Florida Department of Transportation

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SECRETARY

August 2, 2024

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

Re: State Specifications Office
Section: 995
Proposed Specification: **9950103 Traffic Control Signal and Device Materials**

Dear Ms. Kendall:

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

The changes are proposed by Ronald Meyer to update reference and requirements to internal and external publications.

Please review and transmit your comments, if any, within two weeks (10 business days). Comments should be sent via email 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/jb
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

TRAFFIC CONTROL SIGNAL AND DEVICE MATERIALS.
(REV 6-12-24)

SUBARTICLE 995-1.3 is deleted and the following substituted:

995-1.3 Abbreviations: The following abbreviations are used in this Section:

Acrylonitrile Butadiene Styrene (ABS)
Alternating Current (AC)
Direct Current (DC)
~~Electronic Industries Alliance (EIA)~~
Global Positioning System (GPS)
Hypertext Transfer Protocol (HTTP)
Institute of Transportation Engineers (ITE)
Internet Protocol (IP)
Local Area Network (LAN)
Network Time Protocol (NTP)
Telecommunications Industry Association (TIA)
Uniform Code Flash (UCF)
Uniform Resource Locator (URL)
Ultraviolet (UV)

SUBARTICLE 995-2.1 is deleted and the following substituted:

995-2.1 General: All parts shall be constructed of corrosion-resistant materials, such as UV stabilized or UV resistant plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. All fasteners exposed to the elements shall be Type 304 or 316 passivated stainless steel.

If the assembly includes a cabinet, meet the requirements of Section 676.

Detectors shall meet the environmental requirements of NEMA TS 2~~-2021~~.

SUBARTICLE 995-2.2 is deleted and the following substituted:

995-2.2 Inductive Loop Detector Units: Rack mount inductive loop detector units shall meet the requirements of NEMA ~~NEMA~~ TS 2~~-2021~~ and CALTRANS TEES~~-2020~~. Shelf mount detector units shall meet the requirements of NEMA TS 1~~-1989~~.

SUBARTICLE 995-2.3.6 is deleted and the following substituted:

995-2.3.6 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS 2~~-2021, 6.5.2.26~~.

SUBARTICLE 995-2.4.3 is deleted and the following substituted:

995-2.4.3 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS2~~ 2021, 6.5.2.26~~.

SUBARTICLE 995-2.5.3 is deleted and the following substituted:

995-2.5.3 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS2~~ 2021, 6.5.2.26~~.

SUBARTICLE 995-2.7.2 is deleted and the following substituted:

995-2.7.2 Communications: Major components of the WWVDS (such as the sensor and any separate hardware used for contact closures) shall include a minimum of one serial or Ethernet communications interface and shall meet the following criteria:

1. The serial interface and connector conforms to TIA-232 standards and the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).
2. Wired Ethernet interface provides, at a minimum, a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.
3. Wireless communications are secure and that wireless devices are FCC certified. The FCC identification number is displayed on an external label and all WWVDS devices operate within their FCC frequency allocation.
4. Cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.
5. The system can be configured and monitored via one or more communications interface.
6. The WWVDS is compatible with the Department's SunGuide® software. The SunGuide software requirements are listed in ~~supplemental requirement SR 995-2.7.2-01,~~ the document Supplemental Wrong Way Vehicle Detection System SunGuide HTTP Protocol, as published on the Department's State Traffic Engineering and Operations Office website at the following https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm.
7. For WWVDS installed on ramps, the device shall:
    a. Send an alert to the SunGuide® software when the wrong-way vehicle is detected.
    b. Send a sequence of images for up to ten seconds to the SunGuide software that covers a configurable time before and after the wrong-way vehicle detection.
    c. Activate all highlighted signs associated with the WWVDS.
8. For WWVDS installed on mainline lanes, the device shall send an alert to the SunGuide® software when the wrong-way vehicle is detected.
9. Cameras that are integrated and included in a WWVDS shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain

telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

SUBARTICLE 995-2.8.5 is deleted and the following substituted:

995-2.8.5 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS 2~~ 2021, 6.5.2.26~~.

SUBARTICLE 995-2.9 is deleted and the following substituted:

995-2.9 Vehicle Presence Detection System Performance Requirements: Presence detectors shall provide a minimum detection accuracy of 98% and shall meet the requirements for M~~m~~odes of O~~o~~peration in NEMA TS2~~ 2021, 6.5.2.17~~

995-2.9.1 Vehicle Presence Detection Accuracy: To verify conformance with the accuracy requirements in this Section and as a precondition for listing on the APL, sample data collected from the vehicle detection system will be compared against ground truth data collected during the same time by human observation or by another method approved by the FDOT Traffic Engineering Research Laboratory (TERL). Ensure sample data is collected over several time periods under a variety of traffic conditions. Weight each data sample to represent the predominant conditions over the course of a 24-hour period. Samples will consist of 15- and 30-minute data sets collected at various times of the day. Representative data periods and their assigned weights are provided in Table 995-2.

Table 995-2
Data Collection Periods

Period	Intended To Represent	Duration	Weight
Early morning (predawn) [EM]	12:30 a.m. – 6:30 a.m.	15 minutes	24
Dawn [DA]	~~6:30 a.m. – 7:00 a.m.~~15 minutes before sunrise to 15 minutes after sunrise	30 minutes	2
AM Peak [AMP]	7:00 a.m. – 8:00 a.m.	15 minutes	4
Late AM Off-Peak [LAOP]	8:00 a.m. – 12:00 p.m.	15 minutes	16
Noon [NO]	12:00 p.m. – 1:00 p.m.	15 minutes	4
Afternoon Off-Peak [AOP]	1:00 p.m. – 5:00 p.m.	15 minutes	16
PM Peak [PMP]	5:00 p.m. – 6:00 p.m.	15 minutes	4
Dusk [DU]	~~6:00 p.m. – 6:30 p.m.~~15 minutes before sunset to 15 minutes after sunset	30 minutes	2
Night [NI]	6:30 p.m. ~~–~~ – 12:30 a.m.	15 minutes	24
Total Sum of Weights			96

For example, the sample gathered for the Late AM Off-Peak period is intended to represent typical traffic conditions between 8:00 a.m. and 12:00 p.m. Since the sample period's duration is 15 minutes and the actual period of time represented is 4 hours, the multiplication factor or weight assigned is 16, the number of 15-minute intervals in a 4 hour period. Specific times used to capture data for DA shall be adjusted as needed to capture 30 minutes of data that includes darkness, dawn, and daylight. Times for DU shall be adjusted as needed to capture 30 minutes of data that includes daylight, dusk, and darkness.

995-2.9.2 Calculation of Vehicle Presence Detection Accuracy: Determine individual lane presence detection accuracy per period by subtracting ~~from 100 percent the absolute difference of the total time monitored and the~~ cumulative error time from the total time monitored, divided by total time, expressed as a percentage.

Within the equation in 995-2.9.2.1, "EM" represents the early morning period. The variable "i" represents a detector or detection zone and could vary from 1,…, N, where "N" is the total number of detectors observed. Substitute other detector numbers and periods as necessary to determine accuracy for all detectors during each period (i.e., dawn, AM peak, late AM off peak, etc.).

Variables used in the following equations are identified as follows:

PA = Presence detection accuracy

TT = Total time

CET = Cumulative Error Time (duration of all false and missed calls)

N=Total number of detectors observed

995-2.9.2.1 Early Morning Vehicle Presence Detection Accuracy for a Single Detector Expressed as a Percentage:

$$PA_{EM,det_i} = \frac{TT_{EM,det_i} - CET_{EM,det_i}}{TT_{EM,det_i}} \; x100$$

~~$$PA_{EM,\det_i} = 100 - \frac{\left|TT_{EM,\det_i} - CET_{EM,\det_i}\right|}{TT_{EM,\det_i}} x100$$~~

where:

$PA_{EM,\det_i}$ = Presence detection accuracy of detector *i* during the early morning period.

$TT_{EM,\det_i}$ = Total time that detector *i* was monitored (for instance, the 15-minute minimum duration specified in Table 995-2 for the early morning period).

$CET_{EM,\det_i}$ = Cumulative time that detector *i* was in an error state (indicating a detection with no vehicle present or not indicating a detection when vehicle present) during the monitoring period using human observation or another method approved by the Engineer.

The period accuracy will be the arithmetic mean of all individual detector accuracies.

In the equation in 995-2.9.2.2, "EM" represents the early morning period and "*N*" is the total number of detectors tested. Substitute other periods as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

995-2.9.2.2 Early Morning Vehicle Presence Detection Accuracy for All Detectors Expressed as a Percentage:

$$PA_{EM} = \left(\frac{\sum_{i=1}^{N} PA_{EM,\det_i}}{N} \right)$$

Where:

PA_{EM} = Average accuracy of all detectors during the early morning.

$PA_{EM,\det_i}$ = Accuracy of detector *i* during early morning.

Calculate the roadway segment accuracy over all periods using the equation in 995-2.9.2.3.

995-2.9.2.3 Total Vehicle Presence Detection Accuracy for All Detectors Expressed as a Percentage:

$$PA_{Total} = \frac{\left[PA_{EM}x24 + PA_{DA}x2 + PA_{AMP}x4 + PA_{LAOP}x16 + PA_{NO}x4 + PA_{AOP}x16 + PA_{PMP}x4 + PA_{DU}x2 + PA_{NI}x24\right]}{96}$$

Where:

PA_{Total} =Accuracy for all detectors for all periods

PA_{EM} = Accuracy of all detectors during early morning traffic conditions

PA_{DA} = Accuracy of all detectors during dawn traffic conditions

PA_{AMP} = Accuracy of all detectors during AM peak traffic conditions

PA_{LAOP} = Accuracy of all detectors during late AM off-peak traffic conditions

PA_{NO} = Accuracy of all detectors during noon traffic conditions

PA_{AOP} = Accuracy of all detectors during afternoon off-peak traffic conditions

PA_{PMP} = Accuracy of all detectors during PM peak traffic conditions

PA_{DU} = Accuracy of all detectors during dusk traffic conditions

PA_{NI} = Accuracy of all detectors during night traffic conditions

SUBARTICLE 995-4.1 is deleted and the following substituted:

995-4.1 General: Vehicular traffic signal assemblies must meet the requirements of Section 603, the MUTCD, and the ITE Standard for Vehicle Traffic Control Signal Heads.

Fastening hardware such as bolts, screws, nuts, washers, latches, and studs must be SAE Type 316 or 304 stainless steel.

Horizontal signal assemblies must be constructed so the door hinges, when installed, are located on the bottom of the signal assembly. Vertical mounted five-section cluster assemblies must be constructed so that the door hinges, when installed, are located along the outside edges of the complete assembly and each section opens away from the horizontally adjacent section.

SUBARTICLE 995-4.2.7.1 is deleted and the following substituted:

995-4.2.7.1 Flexible Backplates: Flexible backplates must allow the entire length of longer portions of the ~~backplate to flex 90 degrees, or until the~~ backplate width ~~is~~ to be reduced to 2.5 inches or less, when influenced by high wind conditions, and return to ~~zero degrees~~a flat state after the wind conditions subside. Flexible backplates must maintain visibility of the retroreflective border to approaching traffic, with up to 40 mph winds.

SUBARTICLE 995-4.2.8 is deleted and the following substituted:

995-4.2.8 Light-Emitting Diode Optical Unit: The LED optical unit must conform to the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005 or Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007, with the following exceptions.

1. Retrofit LED signal modules must be compatible with all traffic signal housings listed on the APL. The rear of the LED signal module must be marked in accordance with 995-4.1.

2. The lens must be tinted with an appropriate color (red, amber, or green) to reduce sun phantom affect and enhance on/off contrast. The tinting must be uniform across the face of the lens and be free from streaks, wrinkles, chips, bubbles, or other imperfections. If a polymer lens is used, a surface coating must be incorporated to provide abrasion resistance.

3. Red and green modules must meet the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005, with the exception that yellow modules must be 1.7 times brighter than the ITE specification. Arrow modules must meet the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.

4. Light rail transit signals shall conform to the requirements of the ITE's Performance Specification, Vehicle Traffic Control Signal Heads-Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005, regarding environmental requirements, transient protection, operating voltage range, and electronic noise. The indication (bar symbol) must measure 1-1/2 inches wide by 9 inches long. The indication must be capable of being displayed in any angle of orientation from horizontal to vertical.

ARTICLE 995-6 is deleted and the following substituted:

995-6 Midblock Crosswalk Enhancement Assemblies.

995-6.1 General: Midblock crosswalk enhancement assemblies are classified as the following types: In-Roadway Warning Light Assemblies and Rectangular Rapid Flashing Beacon Assemblies (RRFB).

995-6.2 In-Roadway Warning Light Assemblies: In-roadway warning lights ~~assemblies~~ must meet the physical and operational requirements of ~~the latest edition of~~ the MUTCD~~, Chapter 4N~~.

In-roadway warning light assemblies can include a passive detector in addition to a pedestrian pushbutton. In-roadway warning light assemblies must be normally dark and initiate operation upon pedestrian actuation via a pedestrian pushbutton or a passive detector. The In-roadway warning light assembly will cease operation at a predetermined time after the pedestrian actuation. If a passive detector is used, the In-roadway warning light assembly may cease operation after the pedestrian clears the crosswalk. The duration of the predetermined period shall be programmable and capable of matching the pedestrian clearance time for pedestrian signals as determined by MUTCD procedures. The timer that controls flashing must automatically reset each time a pedestrian call is received.

In-roadway warning light assemblies must have a minimum luminance of 101 candelas and a minimum viewing angle of 20 degrees.

