign controller must meet the requirements of NEMA TS 4-2016, Sections 8.3 and 8.4. The sign controller must be capable of displaying a self-updating time and date message on the sign. Sign controllers within ground cabinets must be rack-mountable, designed for a standard Electronic Industries Alliance (EIA) EIA-310 19 inch rack, and includes a keypad and display.

**995-16.8.3 Display System Hardware:** The sign must utilize a system data interface circuit for communications between the sign controller and display modules. Except for embedded DMS, the following components must reside inside the sign housing: sign controller (master or slave), display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, EIA-232 null modem cables (minimum of four feet long for connecting laptop computer to sign controller), and surge protective devices.

**995-16.8.4 Control Cabinet:** A control cabinet that meets the requirements of Section 676 shall be provided. The minimum height of the cabinet must be 46 inches.

A ground control cabinet that includes the following assemblies and components: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, a four foot long cable to connect laptop computers, a workspace for a laptop computer, and duplex outlets shall be provided.

All telephone, data, control, power, and confirmation connections between the sign and ground control box, and for any required wiring harnesses and connectors shall be provided.

**995-16.8.5 Sign Controller Communication Interfaces:** The sign controller must have communication interfaces in accordance with NEMA TS 4-2016, Section 8.3.2. Ensure that EIA-232 serial interfaces support the following:

Table 995-10 Communication Interface Requirements	
Data Bits	7 or 8 bits
Parity	Even, Odd, or None
Number Stop Bits	1 or 2 bit

The sign controller must have a 10/100 Base TX 8P8C port or a 100 Base FX port Ethernet interface.

The TMC or a laptop computer must be able to remotely reset the sign controller.

**995-16.9 Message and Status Monitoring:** The DMS must provide two modes of operation: (1) remote operation, where the TMC commands and controls the sign and determines the appropriate message or test pattern; and (2) local operation, where the sign controller or a laptop computer commands and controls the sign and determines the appropriate message or test pattern.

The sign must perform the following functions:

1. Control Selection – Ensure that local or remote sign control can be selected. Ensure that there is a visual indicator on the controller that identifies whether the sign is under local or remote control.

2. Message Selection – Ensure that the sign controller can select a blank message or any one of the messages stored in the sign controller’s nonvolatile memory when the control mode is set to local.

3. Message Implementation – Ensure that the sign controller can activate the selected message.

Ensure that the sign can be programmed to display a user-defined message, including a blank page, in the event of power loss.

Ensure that message additions, deletions, and sign controller changes may be made from either the remote TMC or a local laptop computer. Ensure that each font may be customized, and modifications to a font may be downloaded to the sign controller from the TMC or a laptop computer at any time without any software or hardware modifications.

Ensure that there is no perceivable flicker or ghosting of the pixels during sign erasure and writing periods.

**995-16.10 TMC Communication Specification for all DMS:** The sign controller must be addressable by the TMC through the Ethernet communications network using software that complies with the NTCIP 1101 base standard (formerly the NEMA TS 3.2-1996 Standard), including all amendments as published at the time of Contract letting, the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. The software must implement all mandatory objects in the supplemental requirement SR-700-4.1.1, Dynamic Message Sign NTCIP Requirements, as published on the Department’s State Traffic Engineering and Operations Office web site at the following URL: <https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm>.

The sign must comply with the NTCIP 1102v01.15, 2101v01.19, 2201v01.15, 2202v01.05, and 2301v02.19 Standards. The sign must comply with NTCIP 1103v02.17, Section 3.

Ensure that the controller’s internal time clock can be configured to synchronize to a time server using the network time protocol (NTP). NTP synchronization frequency must be

user-configurable and permit polling intervals from once per minute to once per week in one-minute increments. The controller must allow the user to define the NTP server by IP address.

**995-16.11 Sign Control Software:** The sign must be provided with computer software from its manufacturer that allows an operator to program, operate, exercise, diagnose, and read current status of all sign features and functions using a laptop computer. The sign control software must provide a graphical representation that visibly depicts the sign face and the current ON/OFF state of all pixels as well as allows messages to be created and displayed on the sign.