995-6.3 Rectangular Rapid Flashing Beacon (RRFB): Rectangular Rapid Flashing Beacons shall meet the physical and operational requirements of the MUTCD.~~RRFB must include two rapidly and alternately flashed rectangular yellow indications having LED-array based pulsing light sources. Each rectangular yellow indication must be a minimum of five inches wide by two inches high. RRFB installations shall comply with the use and technical conditions of FHWA MUTCD Interim Approval 21 – Rectangular Rapid-Flashing Beacons at Crosswalks. The two RRFB indications shall be aligned horizontally, with the longer dimension horizontal and with a minimum space between the two indications of approximately 7 inches measured from inside edge of one indication to inside edge of the other indication.~~

995-6.3.1 Beacon Flashing Requirements: ~~The light intensity of the yellow indications shall meet the minimum specifications of SAE Standard J595 for Class 1 (Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles) dated January 2005. Ensure RRFB assemblies are capable of automatically dimming to reduce brightness of the LEDs at nighttime.~~ RRFBs shall have an integrated photocell and be capable of automatically dimming to reduce brightness and glare of RRFB indications during nighttime and low light conditions.

The flash rate of each individual yellow indication, as applied over the full on-off sequence of a flashing period of the indication, shall not be between 5 and 30 flashes per second. ~~When activated, the two yellow indications in each RRFB shall have a flash rate of 75 flash cycles per minute using the following sequence: left side beacon on for 50 milliseconds (msec), both beacons off for 50 msec, right side beacon on for 50 msec, both beacons off for 50 msec, left side beacon on for 50 msec, both beacons off for 50 msec, right side beacon on for 50 msec, both beacons off for 50 msec, both beacons on for 50 msec, both beacons off for 50 msec, both beacons on for 50 msec, both beacons off for 250 msec.~~ No other flash patterns shall be selectable via hardware or software.

995-6.3.2 RRFB Operation: RRFB shall include a pedestrian pushbutton as specified in 995-6.3.3 for actuation. RRFB can include a passive detector in addition to a

pedestrian pushbutton. ~~RRFBs must be normally dark and initiate operation only upon pedestrian actuation via a pedestrian pushbutton, or a passive detector. The RRFB will cease operation at a predetermined time after the pedestrian actuation. If the passive detector is used, the RRFB may cease operation after the pedestrian clears the crosswalk. The duration of the predetermined period shall be programmable and capable of matching the pedestrian clearance time for pedestrian signals as determined by MUTCD procedures. The timer that controls flashing must automatically reset each time a pedestrian call is received.~~

~~All RRFBs associated with a single crosswalk (including those with an overhead or advance crossing sign, if used) shall simultaneously commence operation of their alternating rapid flashing indications and shall cease operation simultaneously.~~

RRFBs must include an instruction sign (FTP-68C-21) mounted adjacent to or integral with each pedestrian pushbutton, in accordance with the Standard Plans, Index No. 654-001.

A confirmation light directed at and visible to pedestrians in the crosswalk must be installed integral to the RRFB to give confirmation that the RRFB is in operation.

995-6.3.3 ~~Midblock~~ RRFB Accessible Pedestrian Pushbutton: The assembly must contain a speaker, audio amplifier, and noise monitoring microphone for auto volume control.

The accessible pedestrian pushbutton detector must meet 995-9.3 for the locator tone feature. The pushbutton must not include a vibrotactile indication or percussive indications. The audible message must be programmable.

995-6.4 Cabinets, Housings, and Hardware: Cabinets used as part of the midblock crosswalk enhancement assembly must be currently listed on the APL or meet the requirements of Section 676.

All housings other than approved cabinets must be powder coat painted dull black per SAE AMS-STD-595A with a reflectance value not exceeding 25 percent as measured by ASTM E1347. Cabinets and housings must prevent unauthorized access.

Pole-mount assemblies shall allow installation on 4-1/2 inch outer diameter posts.

Ensure 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. Stainless steel nuts must meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized. Carbon steel bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

995-6.5 Electrical Specifications: Equipment must operate on solar power or a nominal voltage of 120 V_{AC}. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter. Solar powered systems must be designed to operate for minimum of 100 activations per day and provide 10 days of operation without sunlight. Each activation must be 30 seconds in duration. Solar powered systems must automatically charge batteries and prevent overcharging and over-discharging. Solar powered systems must include a charge indicator.

995-6.6 Environmental Specifications: All electronic assemblies shall operate as specified during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS2~~-20218.3~~, Sections 2.2.7, 2.2.8, and 2.2.9. Electronics must meet FCC Title 47, Subpart B, Section 15. The optical portion of the housing shall be sealed to provide an IP 67 rating.

SUBARTICLE 995-7.3 is deleted and the following substituted:

995-7.3 Finish: Unless otherwise specified, mounting assemblies and components must be supplied with a natural finish with mill scale removed in accordance with Military Standard MIL-PRF-24712A or AAMA 2603-02 and must meet the requirements of ASTM D3359 and ASTM D3363. Disconnect (interior and exterior) and disconnect hub must be powder-coat painted dull black (Federal Standard 595A-37038) with a reflectance value not exceeding 25 percent as measured by ASTM E97. All finished surfaces must have a smooth finish free from cracks, blow- holes, shrinks, excessive material, and other flaws.

SUBARTICLE 995-7.5.1 is deleted and the following substituted:

995-7.5.1 Span Wire Clamp: Span wire clamps must be aluminum or stainless steel and must have a minimum ultimate tensile strength of 32 ksi and minimum yield strength of 22 ksi in accordance with ASTM B28~~8~~6, ASTM B108, ASTM B85, or ASTM A240.

SUBARTICLE 995-8.3.2 is deleted and the following substituted:

995-8.3.2 Network Interface: Ensure that LAN connections support the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet Connections. Ensure that the connector complies with applicable TIA-568 requirements.

SUBARTICLE 995-8.8 is deleted and the following substituted:

995-8.8 Environmental Specifications: Ensure system electronics perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9. Detectors and detector connections that are exposed to the elements must be weatherproof and designed for outdoor use.

SUBARTICLE 995-9.4.3 is deleted and the following substituted:

995-9.4.3: Solid State Detection Outputs: Ensure outputs meet the requirements of NEMA TS2~~-2021, 6.5.2.26~~.

SUBARTICLE 995-9.7 is deleted and the following substituted:

995-9.7 Environmental: Ensure equipment performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

ARTICLE 995-10 is deleted and the following substituted:

995-10 Traffic Controllers.

Traffic controllers shall~~must meet the industry standards in Table 995-6~~ be an Advanced Transportation Controller (ATC) that meets the requirements of the AASHTO/ITE/NEMA ATC 5201 v.06A.37 standard. ATC controller types are listed in Table 995-6.

~~Table 995-6~~ ~~Traffic Controller Standards~~	
~~Device~~	~~Standard~~
~~NEMA TS2 Controller~~	~~NEMA TS2-2021~~
~~Model 2070 Controller~~	~~CALTRANS TEES, 2020~~
~~Note: All controllers must meet AASHTO/ITE/NEMA ATC 5201, v06.25.~~	

Table 995-6 ATC Controller Types
ATC Controller for ATC Cabinet
ATC Controller for NEMA Cabinet
ATC Controller for CALTRANS Cabinet

All controllers ~~must~~ shall provide functionality that meets or exceeds operational characteristics, including NTCIP support, as described in NEMA TS2~~-2021~~.

All controllers shall~~must~~:

1.Capture all mandatory event-based data elements listed in ~~supplemental requirement SR-671-2,~~ the document Supplemental Traffic Controller High Resolution Data Logging Requirements, as published on the Department's State Traffic Engineering and Operations Office website at the following URL: https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm.

2. Provide high resolution data logs containing header information and rows of timestamped event data in plain text for use with Automated Traffic Signal Performance Measures (ATSPM) systems. Plain text logs of all events shall be made available within 90 seconds of event occurrence. If data provided by the controller requires decoding to produce plain text logs, provide protocol documentation describing the structure of encoded data and provide decoding software at no cost. Decoding software shall not require internet access for operation. Each event data record shall include:

a. Timestamp of event with one-tenth of one (1) second precision

b. Numeric event code

c. Numeric event parameter

~~2~~3. Provide and make Management Information Bases (MIBs) available for Traffic Signal Controller Broadcast Messages (TSCBM) to local agencies and FDOT that are compatible with SAE J2735.

~~3~~4. Support programming of at least 4 destination Internet Protocol (IP) addresses via controller front panel for interface with Roadside Units (RSU) and other devices or systems.

5. Be able to deactivate the dimming circuit of LED street lighting during pedestrian activations. Pedestrian detector diagnostics must be activated when this feature is used.

SUBARTICLE 995-11.1 is deleted and the following substituted:

995-11.1 General: Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. Place the label on the inside of the main door using a water-resistant method. The label must be visible after installation.

Painted and unpainted cabinets must meet the applicable requirements in Aluminum Cabinets, NEMA TS2~~-2021~~.

Cabinets shall be provided with a standard lock or electronic lock. Provide 2 keys for each cabinet and small equipment enclosure unless otherwise shown in the Plans.

995-11.1.1 Standard Locks: Outfit cabinet doors with an industrial standard pin tumbler lock with No. 2 key unless otherwise shown in the Plans.

995-11.1.2 Electronic Locks: Electronic locking systems, including keys, shall be compatible with the existing system used by the maintaining agency. Electronic locks shall include a battery backup, an emergency mechanical override, or integrated power management that maintains security, functionality, and continued operation during extended cabinet power loss. Electronic locking systems shall use a layered security approach including encryption and secure communication protocols. Electronic locks must support standalone operation when network communication for central management and other features is unavailable. If electronic cylinders are used, they shall be battery-powered or key-energized.

SUBARTICLE 995-11.2 is deleted and the following substituted:

995-11.2 NEMA Traffic Signal Controller Cabinets: Provide NEMA traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control meeting the following requirements:

NEMA TS1 Controller Cabinet .....NEMA TS1~~-1989~~
NEMA TS2 Controller Cabinet .....NEMA TS2~~-2021~~

995-11.2.1 Documentation: Provide four paper copies of the cabinet wiring diagram with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan.

Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires.

A heavy duty, resealable plastic opaque bag must be mounted on the backside of main cabinet door for storing cabinet documentation.

995-11.2.2 Police Switches: Provide the following police switches with Type 3 and larger controller cabinets. The switches must be mounted on the police panel and identified as to their function.

1. AUTO-FLASH: When this switch is in the FLASH position, all signal indications must immediately transfer to the flashing mode. AC power shall be removed from the load switches and stop timing applied to the controller unit. When this switch is placed in the AUTO position the controller unit must operate in accordance with the appropriate specification.

2. MANUAL ON-OFF: When this switch is in the on position, a logic ground must be applied to the manual control enable input of the controller unit.

3. MANUAL JACK: Install a manual jack on the police panel. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

Provide a manual pushbutton with Type 3 and larger cabinets. The pushbutton cord must have a minimum length of six feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

995-11.2.3 Service Switches: Service switches must be mounted on the service panel or other locations approved by the Department and identified as to their functions. Provide the following service switches with Type 3 and larger cabinets.

1. SIGNALS ON-OFF: When this switch is in the off position, AC power shall be removed from all signal heads. The SIGNALS ON-OFF switch must be connected to the control input of a contactor (displacement relay). Current supplied to the switch must not exceed five amperes (amps) total. Do not directly route the main signal head power bus and cabinet power through the service or police switches.

2. AUTO-FLASH: When this switch is in the FLASH position, all signal indications must transfer to the flashing mode in accordance with the Uniform Code Flash (UCF) requirements. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode. The controller unit must operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the AUTO position, transfer from the flash mode to normal operation shall be made in accordance with UCF requirements.

3. CONTROLLER ON-OFF: When this switch is in the off position, AC power shall be removed from the controller.

4. AUX POWER ON-OFF: When this switch is in the off position, AC power shall be removed from all circuits of the cabinet except for the duplex receptacle, cabinet light and ventilation fan.

5. VEHICLE DETECTORS: A detector test switch must be provided for each phase of the controller unit. Detector test switches must include a position for normal operation (phase receives calls from detectors), a position that provides a constant call, and a position that provides a momentary call.

995-11.2.4 Doors and Locks: Provide Type 3 and larger cabinets with a hinged, rain tight and dust tight police door which allows access to the police switches and manual jack.

Locate the police door in the bottom half of the main door for Type 3 and 4 pole mount cabinets. Locate the police door in the upper half of the main door for Type 4 and larger base mount cabinets.

Hinges and hinge pins must be constructed of stainless steel and prevent the door (main or police) from sagging. Hinges for the main and police doors must be 14 gauge and be located on the right side (viewed from the front).

Type 3 and larger cabinets must be furnished with a three point draw roller latching system consisting of the following latching points:

1. Center of the cabinet (lock)
2. Top of the cabinet--controlled by the door handle
3. Bottom of the cabinet--controlled by the door handle

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Type 3 and larger cabinets must be furnished with a door stop which retains the main door open in a 90 degree and 120 degree position.

995-11.2.5 Police and Service Panels: Provide a police service panel with Type 3 and larger cabinets. The panels may be constructed of either sheet aluminum or cast aluminum. Locate the police panel behind the police door attached to the main door. The service panel must be mounted on the back side of the police panel. The police panel must have the following minimum dimensions:

1. Height – 4 inches
2. Width – 8 inches
3. Depth – 2-1/2 inches

995-11.2.6 Ventilation: Type 1 and 2 cabinets must be vented to allow dissipation of the heat generated by the equipment housed inside the cabinet.

Type 3 and larger cabinets must have dual, UL listed, thermostatically controlled fans, rated for continuous duty with a service life of at least 3 years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70°F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. The intake vent must be rain tight, located on the bottom half of the cabinet, and covered with a removable filter.

995-11.2.7 Shelves: Type 2 cabinets must be furnished with one shelf. Type 3 and larger cabinets must be furnished with two adjustable shelves. Shelves must be adjustable in a maximum of 2-inch increments from the top of the load panel to 12 inches from the top of the controller cabinet.

995-11.2.8 Mounting Hardware: Type 1, 2, and 3 cabinets must be supplied with hardware for attaching the top and bottom half of the cabinet onto a flat or round surface. Optional wall or pole mount hardware must be provided for mounting Type 4 cabinets in specific installations.

Type 4 cabinets must have rigid tabs attached to the bottom of the cabinet. Type 5 cabinets must have rigid brackets attached to the bottom of the cabinet. Rigid brackets and tabs must be constructed of the same material used for the cabinet.

Type 4 and larger cabinets must be provided with one of the following alternatives for fastening to a concrete base:

1. Galvanized anchor bolts, nuts, lock washers, and flat washers in accordance with ASTM A153. The anchor bolts must be at least 1/2 inch in diameter, seven inches in vertical length with at least three inch horizontal, or
2. Heavy duty machine bolt anchors, flat washers, lock washers and machine screws with at least 1/2 inch thread diameter.

995-11.2.9 Electrical: Fabricate ground busbars of copper or aluminum alloy material compatible with copper wire and provide at least two positions where No. 2 AWG stranded copper wire can be attached.

Mount a ground busbar on the side of the cabinet wall adjacent to the power panel for the connection of AC neutral wires and chassis ground wires.

If more than one ground busbar is used in a cabinet, a minimum of a No. 10 AWG copper wire must be used to interconnect them.

995-11.2.9.1 Wiring: All wiring must be laced. All conductors in the cabinet must be stranded copper.

All inputs and outputs must be terminated on terminal strips. A connector harnesses for the controller, conflict monitor, vehicle detectors, and other controller accessory equipment must be furnished and wired into the cabinet circuitry.

A vehicle detector harness or rack must be furnished with the cabinet. Terminal strip circuits must be provided for connection of the loop lead-in cable.

995-11.2.9.2 Terminal Strips: The voltage and current rating of terminal strips must be greater than the voltage and current rating of the wire which is terminated on the terminal strip.

Conductors must be terminated on terminal strips with insulated terminal lugs. A calibrated ratchet crimping tool must be used to terminate the conductor in the terminal lug.

When two or more conductors are terminated on field wiring terminal strip screws, a terminal ring lug shall be used for termination of those conductors. All terminal strip circuits must be numbered.

995-11.2.9.3 Cabinet Light and Receptacle: For Type 3 and larger cabinets, provide one or more light fixtures that illuminate the entire interior of the cabinet. All lighting fixtures must automatically turn on when the cabinet doors are opened and off when the doors are closed.

Mount and wire a three-wire 115 V_{AC} duplex receptacle in all cabinets. The receptacle must be protected by a 15A circuit breaker. Do not mount the receptacle on the main cabinet door or police and service switch panels.

995-11.2.9.4 Main Circuit Breaker: Provide a 15A circuit breaker with Type 1 and 2 cabinets, and a 30A circuit breaker with Type 3 and larger cabinets.

The main circuit breaker must turn off all power to the cabinet and shall not be used for the power switch located in the service panel.

995-11.2.9.5 Radio Interference Suppression: A radio interference suppressor must be provided in series with the AC power before it is distributed to any equipment inside the cabinet. The suppressor must provide a minimum attenuation of 50 decibels over a frequency range of 200 kHz to 75 MHz when used with normal installations and shall be hermetically sealed in a metal case.

The radio interference suppressor must have the same minimum current rating as the main circuit breaker.

The ground connection of the radio interference suppressor must be connected only to AC neutral and shall not be connected to earth ground directly.

995-11.2.9.6 Optically Isolated Inputs: The Opto common input is the common reference pin for four optically isolated inputs.

The Opto inputs are intended to provide optical isolation for pedestrian detector and remote interconnect inputs. The Opto inputs are intended to connect through external 27 K ohm, 1 W resistors for 120 V_{AC} operation and are intended for direct connection to 12 V_{AC} from the cabinet power supply for pedestrian detector applications. These inputs may alternatively be used for low-true DC applications when the Opto common pin is connected to the 24 V supply.

The Opto inputs shall provide electrical isolation of 10 megohms minimum resistance and 1000 V_{AC} RMS minimum breakdown to all connector pins except the Opto common pin. These inputs shall exhibit nominal impedance to the Opto common pin of 5 K ohm, plus or minus 10 percent, and shall require 2.4 mA, plus or minus 10 percent, from a nominal 12 V_{AC} supply. The Opto inputs shall not recognize 3 V_{AC} RMS or less relative to the common input and recognize 6 V_{AC} RMS or more relative to the common input. Any steady state voltage applied between an Opto input and the Opto common shall not exceed 35 V_{AC} RMS. Opto inputs shall not be acknowledged when active for 25 ms or less, and shall be acknowledged when active for 50 ms or more.

995-11.2.9.7 Load Resistors: A load resistor or capacitor must be installed between the AC (common) and each signal field wiring terminal for the yellow, green and walk indication. All load resistors and capacitors must be on the front side of any panel used in the cabinet.

995-11.2.9.8 Surge Protection: Furnish surge protective devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet. Cabinets utilizing Din rail mounted SPDs must be grounded with a conductor to the cabinet busbar.

The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker.

SPDs for signal and interconnect cable field wiring terminals must meet the following:

1. Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.

2. Withstand a surge current of 1000A with an 8 by 20 µs waveform six times (at 1 second intervals between surges) without damage to the suppressor.

SPDs for loop lead-in cables must be designed in accordance with the following requirements:

1. Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges.

2. Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges.

3. Withstand repetitive 400A surges with an 8 by 20 µs waveform without damage.

SPDs must be installed according to the SPD manufacturer’s instructions and not affect the operation of detectors. SPD leads must be kept as short as possible.

SUBARTICLE 995-11.3 is deleted and the following substituted:

995-11.3 Type 170 Traffic Signal Controller Cabinets: Provide Type 170 traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control and meeting the following requirements:

Model 332, 334 and 336S Cabinets…….CALTRANS TEES ~~2009~~

Model 336S cabinet must incorporate input surge protection mounted on a fold-down termination panel at the input file.

Model 332 cabinets must incorporate a lower input termination panel. Model 332 and 334 cabinets must be base mounted. The Model 332 cabinet must have an auxiliary MODEL 420 output file, and be configured for 8 vehicle, 4 pedestrian, and 4 overlaps.

Model 552A designation is given to Model 332 cabinet assemblies that include a swing-out EIA 19-inch rack cage.

Model 662 designation is given to Model 552A cabinets with a 66 inch height.

Cabinets must comply with figures for traffic control signals and devices available on the Department's State Traffic Engineering and Operations Office website at the following URL:
https://www.fdot.gov/traffic/Traf_Sys/Product-Specifications.shtm.

All terminals and facilities on panels must be clearly identified using permanent silk-screened text.

995-11.3.1 Base Plate and Mounting Brackets: Provide cabinets with a standard base mounting bolt pattern and a minimum of two aluminum plates welded inside for anchoring to a concrete or composite base.

995-11.3.2 Output File: Fabricate the output file using a "hard wired" harness. Printed board circuit boards are not acceptable.

995-11.3.3 Shelf: Provide an aluminum shelf with storage compartment in the rack below the controller (for remote secondary monitor/lap top computer use). The storage compartment must have telescoping drawer guides for full extension. The compartment top must have a non-slip plastic laminate attached. Provide an RS-232 connector for communications to the C2S port.

995-11.3.4 Loads: Provide dummy loads consisting of 4.7k resistors rated at five watts minimum for Greens, Peds, and Yellows. The dummy loads must be mounted on a terminal block in the rear of the output file or other approved location. Wire one side of each dummy load to AC return in a manner that allows a technician to easily attach the load to outputs from selected load switches.

995-11.3.5 Cabinet Light: Provide one or more light fixtures that illuminate the entire interior of the cabinet. All lighting fixtures must automatically turn on when the cabinet doors are opened and off when the doors are closed.

995-11.3.6 Surge Protection: Provide each cabinet with devices to protect equipment from surges. Surge protector termination panels must be attached to the cabinet rack assembly and allow sufficient space for connections, access, and surge protector replacement. AC isolation terminals must be on the same side of the cabinet as the AC service inputs. DC terminals and loop detector terminals must be installed on the opposite side of the cabinet from the AC power lines.

Surge protection for 332A cabinets must be mounted on the lower input termination panel.

Surge protection for 336S cabinets must be mounted on a custom fold down termination panel at the input file.

Under no circumstance (normal operation or short-circuit condition) shall the amperage capacity of the internal wiring and printed circuit board traces be less than the protecting threshold of circuit breakers and surge protectors provided.

995-11.3.6.1 Power Distribution Assembly Protection: The power distribution assembly (PDA) SPD must be a two-stage series/parallel device that meets or exceeds the following:

1. Maximum AC line voltage: 140 V_{AC}
2. 20 pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20kA.
3. The protector must include the following terminals:
    a. Main line (AC Line first stage terminal)
    b. Main Neutral (AC Neutral input terminals)
    c. Equipment Line Out (AC Line second stage output terminal, 10A)
    d. Equipment Neutral Out (Neutral terminal to protected equipment)
    e. Ground (Earth connection)
4. The main AC line in and the equipment line outer terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10A AC service
5. The first stage clamp shall be between Main Line and ground terminals
6. The second stage clamp shall be between Equipment Line Out and Equipment Neutral
7. The protector for the first and second stage clamp must have a metal oxide varistor (MOV) or similar solid state device, rated 20 kA.

The main neutral and equipment neutral output shall be connected together internally and shall have an MOV (or similar solid state device, or gas discharge tubes) rated at 20 kA between main neutral and ground terminals.

The PDA SPD must have a peak clamp voltage of 250V at 20 kA (voltage measured between equipment line out and equipment neutral out terminals, current applied between main line and ground terminals with ground and main neutral terminals externally tied together).

The PDA SPD must have a maximum let through voltage not exceeding 500 Vpk using an 8 by 20 µs/1.2 by 50 µs; 6 kV, 3 kA surge. The SPD must either be epoxy-encapsulated in a flame retardant material or utilize thermally protected varistors and be designed for continuous service current of 10A at 120 V_{AC} RMS. Power to the Type 170E controller and to the 24V power supply must be provided from the equipment line out terminal of the PDA SPD.

995-11.3.6.2 Inductive Loop Detector Protection: Protect each inductive loop detector input channel with an external SPD that meets or exceeds the following:

1. The SPD must be a three-terminal device, two of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.

2.The SPD must instantly clamp differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array shall be designed to appear as a very low capacitance to the detector.

3. The SPD must clamp common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.

4. Peak Surge Current

a. Differential Mode: 400A (8 by 20 µs)

b. Common Mode: 1000A (8 by 20 µs)

c. Estimated Occurrences: 500 @ 200A

5. Response Time: 40 ns

6. Input Capacitance 35 pF typical

7. Clamp Voltage

a. 30V max @ 400A (Differential Mode)

b. 30V max @1000A (Common Mode)

995-11.3.6.3 Signal Load Switch Protection: The outputs of each load switch in the output file shall be provided with a MOV connected from the AC positive field terminal to the chassis ground. The MOV must be rated 150 V_{AC} and shall be a V150LA20A (or approved equal).

995-11.3.6.4 Communication Input Protection: Each low voltage communication input must be protected as it enters the cabinet with a hybrid two-stage SPD that meets or exceeds the following:

1. The SPD must be a dual pair (four-wire) module with a double-sided, gold-plated printed circuit board connector.

2. The SPD must be installed in a ten-circuit card edge terminal block (PCB1B10A).

3. The SPD must be utilized as two independent signal pairs. The data circuits must pass through the SPD in a serial fashion.

4. Peak Surge Current

a. 10kA (8 by 20 µs)

b. Occurrences at 2000A: greater than 100

5. Response Time: less than 1 ns

6. Clamp Voltage: 30V maximum

7. Series Resistance: greater than 15 ohms per line

8. Primary Protector: 3 element gas tube

9. Secondary Protector: Solid state clamp (1.5 kW minimum)

The line side of the SPD must be connected to the communication field wires, the load side connected to the communication connector of the controller, and the ground terminal connected to chassis ground.

995-11.3.6.5 Low Voltage DC input protection: Each DC input must be protected by an SPD that meets or exceeds the following:

~~(a)~~1. The SPD must be a 5 terminal device. Two terminals must be connected to the line side of the low voltage pair, two terminals must be connected to the input file side, and the fifth terminal connected to chassis ground.

~~(b)~~2.Peak Surge Current

2 kA (8 by 20 µs)

Occurrences at peak current: 100 (typical)

~~(c)~~3. Response Time: 5-30 ns

~~(d)~~4. Shock: Must withstand 10-foot drop on concrete

~~(e)~~5. Clamp Voltage: 30V

~~(f)~~6. Series Resistance: greater than 15 ohms each conductor

995-11.3.6.6 Preemption and 115V AC signal input protection: Each preemption or AC signaling input channel must be protected by an external SPD that meets or exceeds the following requirements:

~~(a)~~1. The SPD must be a 3 terminal device

~~(b)~~2. Peak Surge Current

2000A (8 b 20 µs)

Occurrences at peak current: 25 (minimum)

~~(c)~~3. Response Time: less than 200 ns

~~(d)~~4. Peak Surge Trip Point: less than 890V nominal

995-11.3.7 Red Monitor Harness: A connector and terminal assembly designated as P20 for monitoring the absence of red, shall be an integral part of the output file. The connector must terminate, and be compatible with, the cable and connector of a Type 170 conflict monitor unit (CMU), capable of monitoring the absence of red. Provide the pin assignments of the P20 connector and terminal assembly with the cabinet plans. The P20 connector shall be physically like the cable and connector of a Type 170 CMU to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

995-11.3.7.1 Programming of Unused Red Channels: Provide all cabinet assemblies with a means of programming unused red channels by installing jumpers from red monitor inputs to 115 V_{AC}. The connecting terminals for the jumpers must be accessible and located in the same terminal block for all 16 channels to assure full compatibility of all cabinet assemblies with "210 Plus" conflict monitor units.