**995-16.12 Environmental Requirements:** The DMS must meet the requirements of NEMA TS 4-2016, Section 2.

**995-16.13 Warranty:** The DMS system and equipment must have a manufacturer's warranty covering defects for a minimum of five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

### **995-17 Electronic Display Sign.**

**995-17.1 General:** All electronic display signs (EDS) must meet the physical display and operational requirements for warning, guide, or regulatory signs described in the MUTCD and the SHS.

The term EDS refers to a general category of electronically enhanced signs that includes electronic road signs (ERS) with warning, regulatory, or guide legends; electronic speed feedback signs (ESFS); and blank-out signs (BOS).

EDS must allow attachment to vertical and horizontal support structures as part of a single or double sign post configuration. Bolts must be used for load bearing attachments.

**995-17.2 Requirements Common to all EDS:** All EDS must be designed to withstand the loads defined in the Department's Structures Manual without deformation or damage. EDS, other than BOS, must provide an option to include flashing beacons. Printed circuit boards must be protected with conformal coating. Housings that contain electronics must be constructed of aluminum alloy sheet a minimum of .090 inch thick. Welding used during the construction of EDS must be in accordance with Section 965.

Signs included on the APL will be designated with a size and type category and may be listed with restrictions, such as "requires District Traffic Operations Engineer approval", "school zones only", or "low speed only".

**995-17.2.1 Electronic Display Sign with Static Sign Panel:** EDS that include both a static sign panel and dynamic display may be a modular system comprised of a static sign panel with an attached electronic display. Static sign panels must meet the Department's requirements for highway signing found in this Section.

**995-17.2.2 Electronic Display:** Electronic displays must appear completely blank (dark) when not energized. No phantom characters or graphics will be allowed under any ambient light conditions.

**995-17.2.3 Housing:** The housing must protect and seal the dynamic display and other internal electronics. Any polycarbonate material used on the sign face must be a minimum 90% UV opaque and resistant to fading and yellowing. The housing must be NEMA 3R rated and prevent unauthorized access. The housing must include weather tight cable entry or connection points for any required power or data connections.

**995-17.2.4 Cabinet:** Any equipment cabinets provided with the EDS must be listed on the APL.

**995-17.2.5 Optical, Electrical, and Mechanical Specifications for Display Modules:** All LEDs must operate within the LED manufacturer's recommendations for typical

forward voltage, peak pulsed forward current, and other ratings. Component ratings must not be exceeded under any operating conditions.

**995-17.2.6 LED and Pixel Specifications:** All LEDs used in the display must have a wavelength output that varies no more than plus or minus two nanometers from the specified peak wavelength. The display and LED pixel cone of vision must be a minimum of 15 degrees (centered around the optical axis, or zero point, of the pixel). The cone perimeter is defined by the point where light output intensity is 50% of the intensity measured at the zero point of the pixel. For all colors other than white, the sign display must produce an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. For white or full color matrix displays, the sign display must produce white with an overall luminous intensity of at least 12,400 candelas per square meter when operating at 100% intensity. Submit documentation that indicates the LED brightness and color bins that are used in each pixel. LEDs must be individually mounted on a PCB and must be able to be removed and replaced using conventional electronic repair methods. Encapsulated LEDs within a pixel are not allowed. ERS LEDs must be arranged and powered in a manner that maintains a discernible message in the event of a single LED or pixel failure.

**995-17.2.7 Character Size, Fonts, and Graphics:** The minimum numeral and letter size of the electronic display must meet or exceed the numeral and letter sizes prescribed in the MUTCD and the SHS. Fonts and graphics must mimic the characteristics of fonts and graphics defined in the MUTCD and SHS.

**995-17.2.8 Electronic Display Controller:** Any electronic display controller required for the operation of the EDS shall be housed within the sign and be equipped with a security lockout feature to prevent unauthorized use. The controller shall have the capability to provide a stipulated default message upon loss of controller function. A blank message is acceptable.

**995-17.2.9 Communication:** The electronic display controller shall possess a minimum of one serial, Ethernet, USB, or Bluetooth interface with the ability to connect to a laptop computer. The serial data interface shall support multiple data rates from 9,600 bps to 115,200 bps.

**995-17.2.10 Configuration and Management:** Ensure that the sign is provided with computer software from its manufacturer that allows a user to program, operate, exercise, diagnose, and read current status of all sign features and functions using a laptop. Configuration and management functions must be password protected.