995-11.3.8 Police Door and Panel: Provide cabinets with police doors and panels. The police panel must include text informing officers that yellow and all-red clearance intervals are timed internally.

Police switch panels must include a manual jack. The jack must mate with a three circuit, 1/4-inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of six feet with a 1/4-inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

995-11.3.9 Technician Service Panel: Provide cabinets with a technician service panel which is mounted on the back side of the police panel (inside the main cabinet front door).

There must be two switches located on the technician service panel, clearly labeled according to the following functions:

(a) UCF – This toggle switch shall:

Place the intersection into Flashing Operation.

After meeting requirements for Flashing Operations, all power shall be removed immediately from signal load switches.

(b) Signal On/Off – This toggle switch shall disconnect all power to the signal lights through the use of a 60A contact switch placed in series with the load switch packs.

Labels must be silk screened directly on the panel.

995-11.3.10 Swing-out Rack Assembly: Provide 552-A cabinets with a pullout and rotatable rack assembly as well as an interface panel mounted on the top of the rack assembly and attached to the top shelf. The rack assembly must be constructed to house components designed to be installed in a standard EIA 19-inch rack and shall house the Controller, Input File, Output File No. 1, PDA No. 2, and a storage compartment.

Construct the rack and slide/hinged mounting brackets so that when the rack assembly (fully loaded) can be pulled out with one hand with complete ease of operation including rotation of the assembly.

The rack assembly must have a spring-loaded latch mechanism to secure the rack assembly inside the cabinet while in the "rest" position. When pulled out of the cabinet at any point from its resting position (inside cabinet) to its full extension and rotation, the fully loaded rack assembly shall not cause any member of the assembly to bend, warp or bind. The rack must be made of one-inch square aluminum tubing with welded joints and extend and retract smoothly without noticeable friction or stress on roller guides, extension brackets, or other mechanical components. Maximum deflection of the entire rack assembly (with all equipment installed) shall not exceed 1/8 inch.

The rack assembly must have 12 technician test switches mounted to the interface frame assembly. Technician test switches must be of the momentary type and shall have eight vehicle and four pedestrian inputs.

The front of the rack assembly must be tapped with 10-30 threads with EIA universal spacing for 19-inch electrical equipment racks.

The rack assembly must be attached to the left cabinet wall through combination slide/hinged mounting brackets.

The slide/hinged mounting brackets must be fabricated from aluminum and/or stainless steel only.

Mounting bracket guides must utilize 7/8-inch stainless steel ball bearing rollers and allow extension and retraction of a loaded rack with minimal effort.

The rack assembly must be capable of rotating 210 degrees from its rest position after full extension from the cabinet.

The rack assembly must have a minimum 7/16-inch diameter aluminum rack stop rod attached to the inside left cabinet wall from the left side of the rack assembly to lock the rack into final position.

All cabinet harnesses must be long enough to maintain cabinet connections and functionality when the rack assembly is fully extended and rotated to its maximum limit. Harnesses must not bind or crimp when the rack is fully retracted, extended, or in motion.

995-11.3.11 Service Panels for 552A: The 552A cabinet must include a field service panel, auxiliary field service panel, and interface panel, all constructed of aluminum with

a 1/8-inch minimum thickness. All components must be accessible from the front of the panels. Do not mount components or attach wires behind panels.

995-11.3.11.1 Field Service Panel: The field service panel must consist of terminal strips, circuit breakers, transient protection devices, load resistors, capacitors, cable tie mounts and associated wiring for making all field wiring connections. Mount the field service panel in the cabinet on the lower right exterior cabinet wall.

The field service panel must provide the necessary interconnecting junction points between the rack assembly and cabinet for the field service wires. The panel must be grouped for internal connections (jumpers) between terminals boards, wiring from the panel to the rack assembly, and wiring from the panel to the cabinet.

The field service panel wiring harness must have flexible wire covered by a flexible non-metallic conduit from the field service panel to the PDA, output file, and interface panel. The harness must have a metal clamp with a rubber grommet center attached to the field service panel to secure the harness to the panel for proper orientation of the harness with the rack assembly. Terminal strips for the panel shall be as listed below:

1. TBS1 - Terminal Block, Deadfront type, 3 position, No. 4 to No. 14 AWG wire range, 70A, 600V.
2. TBS2 - Terminal Block, Barrier, 16 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V.
3. TBS3 - Terminal Block, Barrier, 20 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No 16 AWG (max), 15A, 250V.
4. TBS4 &TBS5 - Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

The panel must have a main cabinet circuit breaker rated at 30A and a cabinet accessory circuit breaker rated at 15A for cabinet fans and light. Mount the circuit breakers near the back cabinet door on the panel.

The panel must include load resistors for all Walk, Green, Green Arrow, Yellow and Yellow Arrow Switch Pack outputs to prevent the conflict-voltage monitor from going into "Flash" due to a failed signal lamp. Load resistors must be 2K, 10 watt.

MOVs must be physically tied to one side of each terminal on TBS4 and TBS5 and be physically secured to the field service panel with a 6-32 screw.

995-11.3.11.2 Auxiliary Field Service Panel: The auxiliary field service panel must be mounted on the lower left interior cabinet wall and consist of a minimum of four terminal strips, 18 detector surge protectors and one pedestrian button isolation board assembly. The 18 surge protectors must be a three-terminal device, two of which are connected across the signal inputs of the detector for differential mode protection and the third terminal is grounded to protect against common mode damage. Mount the pedestrian button isolation board on the auxiliary field service panel. Terminal strips for the panel shall be Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

Install a four-button pedestrian isolation board on the auxiliary field service panel to provide for the connection of the pedestrian buttons on phases 2, 4, 6 and 8. The board must provide electrical isolation of the field wiring to the internal cabinet wiring. The inputs to this isolation board shall be wired to terminal block TBA5 for connection to field

wiring. The outputs of this board shall be carried through the harness to the input file to the proper wires that go to the interface extension panel of the controller.

The pedestrian button isolation board must include a PC board mounted on an aluminum panel with the following minimum dimensions:

Height: 2 inches
Width: 8 inches
Thickness: 1/8 to 3/16 inch

995-11.3.11.3 Interface Panel: The interface panel must consist of eight terminal strips, one telephone line suppressor and mounting fixture, two 24 V_{DC} relays and mounting fixtures, and all associated wiring for connecting the required interface equipment modules.

The front of the panel must be covered by a 1/4-inch clear plexiglass sheet, supported from the panel by four 1-1/2 inch standoffs. Secure the panels and cover using wing nuts that are removable without the use of tools. The plexiglass cover shall have 1/2-inch slot, centered over each of the terminal strips. All covers and panels must be interchangeable.

The panel wiring must provide the necessary interconnecting junction points between interface equipment cable harnesses and controller cabinet input and output signal. The panel wiring provides the functional wiring information for connecting the interface equipment in the cabinet.

The panel wiring must be grouped for internal connections (jumpers between terminal boards) as well as wiring from the controller and related cabinet functions to the terminal boards on the interface panel.

Ground wires must be No. 14 AWG wire, minimum. The internal harnesses must be located between TB1, TB2 and TB3. The external and internal wiring must be located outside of TB1 and TB4, between TB2 and TB3.

Terminal strips shall be Barrier type, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V. Terminals must use nickel/cadmium plated brass screws. All terminals and facilities on panels must be clearly identified using permanent silk-screened

The K1P and K2F relays shall be 15A miniature relays with polycarbonate cover, 2 form C (CO) contact arrangement, DC coil input, socket mount, .187 inch quick connect/solder terminals, AgCdO (15A) contacts, and 24 V_{AC} coil voltage with matching socket and hold down spring. All screws on the relay socket must be brass with nickel/cadmium plating.

995-11.3.12 Storage Compartment: Mount an aluminum storage compartment in the rack assembly. The storage compartment must have telescoping drawer guides for full extension of drawer from rack assembly and have a continuous front lip for opening the compartment top for storage. The top of the compartment must be non-slip plastic laminate.

Install a communication port on the right hand side of the drawer at the front for connecting to the communications port of the controller unit via the cabinet harness.

995-11.3.13 Cabinet Rails: Provide the cabinet with four cabinet rails for mounting wiring panels and various brackets. Rails must be keyhole design with slots 2 inches on center with a top opening diameter of 5/8 inch to allow the insertion of a 5/8 inch by 1 inch carriage bolt. The rails must be approximately 1-1/2 to 2 inches wide by 1/2 inch deep. Do not use unistruts or other rails.

995-11.3.14 Electrical: Do not use printed circuit boards in any controller cabinet subsystem file or panel, including but not limited to the output file (except for the red monitor program board), service panel, interface panel, and input file.

995-11.3.14.1 Wiring: Cut all wires to the proper length and neatly laced into cables with nylon lacing. No wire shall be doubled back to take up slack. Cables in the cabinet must not interfere with the routing and connection of field wiring. Cables must be secured with nylon cable clamps, unless specified otherwise. The position of cables between the components must be such that when the door is closed, it does not press against the cables or force the cables against the various components inside the controller cabinet.

Fabricate ground busbars of a copper or aluminum alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached. Mount a 6 inch ground busbar with screw terminals on the bottom flange on each side of the cabinet for connection of AC neutral wires and chassis ground. Attach a flexible ground strap between the left side ground busbar and the left side bottom rear of the rack assembly. Wiring harnesses must be covered by a flexible non-metallic conduit. Panel wire size must be a minimum of No. 18 AWG unless otherwise specified.

995-11.3.14.2 Terminals: Terminal connections must be soldered or constructed using a calibrated ratchet type crimping tool. Wiring must be traceable and without entanglement.

SUBARTICLE 995-11.5.2 is deleted and the following substituted:

995-11.5.2 Latches: Provide all cabinets with a three-point draw roller latching system for the doors. The latching system must have the following latching points.

1. Center of the cabinet (lock).
2. Top of the cabinet – controlled by the door handle.
3. Bottom of the cabinet – controlled by the door handle.

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Provide the cabinet with a door stop that retains the main door open in a 90 degree and 120 degree position.

~~Outfit the doors with an industrial standard pin tumbler lock with No. 2 key, or an approved alternate, and hardware that allows the door to be secured using a padlock. Provide two keys for each cabinet lock.~~

SUBARTICLE 995-11.5.8 is deleted and the following substituted:

995-11.5.8 Electrical Requirements: ~~All equipment must conform to applicable UL, NEC, EIA, ASTM, ANSI, and IEEE requirements.~~ SPD's must be accessible from the front of any panel used in the cabinet. Connect the SPD for the cabinet's main AC power input on the load side of the cabinet circuit breaker. All wiring must be laced. All conductors must be stranded copper.

SUBARTICLE 995-11.7 is deleted and the following substituted:

995-11.7 Small Equipment Enclosures: Small equipment enclosures must be a minimum NEMA 3R rated and smaller than 16 inches wide by 24 inches tall by 12 inches deep. The enclosure must be constructed of aluminum or non-metallic materials. Enclosures must include a safe means of removing power from the installed equipment for servicing and replacement, such as a switch, fuse, or breaker. Discrete markings, such as manufacturer name and model, are permitted on the outside of small enclosures.

All fasteners less than 5/8 inch exposed to the elements must be Type 304 or 316 stainless steel.

Construct aluminum enclosures of 5052 sheet aluminum alloy with a minimum thickness of 0.090 inch. Aluminum enclosures must have a uniform natural finish or be powder coat painted in accordance with AAMA-2603-02 specifications. All welds, bends, and seams must be neatly formed and free of cracks, blow holes and other irregularities. All inside and outside edges of the enclosure must be free of burrs, rivet holes, visible scratches, and gouges and have a smooth, uniform finish.

Non-metallic enclosures must be designed for outdoor use, and resist chemicals, corrosion, and ultraviolet rays.

Enclosure doors must include a vandal resistant hinge and be secured with a locking latch or a minimum of two quick-release Type 304 or 316 stainless steel latches with padlock hasps. Removal of the hinge or hinge pin must not be possible while the enclosure is closed. ~~Provide two sets of keys with each lock.~~

Enclosures may be vented. Holes larger than 1/8 inch must be covered by heavy duty screen.

Post mounted enclosures must be supplied with mounting hardware for attaching the enclosure to a 4-1/2 inch (OD) aluminum post.

SUBARTICLE 995-13.2 is deleted and the following substituted:

995-13.2 Environmental Requirements: Ensure system control equipment performs all required functions during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS2~~-2021~~, Sections 2.2.7, 2.2.8, and 2.2.9.

SUBARTICLE 995-14.1 is deleted and the following substituted:

995-14.1 General: Illuminated signs must meet the design and functional requirements of the MUTCD. 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 width 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.

SUBARTICLE 995-14.6 is deleted and the following substituted:

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~~.

SUBARTICLE 995-15.1 is deleted and the following substituted:

995-15.1 General: Highlighted signs must meet the design and functional requirements of the MUTCD~~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.

SUBARTICLE 995-15.2 is deleted and the following substituted:

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~~ and batteries must be capable of at least 10 days of continuous operation without the need for charging.

SUBARTICLE 995-15.6 is deleted and the following substituted:

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~~.

ARTICLE 995-16 is deleted and the following substituted:

995-16 Dynamic Message Signs.

995-16.1 General: Dynamic message signs (DMS) must meet the requirements of the MUTCD and 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 width 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_{AC} must be provided. The DMS must meet the requirements of NEMA TS 4~~-2016~~, Section 10.2.

All 120 V_{AC} 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:

Table 995-9 Operational Support Supplies	
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, display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, EIA-232 null modem cables (minimum of 4 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 4 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,~~document 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 5 years from the date of final acceptance.

SUBARTICLE 995-17.2.15 is deleted and the following substituted:

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.

SUBARTICLE 995-17.3.2 is deleted and the following substituted:

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~~ 1 mph and then activate the display~~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_{DC} 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~~ 1 mph, 1,000 feet in advance of the sign.

SUBARTICLE 995-17.4.1 is deleted and the following substituted:

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~~ 2 hours in the event of utility power loss. Operation on battery backup can have no visible effect on the appearance of the display.

SUBARTICLE 995-17.4.2 is deleted and the following substituted:

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~~ 5 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.

SUBARTICLE 995-17.6.1 is deleted and the following substituted:

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_{DC}. 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.

SUBARTICLE 995-18.1 is deleted and the following substituted:

995-18.1 General: Flashing beacon assemblies incorporating a circular traffic signal must meet the design and functional requirements set forth in the 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.

SUBARTICLE 995-18.4 is deleted and the following substituted:

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.

TRAFFIC CONTROL SIGNAL AND DEVICE MATERIALS.
(REV 6-12-24)

SUBARTICLE 995-1.3 is deleted and the following substituted:

995-1.3 Abbreviations: The following abbreviations are used in this Section:

Acrylonitrile Butadiene Styrene (ABS)
Alternating Current (AC)
Direct Current (DC)
Global Positioning System (GPS)
Hypertext Transfer Protocol (HTTP)
Institute of Transportation Engineers (ITE)
Internet Protocol (IP)
Local Area Network (LAN)
Network Time Protocol (NTP)
Telecommunications Industry Association (TIA)
Uniform Code Flash (UCF)
Uniform Resource Locator (URL)
Ultraviolet (UV)

SUBARTICLE 995-2.1 is deleted and the following substituted:

995-2.1 General: All parts shall be constructed of corrosion-resistant materials, such as UV stabilized or UV resistant plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. All fasteners exposed to the elements shall be Type 304 or 316 passivated stainless steel.

If the assembly includes a cabinet, meet the requirements of Section 676.

Detectors shall meet the environmental requirements of NEMA TS 2.

SUBARTICLE 995-2.2 is deleted and the following substituted:

995-2.2 Inductive Loop Detector Units: Rack mount inductive loop detector units shall meet the requirements of NEMA TS 2 and CALTRANS TEES. Shelf mount detector units shall meet the requirements of NEMA TS 1.

SUBARTICLE 995-2.3.6 is deleted and the following substituted:

995-2.3.6 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS 2.

SUBARTICLE 995-2.4.3 is deleted and the following substituted:

995-2.4.3 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS2.

SUBARTICLE 995-2.5.3 is deleted and the following substituted:

995-2.5.3 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS2.

SUBARTICLE 995-2.7.2 is deleted and the following substituted:

995-2.7.2 Communications: Major components of the WWVDS (such as the sensor and any separate hardware used for contact closures) shall include a minimum of one serial or Ethernet communications interface and shall meet the following criteria:

1. The serial interface and connector conforms to TIA-232 standards and the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

2. Wired Ethernet interface provides, at a minimum, a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

3. Wireless communications are secure and that wireless devices are FCC certified. The FCC identification number is displayed on an external label and all WWVDS devices operate within their FCC frequency allocation.

4. Cellular communications devices are compatible with the cellular carrier used by the agency responsible for system operation and maintenance.

5. The system can be configured and monitored via one or more communications interface.

6. The WWVDS is compatible with the Department's SunGuide® software. The SunGuide software requirements are listed in the document Supplemental Wrong Way Vehicle Detection System SunGuide HTTP Protocol, as published on the Department's State Traffic Engineering and Operations Office website at the following https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm.

7. For WWVDS installed on ramps, the device shall:

   a. Send an alert to the SunGuide® software when the wrong-way vehicle is detected.

   b. Send a sequence of images for up to ten seconds to the SunGuide software that covers a configurable time before and after the wrong-way vehicle detection.

   c. Activate all highlighted signs associated with the WWVDS.

8. For WWVDS installed on mainline lanes, the device shall send an alert to the SunGuide® software when the wrong-way vehicle is detected.

9. Cameras that are integrated and included in a WWVDS shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

SUBARTICLE 995-2.8.5 is deleted and the following substituted:

995-2.8.5 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS 2.

SUBARTICLE 995-2.9 is deleted and the following substituted:

995-2.9 Vehicle Presence Detection System Performance Requirements: Presence detectors shall provide a minimum detection accuracy of 98% and shall meet the requirements for Modes of Operation in NEMA TS2

995-2.9.1 Vehicle Presence Detection Accuracy: To verify conformance with the accuracy requirements in this Section and as a precondition for listing on the APL, sample data collected from the vehicle detection system will be compared against ground truth data collected during the same time by human observation or by another method approved by the FDOT Traffic Engineering Research Laboratory (TERL). Ensure sample data is collected over several time periods under a variety of traffic conditions. Weight each data sample to represent the predominant conditions over the course of a 24-hour period. Samples will consist of 15- and 30-minute data sets collected at various times of the day. Representative data periods and their assigned weights are provided in Table 995-2.

Table 995-2
Data Collection Periods

Period	Intended To Represent	Duration	Weight
Early morning (predawn) [EM]	12:30 a.m. – 6:30 a.m.	15 minutes	24
Dawn [DA]	15 minutes before sunrise to 15 minutes after sunrise	30 minutes	2
AM Peak [AMP]	7:00 a.m. – 8:00 a.m.	15 minutes	4
Late AM Off-Peak [LAOP]	8:00 a.m. – 12:00 p.m.	15 minutes	16
Noon [NO]	12:00 p.m. – 1:00 p.m.	15 minutes	4
Afternoon Off-Peak [AOP]	1:00 p.m. – 5:00 p.m.	15 minutes	16
PM Peak [PMP]	5:00 p.m. – 6:00 p.m.	15 minutes	4
Dusk [DU]	15 minutes before sunset to 15 minutes after sunset	30 minutes	2
Night [NI]	6:30 p.m. – 12:30 a.m.	15 minutes	24
Total Sum of Weights			96

For example, the sample gathered for the Late AM Off-Peak period is intended to represent typical traffic conditions between 8:00 a.m. and 12:00 p.m. Since the sample period's duration is 15 minutes and the actual period of time represented is 4 hours, the multiplication factor or weight assigned is 16, the number of 15-minute intervals in a 4 hour period. Specific times used to capture data for DA shall be adjusted as needed to capture 30 minutes of data that

includes darkness, dawn, and daylight. Times for DU shall be adjusted as needed to capture 30 minutes of data that includes daylight, dusk, and darkness.

995-2.9.2 Calculation of Vehicle Presence Detection Accuracy: Determine individual lane presence detection accuracy per period by subtracting cumulative error time from the total time monitored, divided by total time, expressed as a percentage.

Within the equation in 995-2.9.2.1, "EM" represents the early morning period. The variable "i" represents a detector or detection zone and could vary from 1,…, N, where "N" is the total number of detectors observed. Substitute other detector numbers and periods as necessary to determine accuracy for all detectors during each period (i.e., dawn, AM peak, late AM off peak, etc.).

Variables used in the following equations are identified as follows:

PA = Presence detection accuracy

TT = Total time

CET = Cumulative Error Time (duration of all false and missed calls)

N=Total number of detectors observed

995-2.9.2.1 Early Morning Vehicle Presence Detection Accuracy for a Single Detector Expressed as a Percentage:

$$PA_{EM,det_i} = \frac{TT_{EM,det_i} - CET_{EM,det_i}}{TT_{EM,det_i}} \; x100$$

where:

$PA_{EM,\det_i}$ = Presence detection accuracy of detector *i* during the early morning period.

$TT_{EM,\det_i}$ = Total time that detector *i* was monitored (for instance, the 15-minute minimum duration specified in Table 995-2 for the early morning period).

$CET_{EM,\det_i}$ = Cumulative time that detector *i* was in an error state (indicating a detection with no vehicle present or not indicating a detection when vehicle present) during the monitoring period using human observation or another method approved by the Engineer.

The period accuracy will be the arithmetic mean of all individual detector accuracies.

In the equation in 995-2.9.2.2, "EM" represents the early morning period and "*N"* is the total number of detectors tested. Substitute other periods as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

995-2.9.2.2 Early Morning Vehicle Presence Detection Accuracy for All Detectors Expressed as a Percentage:

$$PA_{EM} = \left(\frac{\sum_{i=1}^{N} PA_{EM,\det_i}}{N} \right)$$

Where:

PA_{EM} = Average accuracy of all detectors during the early morning.

$PA_{EM,\det_i}$ = Accuracy of detector *i* during early morning.

Calculate the roadway segment accuracy over all periods using the equation in 995-2.9.2.3.

995-2.9.2.3 Total Vehicle Presence Detection Accuracy for All Detectors Expressed as a Percentage:

$$PA_{Total} = \frac{\left[PA_{EM}x24 + PA_{DA}x2 + PA_{AMP}x4 + PA_{LAOP}x16 + PA_{NO}x4 + PA_{AOP}x16 + PA_{PMP}x4 + PA_{DU}x2 + PA_{NI}x24\right]}{96}$$

Where:

PA_{Total} =Accuracy for all detectors for all periods

PA_{EM} = Accuracy of all detectors during early morning traffic conditions

PA_{DA} = Accuracy of all detectors during dawn traffic conditions

PA_{AMP} = Accuracy of all detectors during AM peak traffic conditions

PA_{LAOP} = Accuracy of all detectors during late AM off-peak traffic conditions

PA_{NO} = Accuracy of all detectors during noon traffic conditions

PA_{AOP} = Accuracy of all detectors during afternoon off-peak traffic conditions

PA_{PMP} = Accuracy of all detectors during PM peak traffic conditions

PA_{DU} = Accuracy of all detectors during dusk traffic conditions

PA_{NI} = Accuracy of all detectors during night traffic conditions

SUBARTICLE 995-4.1 is deleted and the following substituted:

995-4.1 General: Vehicular traffic signal assemblies must meet the requirements of Section 603, the MUTCD, and the ITE Standard for Vehicle Traffic Control Signal Heads.

Fastening hardware such as bolts, screws, nuts, washers, latches, and studs must be SAE Type 316 or 304 stainless steel.

Horizontal signal assemblies must be constructed so the door hinges, when installed, are located on the bottom of the signal assembly. Vertical mounted five-section cluster assemblies must be constructed so that the door hinges, when installed, are located along the outside edges of the complete assembly and each section opens away from the horizontally adjacent section.

SUBARTICLE 995-4.2.7.1 is deleted and the following substituted:

995-4.2.7.1 Flexible Backplates: Flexible backplates must allow the entire length of longer portions of the backplate width to be reduced to 2.5 inches or less, when influenced by high wind conditions, and return to a flat state after the wind conditions subside. Flexible backplates must maintain visibility of the retroreflective border to approaching traffic, with up to 40 mph winds.

SUBARTICLE 995-4.2.8 is deleted and the following substituted:

995-4.2.8 Light-Emitting Diode Optical Unit: The LED optical unit must conform to the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005 or Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007, with the following exceptions.

1. Retrofit LED signal modules must be compatible with all traffic signal housings listed on the APL. The rear of the LED signal module must be marked in accordance with 995-4.1.

2. The lens must be tinted with an appropriate color (red, amber, or green) to reduce sun phantom affect and enhance on/off contrast. The tinting must be uniform across the face of the lens and be free from streaks, wrinkles, chips, bubbles, or other imperfections. If a polymer lens is used, a surface coating must be incorporated to provide abrasion resistance.

3. Red and green modules must meet the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005, with the exception that yellow modules must be 1.7 times brighter than the ITE specification. Arrow modules must meet the requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement, dated July 1, 2007.

4. Light rail transit signals shall conform to the requirements of the ITE's Performance Specification, Vehicle Traffic Control Signal Heads-Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005, regarding environmental requirements, transient protection, operating voltage range, and electronic noise. The indication (bar symbol) must measure 1-1/2 inches wide by 9 inches long. The indication must be capable of being displayed in any angle of orientation from horizontal to vertical.

ARTICLE 995-6 is deleted and the following substituted:

995-6 Midblock Crosswalk Enhancement Assemblies.

995-6.1 General: Midblock crosswalk enhancement assemblies are classified as the following types: In-Roadway Warning Light Assemblies and Rectangular Rapid Flashing Beacon Assemblies (RRFB).

995-6.2 In-Roadway Warning Light Assemblies: In-roadway warning lights must meet the physical and operational requirements of the MUTCD.

In-roadway warning light assemblies can include a passive detector in addition to a pedestrian pushbutton. In-roadway warning light assemblies must be normally dark and initiate

operation upon pedestrian actuation via a pedestrian pushbutton or a passive detector. The In-roadway warning light assembly will cease operation at a predetermined time after the pedestrian actuation. If a passive detector is used, the In-roadway warning light assembly may cease operation after the pedestrian clears the crosswalk. The duration of the predetermined period shall be programmable and capable of matching the pedestrian clearance time for pedestrian signals as determined by MUTCD procedures. The timer that controls flashing must automatically reset each time a pedestrian call is received.

In-roadway warning light assemblies must have a minimum luminance of 101 candelas and a minimum viewing angle of 20 degrees.

995-6.3 Rectangular Rapid Flashing Beacon (RRFB): Rectangular Rapid Flashing Beacons shall meet the physical and operational requirements of the MUTCD.

995-6.3.1 Beacon Flashing Requirements: RRFBs shall have an integrated photocell and be capable of automatically dimming to reduce brightness and glare of RRFB indications during nighttime and low light conditions.