**995-17.2.11 Operation and Performance:** Ensure that the EDS is visible from a distance of at least 1/4 mile and legible from a distance of 400 feet for applications on roads with a speed limit less than 45 mph and visible from a distance of at least 1/2 mile and legible from a distance of at least 650 feet for roads with speed limits 45 mph or higher. In both cases, the requirements must be met under both day and night conditions.

The electronic display shall automatically adjust brightness for day and night operation. The EDS must be equipped with a light sensor that accurately measures ambient light level conditions at the sign location. The EDS must automatically adjust LED intensity based on the ambient light conditions in small enough increments that the sign's brightness changes smoothly, with no perceivable brightness change between adjacent levels. Stray headlights shining on the photoelectric sensor at night must not cause LED brightness changes.

Flashing messages must not exceed 150 flashes per minute.

**995-17.2.12 Mechanical Specifications:** EDS mounting provisions and mounting hardware must accommodate sign weight and wind loading requirements of the Department's Structures Manual. BOS must be designed to accommodate overhead attachment using a tri-stud signal hanger. Multiple tri-stud attachment points may be used to meet weight and wind loading requirements. Tri-stud attachment points must be weather-tight and structurally reinforced.

**995-17.2.13 Fasteners and Attachment Hardware:** Ensure that all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, are Type 304 or 316 passivated stainless steel. Stainless steel bolts, screws and studs must meet ASTM F593. Nuts must meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized. Bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

**995-17.2.14 Electrical Specifications:** All power inputs must be fuse and reverse polarity protected. All EDS must be able to recover from power loss and return to their operational state without user intervention.

**995-17.2.14.1 Solar Power:** Solar powered signs must be capable of fully autonomous operation 24 hours per day, 365 days per year. Batteries must be a standard 12 volt deep cycle battery suitable for the application and operating environment. Flooded lead-acid batteries are prohibited.

Batteries must be capable of providing 10 days of continuous operation without sunlight. Charging system must use a solar charge controller with temperature compensation. The system must provide for automatic battery charging, overcharge protection, and have indications that display current status and faults.

**995-17.2.14.2 AC Power:** Fluctuations in line voltage must have no visible effect on the appearance of the display.

**995-17.2.15 Environmental Requirements:** The EDS assembly must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 4-2016, Section 2. Fog, frost, or condensation must not form within the dynamic portion of the sign. Electronics must meet FCC Title 47, Subpart B Section 15.

**995-17.2.16 Warranty:** The EDS systems and equipment furnished must have a manufacturer's warranty covering defects in assembly, fabrication, and materials for a minimum of three years.

**995-17.3 Electronic Warning Signs:** EWS must include a secure wireless connection to communicate with a nearby laptop.

**995-17.3.1 EWS Foreground/Background Colors:** If a black background is used on the changeable electronic display, the color used for the legend must match the background color that would be used on a standard sign for that type of legend, in accordance with the MUTCD. Black EWS display backgrounds must be flat black (FED-STD-595-37038) with a reflectance value not exceeding 25%. EWS must utilize yellow LEDs with a peak wavelength of either 585 or 590 nanometers. EWS must have a minimum one-inch contrasting margin around illuminated characters or graphics.

**995-17.3.2 Speed Detector:** EWS that detect or display the speed of approaching vehicles must be programmable for the posted speed limit and the maximum speed to display. When the detected speed exceeds the maximum programmed speed (high speed cut-off) threshold, the display must automatically blank. Alternately, the display may show an alert message such as "SLOW DOWN" when speeds above the maximum programmed speed threshold are detected.

The EWS must detect when the posted speed is exceeded by one mph and then activate the alert. When the alert is activated, the display shall be able to flash. When no advancing traffic is detected, the display must be blank. The speed detector must not activate alerts for vehicles outside the display cone of vision.

The speed detector must meet the requirements of FCC Title 47, Part 90 and not require an FCC operating license. The speed detector must operate on 10.8 to 16.6 V<sub>DC</sub> and draw less than three amperes. The EWS must monitor and display the speed of approaching traffic only. The EWS detector must be able to accurately detect and determine the speed of approaching vehicles. The EWS must be capable of measuring and displaying speeds of approaching traffic only between 10 and 99 mph with an accuracy of plus or minus one mph, 1,000 feet in advance of the sign.

**995-17.4 Electronic Regulatory Signs:** Display modules for ERS must have a minimum two-inch contrasting margin around digits, text, or graphics. ERS must utilize LED technology for the dynamic display.

**995-17.4.1 ERS Battery Backup System:** AC powered signs must include a battery backup system that maintains full operation of the sign for a minimum of two hours in the event of utility power loss. Operation on battery backup can have no visible effect on the appearance of the display.

**995-17.4.2 Variable Speed Limit Signs:** Variable speed limit signs (VSLS) must be able to display speed limits from 5-70 mph in five mph increments and mimic the physical appearance of a static regulatory speed limit sign as shown in the MUTCD and SHS. VSLS must use black characters on a white background. VSLS must log the time and date of any speed limit change to internal non-volatile memory. The log must be able to record a minimum of 1,000 events in a first-in, first-out fashion.

**995-17.4.2.1 VSLS Controller Communications:** VSLS must be equipped with a sign controller that includes a minimum of one Ethernet 10/100 Base TX 8P8C port.

**995-17.4.2.2 Configuration and Management Requirements for VSLS:** VSLS must support remote management from a TMC and local management using a laptop computer. Remote and local computers must be able to reset VSLS sign controller. VSLS must log and report status, errors, and failures, including data transmission errors, receipt of invalid data, communication failure recoveries, power failures, power recoveries, display errors, fan and airflow status, temperature status, power supply status, and information on the operational status of the temperature, photocell, airflow, humidity, and LED power supply sensors.

The sign controller must be addressable through an Ethernet communication network using software that complies with the NTCIP requirements published online by the Department's Transportation Traffic Engineering Research Laboratory (TERL) at: <https://www.fdot.gov/traffic/>. The sign must implement any NTCIP standards required to achieve interoperability and interchangeability. Any additional objects implemented by the software must not interfere with the standard operation of any mandatory objects. VSLS must be compatible with the Department's SunGuide<sup>®</sup> software.

**995-17.5 Blank-Out Signs:** BOS must have a black exterior finish (FED-STD-595-37038) with a reflectance value not exceeding 25%. Overhead BOS must include a visor.

**995-17.6 Electronic Speed Feedback Signs:** The ESFS display background must be flat black (FED-STD-595-37038) with a reflectance value not exceeding 25%. ESFS must utilize

amber LEDs with a peak wavelength of 590 nanometers. ESFS shall have a minimum one-inch contrasting margin around illuminated characters or graphics.

**995-17.6.1 Speed Detector:** The ESFS must be programmable for the posted speed limit and the maximum speed to display. When the detected speed exceeds the maximum programmed speed (high speed cut-off) threshold, the display must automatically blank. Alternately, the display may show an alert message such as “SLOW DOWN” when speeds above the maximum programmed speed threshold are detected. The ESFS must detect when the posted speed is exceeded by one mph and then activate the alert. When the alert is activated, the display must flash at a rate of 50 to 60 cycles per minute. When no advancing traffic is detected, the display must be blank. The speed detector must not activate alerts or display speeds for vehicles outside the display’s cone of vision. The ESFS must meet the requirements of FCC Part 90 and not require an FCC operating license. The speed detector must operate on 10.8 to 16.6 V<sub>DC</sub>. The ESFS must be capable of measuring speeds of approaching traffic between 10 and 99 mph with an accuracy of plus or minus one mph, 1,000 feet in advance of the sign.

### **995-18 Sign Beacon.**

**995-18.1 General:** Flashing beacon assemblies incorporating a circular traffic signal must meet the design and functional requirements set forth in MUTCD Chapter 4L. All circular beacons must have a minimum nominal diameter of 12 inches and meet the requirements of Section 650. All beacons must use a LED light source.

**995-18.1.1 School Zone Beacon:** Beacons designed for use with school zone signing must include a means of calendar scheduling to program days and times of operation.

**995-18.1.2 Vehicle Activated Beacon:** Vehicle activated beacons must utilize a vehicle detection system listed on the APL.

**995-18.1.3 Pedestrian Activated Beacon:** Pedestrian activated beacons must utilize a pedestrian detector listed on the APL.