The flash rate of each individual yellow indication, as applied over the full on-off sequence of a flashing period of the indication, shall not be between 5 and 30 flashes per second. No other flash patterns shall be selectable via hardware or software.

995-6.3.2 RRFB Operation: RRFB shall include a pedestrian pushbutton as specified in 995-6.3.3 for actuation. RRFB can include a passive detector in addition to a pedestrian pushbutton.

RRFBs must include an instruction sign (FTP-68C-21) mounted adjacent to or integral with each pedestrian pushbutton, in accordance with the Standard Plans, Index No. 654-001.

A confirmation light directed at and visible to pedestrians in the crosswalk must be installed integral to the RRFB to give confirmation that the RRFB is in operation.

995-6.3.3 RRFB Accessible Pedestrian Pushbutton: The assembly must contain a speaker, audio amplifier, and noise monitoring microphone for auto volume control.

The accessible pedestrian pushbutton detector must meet 995-9.3 for the locator tone feature. The pushbutton must not include a vibrotactile indication or percussive indications. The audible message must be programmable.

995-6.4 Cabinets, Housings, and Hardware: Cabinets used as part of the midblock crosswalk enhancement assembly must be currently listed on the APL or meet the requirements of Section 676.

All housings other than approved cabinets must be powder coat painted dull black per SAE AMS-STD-595A with a reflectance value not exceeding 25 percent as measured by ASTM E1347. Cabinets and housings must prevent unauthorized access.

Pole-mount assemblies shall allow installation on 4-1/2 inch outer diameter posts.

Ensure 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. Stainless steel nuts must meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized. Carbon steel bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

995-6.5 Electrical Specifications: Equipment must operate on solar power or a nominal voltage of 120 V_{AC}. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter. Solar powered systems must be designed to operate for minimum

of 100 activations per day and provide 10 days of operation without sunlight. Each activation must be 30 seconds in duration. Solar powered systems must automatically charge batteries and prevent overcharging and over-discharging. Solar powered systems must include a charge indicator.

995-6.6 Environmental Specifications: All electronic assemblies shall operate as specified during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9. Electronics must meet FCC Title 47, Subpart B, Section 15. The optical portion of the housing shall be sealed to provide an IP 67 rating.

SUBARTICLE 995-7.3 is deleted and the following substituted:

995-7.3 Finish: Unless otherwise specified, mounting assemblies and components must be supplied with a natural finish with mill scale removed in accordance with Military Standard MIL-PRF-24712A or AAMA 2603-02 and must meet the requirements of ASTM D3359 and ASTM D3363. Disconnect (interior and exterior) and disconnect hub must be powder-coat painted dull black (Federal Standard 595A-37038) with a reflectance value not exceeding 25 percent as measured by ASTM E97. All finished surfaces must have a smooth finish free from cracks, blow holes, shrinks, excessive material, and other flaws.

SUBARTICLE 995-7.5.1 is deleted and the following substituted:

995-7.5.1 Span Wire Clamp: Span wire clamps must be aluminum or stainless steel and must have a minimum ultimate tensile strength of 32 ksi and minimum yield strength of 22 ksi in accordance with ASTM B26, ASTM B108, ASTM B85, or ASTM A240.

SUBARTICLE 995-8.3.2 is deleted and the following substituted:

995-8.3.2 Network Interface: Ensure that LAN connections support the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet Connections. Ensure that the connector complies with applicable TIA-568 requirements.

SUBARTICLE 995-8.8 is deleted and the following substituted:

995-8.8 Environmental Specifications: Ensure system electronics perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS 2, Sections 2.2.7, 2.2.8, and 2.2.9. Detectors and detector connections that are exposed to the elements must be weatherproof and designed for outdoor use.

SUBARTICLE 995-9.4.3 is deleted and the following substituted:

995-9.4.3: Solid State Detection Outputs: Ensure outputs meet the requirements of NEMA TS2.

SUBARTICLE 995-9.7 is deleted and the following substituted:

995-9.7 Environmental: Ensure equipment performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.

ARTICLE 995-10 is deleted and the following substituted:

995-10 Traffic Controllers.

Traffic controllers shall be an Advanced Transportation Controller (ATC) that meets the requirements of the AASHTO/ITE/NEMA ATC 5201 v.06A.37 standard. ATC controller types are listed in Table 995-6.

Table 995-6 ATC Controller Types
ATC Controller for ATC Cabinet
ATC Controller for NEMA Cabinet
ATC Controller for CALTRANS Cabinet

All controllers shall provide functionality that meets or exceeds operational characteristics, including NTCIP support, as described in NEMA TS2.

All controllers shall:

1.Capture all mandatory event-based data elements listed in the document Supplemental Traffic Controller High Resolution Data Logging Requirements, as published on the Department's State Traffic Engineering and Operations Office website at the following URL: https://www.fdot.gov/traffic/Traf-Sys/Product-Specifications.shtm.

2. Provide high resolution data logs containing header information and rows of timestamped event data in plain text for use with Automated Traffic Signal Performance Measures (ATSPM) systems. Plain text logs of all events shall be made available within 90 seconds of event occurrence. If data provided by the controller requires decoding to produce plain text logs, provide protocol documentation describing the structure of encoded data and provide decoding software at no cost. Decoding software shall not require internet access for operation. Each event data record shall include:

a. Timestamp of event with one-tenth of one (1) second precision

b. Numeric event code

c. Numeric event parameter

3. Provide and make Management Information Bases (MIBs) available for Traffic Signal Controller Broadcast Messages (TSCBM) to local agencies and FDOT that are compatible with SAE J2735.

4. Support programming of at least 4 destination Internet Protocol (IP) addresses via controller front panel for interface with Roadside Units (RSU) and other devices or systems.

5. Be able to deactivate the dimming circuit of LED street lighting during pedestrian activations. Pedestrian detector diagnostics must be activated when this feature is used.

SUBARTICLE 995-11.1 is deleted and the following substituted:

995-11.1 General: Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. Place the label on the inside of the main door using a water-resistant method. The label must be visible after installation.

Painted and unpainted cabinets must meet the applicable requirements in Aluminum Cabinets, NEMA TS2.

Cabinets shall be provided with a standard lock or electronic lock. Provide 2 keys for each cabinet and small equipment enclosure unless otherwise shown in the Plans.

995-11.1.1 Standard Locks: Outfit cabinet doors with an industrial standard pin tumbler lock with No. 2 key unless otherwise shown in the Plans.

995-11.1.2 Electronic Locks: Electronic locking systems, including keys, shall be compatible with the existing system used by the maintaining agency. Electronic locks shall include a battery backup, an emergency mechanical override, or integrated power management that maintains security, functionality, and continued operation during extended cabinet power loss. Electronic locking systems shall use a layered security approach including encryption and secure communication protocols. Electronic locks must support standalone operation when network communication for central management and other features is unavailable. If electronic cylinders are used, they shall be battery-powered or key-energized.

SUBARTICLE 995-11.2 is deleted and the following substituted:

995-11.2 NEMA Traffic Signal Controller Cabinets: Provide NEMA traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control meeting the following requirements:

NEMA TS1 Controller Cabinet ..... NEMA TS1
NEMA TS2 Controller Cabinet ..... NEMA TS2

995-11.2.1 Documentation: Provide four paper copies of the cabinet wiring diagram with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan.

Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires.

A heavy duty, resealable plastic opaque bag must be mounted on the backside of main cabinet door for storing cabinet documentation.

995-11.2.2 Police Switches: Provide the following police switches with Type 3 and larger controller cabinets. The switches must be mounted on the police panel and identified as to their function.

1. AUTO-FLASH: When this switch is in the FLASH position, all signal indications must immediately transfer to the flashing mode. AC power shall be removed from the load switches and stop timing applied to the controller unit. When this switch is placed in the AUTO position the controller unit must operate in accordance with the appropriate specification.

2. MANUAL ON-OFF: When this switch is in the on position, a logic ground must be applied to the manual control enable input of the controller unit.

3. MANUAL JACK: Install a manual jack on the police panel. The jack must mate with a three circuit, 1/4 inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

Provide a manual pushbutton with Type 3 and larger cabinets. The pushbutton cord must have a minimum length of six feet with a 1/4 inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

995-11.2.3 Service Switches: Service switches must be mounted on the service panel or other locations approved by the Department and identified as to their functions. Provide the following service switches with Type 3 and larger cabinets.

1. SIGNALS ON-OFF: When this switch is in the off position, AC power shall be removed from all signal heads. The SIGNALS ON-OFF switch must be connected to the control input of a contactor (displacement relay). Current supplied to the switch must not exceed five amperes (amps) total. Do not directly route the main signal head power bus and cabinet power through the service or police switches.

2. AUTO-FLASH: When this switch is in the FLASH position, all signal indications must transfer to the flashing mode in accordance with the Uniform Code Flash (UCF) requirements. AC power shall be removed from the load switches when the signal indications transfer to the flashing mode. The controller unit must operate in accordance with appropriate specifications during the flashing mode. When the switch is placed in the AUTO position, transfer from the flash mode to normal operation shall be made in accordance with UCF requirements.

3. CONTROLLER ON-OFF: When this switch is in the off position, AC power shall be removed from the controller.

4. AUX POWER ON-OFF: When this switch is in the off position, AC power shall be removed from all circuits of the cabinet except for the duplex receptacle, cabinet light and ventilation fan.

5. VEHICLE DETECTORS: A detector test switch must be provided for each phase of the controller unit. Detector test switches must include a position for normal operation (phase receives calls from detectors), a position that provides a constant call, and a position that provides a momentary call.

995-11.2.4 Doors and Locks: Provide Type 3 and larger cabinets with a hinged, rain tight and dust tight police door which allows access to the police switches and manual jack.

Locate the police door in the bottom half of the main door for Type 3 and 4 pole mount cabinets. Locate the police door in the upper half of the main door for Type 4 and larger base mount cabinets.

Hinges and hinge pins must be constructed of stainless steel and prevent the door (main or police) from sagging. Hinges for the main and police doors must be 14 gauge and be located on the right side (viewed from the front).

Type 3 and larger cabinets must be furnished with a three point draw roller latching system consisting of the following latching points:

1. Center of the cabinet (lock)
2. Top of the cabinet--controlled by the door handle
3. Bottom of the cabinet--controlled by the door handle

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Type 3 and larger cabinets must be furnished with a door stop which retains the main door open in a 90 degree and 120 degree position.

995-11.2.5 Police and Service Panels: Provide a police service panel with Type 3 and larger cabinets. The panels may be constructed of either sheet aluminum or cast aluminum. Locate the police panel behind the police door attached to the main door. The service panel must be mounted on the back side of the police panel. The police panel must have the following minimum dimensions:

1. Height – 4 inches
2. Width – 8 inches
3. Depth – 2-1/2 inches

995-11.2.6 Ventilation: Type 1 and 2 cabinets must be vented to allow dissipation of the heat generated by the equipment housed inside the cabinet.

Type 3 and larger cabinets must have dual, UL listed, thermostatically controlled fans, rated for continuous duty with a service life of at least 3 years. Mount thermostats on the inside top of the cabinet. Thermostats must be user adjustable to allow temperature settings ranging from a minimum of 70°F to a maximum of 140°F and capable of activating the fans within plus or minus 5 degrees of the set temperature. The intake vent must be rain tight, located on the bottom half of the cabinet, and covered with a removable filter.

995-11.2.7 Shelves: Type 2 cabinets must be furnished with one shelf. Type 3 and larger cabinets must be furnished with two adjustable shelves. Shelves must be adjustable in a maximum of 2-inch increments from the top of the load panel to 12 inches from the top of the controller cabinet.

995-11.2.8 Mounting Hardware: Type 1, 2, and 3 cabinets must be supplied with hardware for attaching the top and bottom half of the cabinet onto a flat or round surface. Optional wall or pole mount hardware must be provided for mounting Type 4 cabinets in specific installations.

Type 4 cabinets must have rigid tabs attached to the bottom of the cabinet. Type 5 cabinets must have rigid brackets attached to the bottom of the cabinet. Rigid brackets and tabs must be constructed of the same material used for the cabinet.

Type 4 and larger cabinets must be provided with one of the following alternatives for fastening to a concrete base:

1. Galvanized anchor bolts, nuts, lock washers, and flat washers in accordance with ASTM A153. The anchor bolts must be at least 1/2 inch in diameter, seven inches in vertical length with at least three inch horizontal, or

2. Heavy duty machine bolt anchors, flat washers, lock washers and machine screws with at least 1/2 inch thread diameter.

995-11.2.9 Electrical: Fabricate ground busbars of copper or aluminum alloy material compatible with copper wire and provide at least two positions where No. 2 AWG stranded copper wire can be attached.

Mount a ground busbar on the side of the cabinet wall adjacent to the power panel for the connection of AC neutral wires and chassis ground wires.

If more than one ground busbar is used in a cabinet, a minimum of a No. 10 AWG copper wire must be used to interconnect them.

995-11.2.9.1 Wiring: All wiring must be laced. All conductors in the cabinet must be stranded copper.

All inputs and outputs must be terminated on terminal strips. A connector harnesses for the controller, conflict monitor, vehicle detectors, and other controller accessory equipment must be furnished and wired into the cabinet circuitry.

A vehicle detector harness or rack must be furnished with the cabinet. Terminal strip circuits must be provided for connection of the loop lead-in cable.

995-11.2.9.2 Terminal Strips: The voltage and current rating of terminal strips must be greater than the voltage and current rating of the wire which is terminated on the terminal strip.

Conductors must be terminated on terminal strips with insulated terminal lugs. A calibrated ratchet crimping tool must be used to terminate the conductor in the terminal lug.

When two or more conductors are terminated on field wiring terminal strip screws, a terminal ring lug shall be used for termination of those conductors. All terminal strip circuits must be numbered.