**995-18.2 Cabinets, Housings, and Hardware:** Flashing beacon cabinets must be currently listed on the APL or meet the requirements of Section 676.

All housings, other than pole-mounted cabinets, must be powder coated dull black (FED-STD-595-37038) with a reflectance value not exceeding 25% as measured by ASTM E1347. Cabinets and housings must prevent unauthorized access.

Flashing beacon assemblies must allow installation on 4-1/2 inch outer diameter posts.

Ensure all exposed assembly hardware including nuts, bolts, screws, and locking washers less than 5/8 inch in diameter, is Type 304 or 316 passivated stainless steel and meets the requirements of ASTM F593 and ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized and meet the requirements of ASTM A307.

**995-18.3 Electrical Specifications:** Provide equipment that operates on solar power or a nominal voltage of 120 V<sub>AC</sub>. If the device requires operating voltages of less than 120 V<sub>AC</sub>, supply the appropriate voltage converter. Solar powered beacon systems must be designed to provide 10 days of continuous operation without sunlight and must automatically charge batteries and prevent overcharging and over-discharging. Solar powered systems must include a charge indicator.

**995-18.4 Environmental Specifications:** All electronic assemblies must operate as specified during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS 4-2016, Section 2. All electronic equipment must comply with FCC Title 47 Subpart B Section 15.

**995-18.5 Warranty:** Ensure all flashing beacons have a manufacturer's warranty covering defects for a minimum of three years from the date of final acceptance in accordance with 5-11 and Section 608. Ensure the manufacturer will furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department or maintaining agency within 30 calendar days of notification.

### **995-19 In-Street Signs.**

**995-19.1 General:** In-Street signs consist of the R1 6a or R1 6c In Street Pedestrian Crossing Sign assemblies including the sign base.

**995-19.2 Materials:** The sign assembly includes the vertical panel, retroreflective sign sheeting, a rebounding boot support, and a base. The vertical panel is bolted to a flexible boot which is fastened to a plastic, recycled PVC, or rubber base. The sign assembly shall contain no upright metal parts.

The vertical panel shall yield (bend) fully upon vehicle impact, then return to vertical position plus or minus 10 degrees with no delaminating. The face of the vertical panel shall resist twisting and remain oriented to the installed direction after vehicle impact. The vertical panel shall not split, crack, break, or separate from base. Use only UV stabilized, ozone and hydrocarbon resistant outdoor-grade thermoplastic polymer, polycarbonate, recycled PVC, or HDPE materials. UV stabilization testing shall be in accordance with ASTM D1435.

Use Type XI fluorescent yellow-green retroreflective sign sheeting meeting the requirements of Section 994 on both sides of the vertical panel. The surface of the panel shall be smooth and free of defects, suitable for adherence of appropriate retroreflective sheeting.

#### **995-19.2.3 Base:**

**995-19.2.3.1 Sign Base (Fixed):** The base shall be constructed with high-impact materials using ozone and hydrocarbon resistant outdoor grade thermoplastic polymer, polycarbonate, or HDPE materials meeting the general provisions for all In-Street sign bases.

**995-19.2.3.2 Sign Base (Portable):** Portable base assemblies shall consist of a lightweight plastic, recycled PVC, or rubber material that may be easily moved or relocated by a single person.

**995-19.2.3.3 Color:** Sign bases shall be either black, or the same color as the adjacent pavement marking.

**995-19.2.4 Approved Product List (APL):** In addition to the APL requirements of 995-1.2, provide the following:

1. Product Drawings, which at a minimum includes:
  - a. Model Number
  - b. Allowable sign panel size and substrate
  - c. Dimensions of sign base and mounting heights
2. Crash Test Reports demonstrating MASH compliance
3. All FHWA Eligibility Letters
4. When requested, submit product sample

**995-19.3 Vertical Panel Messages:** Fabricate vertical panel messages in accordance with Section 994. Vertical panels of 8 inches wide x 28 inches tall or 12 inches x 36 inches are acceptable. See Standard Plans Section 700-102.

**995-19.4 Connection Method:** Products will be categorized as either Fixed Base or Portable. Fixed base will be installed in accordance with the manufacturer's instructions. Portable base will be limited to temporary applications at school crossings where a crossing guard is present during school arrival and departure times or when children are present.