995-11.2.9.3 Cabinet Light and Receptacle: For Type 3 and larger cabinets, provide one or more light fixtures that illuminate the entire interior of the cabinet. All lighting fixtures must automatically turn on when the cabinet doors are opened and off when the doors are closed.

Mount and wire a three-wire 115 V_{AC} duplex receptacle in all cabinets. The receptacle must be protected by a 15A circuit breaker. Do not mount the receptacle on the main cabinet door or police and service switch panels.

995-11.2.9.4 Main Circuit Breaker: Provide a 15A circuit breaker with Type 1 and 2 cabinets, and a 30A circuit breaker with Type 3 and larger cabinets.

The main circuit breaker must turn off all power to the cabinet and shall not be used for the power switch located in the service panel.

995-11.2.9.5 Radio Interference Suppression: A radio interference suppressor must be provided in series with the AC power before it is distributed to any equipment inside the cabinet. The suppressor must provide a minimum attenuation of 50 decibels over a frequency range of 200 kHz to 75 MHz when used with normal installations and shall be hermetically sealed in a metal case.

The radio interference suppressor must have the same minimum current rating as the main circuit breaker.

The ground connection of the radio interference suppressor must be connected only to AC neutral and shall not be connected to earth ground directly.

995-11.2.9.6 Optically Isolated Inputs: The Opto common input is the common reference pin for four optically isolated inputs.

The Opto inputs are intended to provide optical isolation for pedestrian detector and remote interconnect inputs. The Opto inputs are intended to connect through external 27 K ohm, 1 W resistors for 120 V_{AC} operation and are intended for direct connection to 12 V_{AC} from the cabinet power supply for pedestrian detector applications. These inputs may alternatively be used for low-true DC applications when the Opto common pin is connected to the 24 V supply.

The Opto inputs shall provide electrical isolation of 10 megohms minimum resistance and 1000 V_{AC} RMS minimum breakdown to all connector pins except the Opto common pin. These inputs shall exhibit nominal impedance to the Opto common pin of 5 K ohm, plus or minus 10 percent, and shall require 2.4 mA, plus or minus 10 percent, from a nominal 12 V_{AC} supply. The Opto inputs shall not recognize 3 V_{AC} RMS or less relative to the common input and recognize 6 V_{AC} RMS or more relative to the common input. Any steady state voltage applied between an Opto input and the Opto common shall not exceed 35 V_{AC} RMS. Opto inputs shall not be acknowledged when active for 25 ms or less, and shall be acknowledged when active for 50 ms or more.

995-11.2.9.7 Load Resistors: A load resistor or capacitor must be installed between the AC (common) and each signal field wiring terminal for the yellow, green and walk indication. All load resistors and capacitors must be on the front side of any panel used in the cabinet.

995-11.2.9.8 Surge Protection: Furnish surge protective devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet. Cabinets utilizing Din rail mounted SPDs must be grounded with a conductor to the cabinet busbar.

The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker.

SPDs for signal and interconnect cable field wiring terminals must meet the following:

1. Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.
2. Withstand a surge current of 1000A with an 8 by 20 µs waveform six times (at 1 second intervals between surges) without damage to the suppressor.

SPDs for loop lead-in cables must be designed in accordance with the following requirements:

1. Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges.
2. Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges.
3. Withstand repetitive 400A surges with an 8 by 20 µs waveform without damage.

SPDs must be installed according to the SPD manufacturer's instructions and not affect the operation of detectors. SPD leads must be kept as short as possible.

SUBARTICLE 995-11.3 is deleted and the following substituted:

995-11.3 Type 170 Traffic Signal Controller Cabinets: Provide Type 170 traffic signal controller cabinets with all terminals and facilities necessary for traffic signal control and meeting the following requirements:

Model 332, 334 and 336S Cabinets…….CALTRANS TEES

Model 336S cabinet must incorporate input surge protection mounted on a fold-down termination panel at the input file.

Model 332 cabinets must incorporate a lower input termination panel. Model 332 and 334 cabinets must be base mounted. The Model 332 cabinet must have an auxiliary MODEL 420 output file, and be configured for 8 vehicle, 4 pedestrian, and 4 overlaps.

Model 552A designation is given to Model 332 cabinet assemblies that include a swing-out EIA 19-inch rack cage.

Model 662 designation is given to Model 552A cabinets with a 66 inch height.

Cabinets must comply with figures for traffic control signals and devices available on the Department's State Traffic Engineering and Operations Office website at the following URL:
https://www.fdot.gov/traffic/Traf_Sys/Product-Specifications.shtm.

All terminals and facilities on panels must be clearly identified using permanent silk-screened text.

995-11.3.1 Base Plate and Mounting Brackets: Provide cabinets with a standard base mounting bolt pattern and a minimum of two aluminum plates welded inside for anchoring to a concrete or composite base.

995-11.3.2 Output File: Fabricate the output file using a "hard wired" harness. Printed board circuit boards are not acceptable.

995-11.3.3 Shelf: Provide an aluminum shelf with storage compartment in the rack below the controller (for remote secondary monitor/lap top computer use). The storage compartment must have telescoping drawer guides for full extension. The compartment top must have a non-slip plastic laminate attached. Provide an RS-232 connector for communications to the C2S port.

995-11.3.4 Loads: Provide dummy loads consisting of 4.7k resistors rated at five watts minimum for Greens, Peds, and Yellows. The dummy loads must be mounted on a terminal block in the rear of the output file or other approved location. Wire one side of each dummy load to AC return in a manner that allows a technician to easily attach the load to outputs from selected load switches.

995-11.3.5 Cabinet Light: Provide one or more light fixtures that illuminate the entire interior of the cabinet. All lighting fixtures must automatically turn on when the cabinet doors are opened and off when the doors are closed.

995-11.3.6 Surge Protection: Provide each cabinet with devices to protect equipment from surges. Surge protector termination panels must be attached to the cabinet rack assembly and allow sufficient space for connections, access, and surge protector replacement.

AC isolation terminals must be on the same side of the cabinet as the AC service inputs. DC terminals and loop detector terminals must be installed on the opposite side of the cabinet from the AC power lines.

Surge protection for 332A cabinets must be mounted on the lower input termination panel.

Surge protection for 336S cabinets must be mounted on a custom fold down termination panel at the input file.

Under no circumstance (normal operation or short-circuit condition) shall the amperage capacity of the internal wiring and printed circuit board traces be less than the protecting threshold of circuit breakers and surge protectors provided.

995-11.3.6.1 Power Distribution Assembly Protection: The power distribution assembly (PDA) SPD must be a two-stage series/parallel device that meets or exceeds the following:

1. Maximum AC line voltage: 140 V_{AC}
2. 20 pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20kA.
3. The protector must include the following terminals:
    a. Main line (AC Line first stage terminal)
    b. Main Neutral (AC Neutral input terminals)
    c. Equipment Line Out (AC Line second stage output terminal, 10A)
    d. Equipment Neutral Out (Neutral terminal to protected equipment)
    e. Ground (Earth connection)
4. The main AC line in and the equipment line outer terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10A AC service
5. The first stage clamp shall be between Main Line and ground terminals
6. The second stage clamp shall be between Equipment Line Out and Equipment Neutral
7. The protector for the first and second stage clamp must have a metal oxide varistor (MOV) or similar solid state device, rated 20 kA.

The main neutral and equipment neutral output shall be connected together internally and shall have an MOV (or similar solid state device, or gas discharge tubes) rated at 20 kA between main neutral and ground terminals.

The PDA SPD must have a peak clamp voltage of 250V at 20 kA (voltage measured between equipment line out and equipment neutral out terminals, current applied between main line and ground terminals with ground and main neutral terminals externally tied together).

The PDA SPD must have a maximum let through voltage not exceeding 500 Vpk using an 8 by 20 µs/1.2 by 50 µs; 6 kV, 3 kA surge. The SPD must either be epoxy-encapsulated in a flame retardant material or utilize thermally protected varistors and be designed for continuous service current of 10A at 120 V_{AC} RMS. Power to the Type 170E controller and to the 24V power supply must be provided from the equipment line out terminal of the PDA SPD.

995-11.3.6.2 Inductive Loop Detector Protection: Protect each inductive loop detector input channel with an external SPD that meets or exceeds the following:

1. The SPD must be a three-terminal device, two of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.

2.The SPD must instantly clamp differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array shall be designed to appear as a very low capacitance to the detector.

3. The SPD must clamp common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.

4. Peak Surge Current
    a. Differential Mode: 400A (8 by 20 µs)
    b. Common Mode: 1000A (8 by 20 µs)
    c. Estimated Occurrences: 500 @ 200A
5. Response Time: 40 ns
6. Input Capacitance 35 pF typical
7. Clamp Voltage
    a. 30V max @ 400A (Differential Mode)
    b. 30V max @1000A (Common Mode)

995-11.3.6.3 Signal Load Switch Protection: The outputs of each load switch in the output file shall be provided with a MOV connected from the AC positive field terminal to the chassis ground. The MOV must be rated 150 V_{AC} and shall be a V150LA20A (or approved equal).

995-11.3.6.4 Communication Input Protection: Each low voltage communication input must be protected as it enters the cabinet with a hybrid two-stage SPD that meets or exceeds the following:

1. The SPD must be a dual pair (four-wire) module with a double-sided, gold-plated printed circuit board connector.

2. The SPD must be installed in a ten-circuit card edge terminal block (PCB1B10A).

3. The SPD must be utilized as two independent signal pairs. The data circuits must pass through the SPD in a serial fashion.

4. Peak Surge Current
    a. 10kA (8 by 20 µs)
    b. Occurrences at 2000A: greater than 100
5. Response Time: less than 1 ns
6. Clamp Voltage: 30V maximum
7. Series Resistance: greater than 15 ohms per line
8. Primary Protector: 3 element gas tube
9. Secondary Protector: Solid state clamp (1.5 kW minimum)

The line side of the SPD must be connected to the communication field wires, the load side connected to the communication connector of the controller, and the ground terminal connected to chassis ground.

995-11.3.6.5 Low Voltage DC input protection: Each DC input must be protected by an SPD that meets or exceeds the following:

1. The SPD must be a 5 terminal device. Two terminals must be connected to the line side of the low voltage pair, two terminals must be connected to the input file side, and the fifth terminal connected to chassis ground.

2.Peak Surge Current

2 kA (8 by 20 µs)

Occurrences at peak current: 100 (typical)

3. Response Time: 5-30 ns

4. Shock: Must withstand 10-foot drop on concrete

5. Clamp Voltage: 30V

6. Series Resistance: greater than 15 ohms each conductor

995-11.3.6.6 Preemption and 115V AC signal input protection: Each preemption or AC signaling input channel must be protected by an external SPD that meets or exceeds the following requirements:

1. The SPD must be a 3 terminal device

2. Peak Surge Current

2000A (8 b 20 µs)

Occurrences at peak current: 25 (minimum)

3. Response Time: less than 200 ns

4. Peak Surge Trip Point: less than 890V nominal

995-11.3.7 Red Monitor Harness: A connector and terminal assembly designated as P20 for monitoring the absence of red, shall be an integral part of the output file. The connector must terminate, and be compatible with, the cable and connector of a Type 170 conflict monitor unit (CMU), capable of monitoring the absence of red. Provide the pin assignments of the P20 connector and terminal assembly with the cabinet plans. The P20 connector shall be physically like the cable and connector of a Type 170 CMU to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

995-11.3.7.1 Programming of Unused Red Channels: Provide all cabinet assemblies with a means of programming unused red channels by installing jumpers from red monitor inputs to 115 V_{AC}. The connecting terminals for the jumpers must be accessible and located in the same terminal block for all 16 channels to assure full compatibility of all cabinet assemblies with "210 Plus" conflict monitor units.

995-11.3.8 Police Door and Panel: Provide cabinets with police doors and panels. The police panel must include text informing officers that yellow and all-red clearance intervals are timed internally.

Police switch panels must include a manual jack. The jack must mate with a three circuit, 1/4-inch diameter phone plug. Connect the tip and ring (middle) circuits of the jack to the logic ground and the interval advance inputs of controller unit. When the manual hand cord is plugged into the jack and the pushbutton is pressed, logic ground must be connected to the interval advance input of the controller unit.

The pushbutton cord must have a minimum length of six feet with a 1/4-inch diameter three circuit plug connected to one end and a hand held manual pushbutton at the other end. With the exception of the vehicular yellow and all red clearance intervals, a complete cycle (push-release) of the manual pushbutton shall terminate the controller unit interval that is active. Cycling the push-button during the vehicular yellow or all red clearance intervals must not terminate the timing of those intervals.

995-11.3.9 Technician Service Panel: Provide cabinets with a technician service panel which is mounted on the back side of the police panel (inside the main cabinet front door).

There must be two switches located on the technician service panel, clearly labeled according to the following functions:

(a) UCF – This toggle switch shall:

Place the intersection into Flashing Operation.

After meeting requirements for Flashing Operations, all power shall be removed immediately from signal load switches.

(b) Signal On/Off – This toggle switch shall disconnect all power to the signal lights through the use of a 60A contact switch placed in series with the load switch packs.

Labels must be silk screened directly on the panel.

995-11.3.10 Swing-out Rack Assembly: Provide 552-A cabinets with a pullout and rotatable rack assembly as well as an interface panel mounted on the top of the rack assembly and attached to the top shelf. The rack assembly must be constructed to house components designed to be installed in a standard EIA 19-inch rack and shall house the Controller, Input File, Output File No. 1, PDA No. 2, and a storage compartment.

Construct the rack and slide/hinged mounting brackets so that when the rack assembly (fully loaded) can be pulled out with one hand with complete ease of operation including rotation of the assembly.

The rack assembly must have a spring-loaded latch mechanism to secure the rack assembly inside the cabinet while in the "rest" position. When pulled out of the cabinet at any point from its resting position (inside cabinet) to its full extension and rotation, the fully loaded rack assembly shall not cause any member of the assembly to bend, warp or bind. The rack must be made of one-inch square aluminum tubing with welded joints and extend and retract smoothly without noticeable friction or stress on roller guides, extension brackets, or other mechanical components. Maximum deflection of the entire rack assembly (with all equipment installed) shall not exceed 1/8 inch.

The rack assembly must have 12 technician test switches mounted to the interface frame assembly. Technician test switches must be of the momentary type and shall have eight vehicle and four pedestrian inputs.

The front of the rack assembly must be tapped with 10-30 threads with EIA universal spacing for 19-inch electrical equipment racks.

The rack assembly must be attached to the left cabinet wall through combination slide/hinged mounting brackets.

The slide/hinged mounting brackets must be fabricated from aluminum and/or stainless steel only.

Mounting bracket guides must utilize 7/8-inch stainless steel ball bearing rollers and allow extension and retraction of a loaded rack with minimal effort.

The rack assembly must be capable of rotating 210 degrees from its rest position after full extension from the cabinet.

The rack assembly must have a minimum 7/16-inch diameter aluminum rack stop rod attached to the inside left cabinet wall from the left side of the rack assembly to lock the rack into final position.

All cabinet harnesses must be long enough to maintain cabinet connections and functionality when the rack assembly is fully extended and rotated to its

maximum limit. Harnesses must not bind or crimp when the rack is fully retracted, extended, or in motion.

995-11.3.11 Service Panels for 552A: The 552A cabinet must include a field service panel, auxiliary field service panel, and interface panel, all constructed of aluminum with a 1/8-inch minimum thickness. All components must be accessible from the front of the panels. Do not mount components or attach wires behind panels.

995-11.3.11.1 Field Service Panel: The field service panel must consist of terminal strips, circuit breakers, transient protection devices, load resistors, capacitors, cable tie mounts and associated wiring for making all field wiring connections. Mount the field service panel in the cabinet on the lower right exterior cabinet wall.

The field service panel must provide the necessary interconnecting junction points between the rack assembly and cabinet for the field service wires. The panel must be grouped for internal connections (jumpers) between terminals boards, wiring from the panel to the rack assembly, and wiring from the panel to the cabinet.

The field service panel wiring harness must have flexible wire covered by a flexible non-metallic conduit from the field service panel to the PDA, output file, and interface panel. The harness must have a metal clamp with a rubber grommet center attached to the field service panel to secure the harness to the panel for proper orientation of the harness with the rack assembly. Terminal strips for the panel shall be as listed below:

1. TBS1 - Terminal Block, Deadfront type, 3 position, No. 4 to No. 14 AWG wire range, 70A, 600V.
2. TBS2 - Terminal Block, Barrier, 16 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V.
3. TBS3 - Terminal Block, Barrier, 20 position, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No 16 AWG (max), 15A, 250V.
4. TBS4 &TBS5 - Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

The panel must have a main cabinet circuit breaker rated at 30A and a cabinet accessory circuit breaker rated at 15A for cabinet fans and light. Mount the circuit breakers near the back cabinet door on the panel.

The panel must include load resistors for all Walk, Green, Green Arrow, Yellow and Yellow Arrow Switch Pack outputs to prevent the conflict-voltage monitor from going into "Flash" due to a failed signal lamp. Load resistors must be 2K, 10 watt.

MOVs must be physically tied to one side of each terminal on TBS4 and TBS5 and be physically secured to the field service panel with a 6-32 screw.

995-11.3.11.2 Auxiliary Field Service Panel: The auxiliary field service panel must be mounted on the lower left interior cabinet wall and consist of a minimum of four terminal strips, 18 detector surge protectors and one pedestrian button isolation board assembly. The 18 surge protectors must be a three-terminal device, two of which are connected across the signal inputs of the detector for differential mode protection and the third terminal is grounded to protect against common mode damage. Mount the pedestrian button isolation board on the auxiliary field service panel. Terminal strips for the panel shall be Terminal Block, Barrier, 12 position, .438 Density, 6-32 x 1/4 BH Screw, Open Bottom, Double Row, No. 14 AWG (max), 20A, 250V.

Install a four-button pedestrian isolation board on the auxiliary field service panel to provide for the connection of the pedestrian buttons on phases 2, 4, 6 and 8. The board must provide electrical isolation of the field wiring to the internal cabinet wiring. The inputs to this isolation board shall be wired to terminal block TBA5 for connection to field wiring. The outputs of this board shall be carried through the harness to the input file to the proper wires that go to the interface extension panel of the controller.

The pedestrian button isolation board must include a PC board mounted on an aluminum panel with the following minimum dimensions:

Height: 2 inches
Width: 8 inches
Thickness: 1/8 to 3/16 inch

995-11.3.11.3 Interface Panel: The interface panel must consist of eight terminal strips, one telephone line suppressor and mounting fixture, two 24 V_{DC} relays and mounting fixtures, and all associated wiring for connecting the required interface equipment modules.

The front of the panel must be covered by a 1/4-inch clear plexiglass sheet, supported from the panel by four 1-1/2 inch standoffs. Secure the panels and cover using wing nuts that are removable without the use of tools. The plexiglass cover shall have 1/2-inch slot, centered over each of the terminal strips. All covers and panels must be interchangeable.

The panel wiring must provide the necessary interconnecting junction points between interface equipment cable harnesses and controller cabinet input and output signal. The panel wiring provides the functional wiring information for connecting the interface equipment in the cabinet.

The panel wiring must be grouped for internal connections (jumpers between terminal boards) as well as wiring from the controller and related cabinet functions to the terminal boards on the interface panel.

Ground wires must be No. 14 AWG wire, minimum. The internal harnesses must be located between TB1, TB2 and TB3. The external and internal wiring must be located outside of TB1 and TB4, between TB2 and TB3.

Terminal strips shall be Barrier type, .375 Density, 5-40 x 3/16 BH Screw, Open Bottom, Double Row, No. 16 AWG (max), 15A, 250V. Terminals must use nickel/cadmium plated brass screws. All terminals and facilities on panels must be clearly identified using permanent silk-screened

The K1P and K2F relays shall be 15A miniature relays with polycarbonate cover, 2 form C (CO) contact arrangement, DC coil input, socket mount, .187 inch quick connect/solder terminals, AgCdO (15A) contacts, and 24 V_{AC} coil voltage with matching socket and hold down spring. All screws on the relay socket must be brass with nickel/cadmium plating.

995-11.3.12 Storage Compartment: Mount an aluminum storage compartment in the rack assembly. The storage compartment must have telescoping drawer guides for full extension of drawer from rack assembly and have a continuous front lip for opening the compartment top for storage. The top of the compartment must be non-slip plastic laminate.

Install a communication port on the right hand side of the drawer at the front for connecting to the communications port of the controller unit via the cabinet harness.

995-11.3.13 Cabinet Rails: Provide the cabinet with four cabinet rails for mounting wiring panels and various brackets. Rails must be keyhole design with slots 2 inches on center with a top opening diameter of 5/8 inch to allow the insertion of a 5/8 inch by 1 inch carriage bolt. The rails must be approximately 1-1/2 to 2 inches wide by 1/2 inch deep. Do not use unistruts or other rails.

995-11.3.14 Electrical: Do not use printed circuit boards in any controller cabinet subsystem file or panel, including but not limited to the output file (except for the red monitor program board), service panel, interface panel, and input file.

995-11.3.14.1 Wiring: Cut all wires to the proper length and neatly laced into cables with nylon lacing. No wire shall be doubled back to take up slack. Cables in the cabinet must not interfere with the routing and connection of field wiring. Cables must be secured with nylon cable clamps, unless specified otherwise. The position of cables between the components must be such that when the door is closed, it does not press against the cables or force the cables against the various components inside the controller cabinet.

Fabricate ground busbars of a copper or aluminum alloy material compatible with copper wire and provide at least two positions where a No. 2 AWG stranded copper wire can be attached. Mount a 6 inch ground busbar with screw terminals on the bottom flange on each side of the cabinet for connection of AC neutral wires and chassis ground. Attach a flexible ground strap between the left side ground busbar and the left side bottom rear of the rack assembly. Wiring harnesses must be covered by a flexible non-metallic conduit. Panel wire size must be a minimum of No. 18 AWG unless otherwise specified.

995-11.3.14.2 Terminals: Terminal connections must be soldered or constructed using a calibrated ratchet type crimping tool. Wiring must be traceable and without entanglement.

SUBARTICLE 995-11.5.2 is deleted and the following substituted:

995-11.5.2 Latches: Provide all cabinets with a three-point draw roller latching system for the doors. The latching system must have the following latching points.

1. Center of the cabinet (lock).
2. Top of the cabinet – controlled by the door handle.
3. Bottom of the cabinet – controlled by the door handle.

The latching points on the top and bottom of the cabinet must remain in the locked position until the main cabinet door lock is unlocked. The locking mechanism must be equipped with nylon rollers to secure the top and bottom of the door.

Provide the cabinet with a door stop that retains the main door open in a 90 degree and 120 degree position.

SUBARTICLE 995-11.5.8 is deleted and the following substituted:

995-11.5.8 Electrical Requirements: SPD's must be accessible from the front of any panel used in the cabinet. Connect the SPD for the cabinet’s main AC power input on the load side of the cabinet circuit breaker. All wiring must be laced. All conductors must be stranded copper.

SUBARTICLE 995-11.7 is deleted and the following substituted:

995-11.7 Small Equipment Enclosures: Small equipment enclosures must be a minimum NEMA 3R rated and smaller than 16 inches wide by 24 inches tall by 12 inches deep. The enclosure must be constructed of aluminum or non-metallic materials. Enclosures must include a safe means of removing power from the installed equipment for servicing and replacement, such as a switch, fuse, or breaker. Discrete markings, such as manufacturer name and model, are permitted on the outside of small enclosures.

All fasteners less than 5/8 inch exposed to the elements must be Type 304 or 316 stainless steel.

Construct aluminum enclosures of 5052 sheet aluminum alloy with a minimum thickness of 0.090 inch. Aluminum enclosures must have a uniform natural finish or be powder coat painted in accordance with AAMA-2603-02 specifications. All welds, bends, and seams must be neatly formed and free of cracks, blow holes and other irregularities. All inside and outside edges of the enclosure must be free of burrs, rivet holes, visible scratches, and gouges and have a smooth, uniform finish.

Non-metallic enclosures must be designed for outdoor use, and resist chemicals, corrosion, and ultraviolet rays.

Enclosure doors must include a vandal resistant hinge and be secured with a locking latch or a minimum of two quick-release Type 304 or 316 stainless steel latches with padlock hasps. Removal of the hinge or hinge pin must not be possible while the enclosure is closed.

Enclosures may be vented. Holes larger than 1/8 inch must be covered by heavy duty screen.

Post mounted enclosures must be supplied with mounting hardware for attaching the enclosure to a 4-1/2 inch (OD) aluminum post.

SUBARTICLE 995-13.2 is deleted and the following substituted:

995-13.2 Environmental Requirements: Ensure system control equipment performs all required functions during and after being subjected to the transients, temperature, voltage, humidity, vibration, and shock tests described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.

SUBARTICLE 995-14.1 is deleted and the following substituted:

995-14.1 General: Illuminated signs must meet the design and functional requirements of the MUTCD. 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 width or be larger than 18.0 square feet 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.

SUBARTICLE 995-14.6 is deleted and the following substituted:

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.

SUBARTICLE 995-15.1 is deleted and the following substituted:

995-15.1 General: Highlighted signs must meet the design and functional requirements 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.

SUBARTICLE 995-15.2 is deleted and the following substituted:

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 and batteries must be capable of at least 10 days of continuous operation without the need for charging.

SUBARTICLE 995-15.6 is deleted and the following substituted:

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.

ARTICLE 995-16 is deleted and the following substituted:

995-16 Dynamic Message Signs.

995-16.1 General: Dynamic message signs (DMS) must meet the requirements of the MUTCD and NEMA TS4. 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, Section 3.2.6.

995-16.1.2 Walk-In DMS: Walk-in signs must meet the requirements of NEMA TS 4, 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, 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, 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 width 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, 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, 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, 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, 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, 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, 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, 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, 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, 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, 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, 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_{AC} must be provided. The DMS must meet the requirements of NEMA TS 4, Section 10.2.

All 120 V_{AC} 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:

Table 995-9 Operational Support Supplies	
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, 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, 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, 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, display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, EIA-232 null modem cables (minimum of 4 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 4 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, 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, 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 document 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, Section 2.

995-16.13 Warranty: The DMS system and equipment must have a manufacturer's warranty covering defects for a minimum of 5 years from the date of final acceptance.

SUBARTICLE 995-17.2.15 is deleted and the following substituted:

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, 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.

SUBARTICLE 995-17.3.2 is deleted and the following substituted:

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 1 mph and then activate the display. 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_{DC} 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 speeds of approaching traffic only between 10 and 99 mph with an accuracy of plus or minus 1 mph, 1,000 feet in advance of the sign.

SUBARTICLE 995-17.4.1 is deleted and the following substituted:

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 2 hours in the event of utility power loss. Operation on battery backup can have no visible effect on the appearance of the display.

SUBARTICLE 995-17.4.2 is deleted and the following substituted:

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 5 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.

SUBARTICLE 995-17.6.1 is deleted and the following substituted:

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. When no advancing traffic is detected, the display must be blank. The speed detector must not 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_{DC}. 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.

SUBARTICLE 995-18.1 is deleted and the following substituted:

995-18.1 General: Flashing beacon assemblies incorporating a circular traffic signal must meet the design and functional requirements set forth in the MUTCD. 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.

SUBARTICLE 995-18.4 is deleted and the following substituted:

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, Section 2. All electronic equipment must comply with FCC Title 47 Subpart B Section 15.